

CALIFORNIA BUILDING CODE

**California Code of Regulations
Title 24, Part 2, Volume 2 of 2**

Based on the 2012 International Building Code®

2013 California Historical Building Code, Title 24, Part 8

2013 California Existing Building Code, Title 24, Part 10

Based on the 2012 International Existing Building Code®

California Building Standards Commission



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California Code of Regulations, Title 24, Volume 2 of Part 2

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PREFACE

This document is Part 2 of 12 parts of the official triennial compilation and publication of the adoptions, amendments and repeal of administrative regulations to *California Code of Regulations, Title 24*, also referred to as the *California Building Standards Code*. This part is known as the *California Building Code*.

The *California Building Standards Code* is published in its entirety every three years by order of the California legislature, with supplements published in intervening years. The California legislature delegated authority to various state agencies, boards, commissions and departments to create building regulations to implement the state's statutes. These building regulations, or standards, have the same force of law, and take effect 180 days after their publication unless otherwise stipulated. The *California Building Standards Code* applies to occupancies in the State of California as annotated.

A city, county, or city and county may establish more restrictive building standards reasonably necessary because of local climatic, geological or topographical conditions. Findings of the local condition(s) and the adopted local building standard(s) must be filed with the California Building Standards Commission to become effective and may not be effective sooner than the effective date of this edition of the *California Building Standards Code*. Local building standards that were adopted and applicable to previous editions of the *California Building Standards Code* do not apply to this edition without appropriate adoption and the required filing.

Should you find publication (e.g., typographical) errors or inconsistencies in this code or wish to offer comments toward improving its format, please address your comments to:

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This collaborative effort included the assistance of the Commission's Code Advisory Committees and many other volunteers who worked tirelessly to assist the Commission in the production of this Code.

Governor Edmund G. Brown Jr.

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For questions on California state agency amendments, please refer to the contact list on the following page.

CALIFORNIA CODE OF REGULATIONS, TITLE 24

California Agency Information Contact List

Board of State and Community Corrections

www.bscc.ca.gov (916) 445 5073
Local Adult Jail Standards
Local Juvenile Facility Standards

California Building Standards Commission

www.bsc.ca.gov (916) 263 0916

California Energy Commission

www.energy.ca.gov Energy Hotline (800) 772 3300
Building Efficiency Standards
Appliance Efficiency Standards
Compliance Manual/Forms

California State Lands Commission

www.slc.ca.gov (562) 499-6312
Marine Oil Terminals

California State Library

www.library.ca.gov (916) 654-0266

Department of Consumer Affairs:

Acupuncture Board
www.acupuncture.ca.gov (916) 515 5200
Office Standards

Board of Pharmacy
www.pharmacy.ca.gov (916) 574-7900
Pharmacy Standards

Bureau of Barbering and Cosmetology
www.barbercosmo.ca.gov (916) 952 5210
Barber and Beauty Shop,
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**Bureau of Electronic and Appliance Repair,
Home Furnishings and Thermal Insulation**
www.bearhti.ca.gov (916) 999 2041
Insulation Testing Standards

Structural Pest Control Board
www.pestboard.ca.gov (800) 737-8188
Structural Standards

Veterinary Medical Board
www.vmb.ca.gov (916) 263 2610
Veterinary Hospital Standards

Department of Food and Agriculture

www.cdfa.ca.gov
Meat & Poultry Packing Plant Standards (916) 654-0509
Dairy Standards (916) 654-0773

Department of Housing and Community Development

www.hcd.ca.gov (916) 445 9471
Residential - Hotels, Motels, Apartments,
Single Family Dwellings; and
Permanent Structures in Mobilehome &
Special Occupancy Parks

(916) 445-3338
Factory Built Housing, Manufactured Housing &
Commercial Modular

Mobilehome Permits & Inspections
Northern Region-(916) 255 2501
Southern Region-(951) 782 4420

(916) 445-9471
Employee Housing Standards

Department of Public Health

www.dph.ca.gov (916) 449 5661
Organized Camps Standards
Public Swimming Pools Standards

Division of the State Architect

www.dgs.ca.gov/dsa (916) 445 8100
Access Compliance
Structural Safety
Public Schools Standards
Essential Services Building Standards
Community College Standards

State Historical Building Safety Board

Alternative Building Standards

Office of Statewide Health Planning and Development

www.oshpd.ca.gov (916) 440 8356
Hospital Standards
Skilled Nursing Facility Standards &
Clinic Standards
Permits

Office of the State Fire Marshal

osfm.fire.ca.gov (916) 445 8200
Code Development and Analysis
Fire Safety Standards

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate a technical change from the requirements of the 2009 edition. Deletion indicators in the form of an arrow (➡) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.

Symbols in the margin indicate the status of code changes as follows:

- || This symbol indicates that a change has been made to a California amendment.
- > This symbol indicates deletion of California amendment language.
- | This symbol indicates that a change has been made to International Code Council model language.
- ➡ This symbol indicates deletion of International Code Council model language.

A single asterisk [*] placed in the margin indicates that text or a table has been relocated within the code. A double asterisk [**] placed in the margin indicates that the text or table immediately following it has been relocated there from elsewhere in the code. The following table indicates such relocations in the 2012 edition of the *International Building Code*.

| 2012 LOCATION | 2009 LOCATION |
|--------------------------|------------------------------|
| 407.4 | 1014.2 |
| 410.6 | 1015.6 |
| 424 | 402.6.3 |
| 712.1 | 708.1 |
| 712.1.2 | 708.2, Exception 1 |
| 712.1.3 | 708.2, Exception 2 |
| 712.1.3.1 | 708.2, Exception 2.1 |
| 712.1.3.2 | 708.2, Exception 2.2 |
| 712.1.4 | 708.2, Exception 3 |
| 712.1.5 | 708.2, Exception 4 |
| 712.1.6 | 708.2, Exception 5 |
| 712.1.7 | 708.2, Exception 6 |
| 712.1.8 | 708.2, Exception 7 |
| 712.1.9 | 708.2, Exception 8 |
| 712.1.10 | 708.2, Exception 9 |
| 712.1.11 | 708.2, Exception 10 |
| 712.1.12 | 708.2, Exception 11 |
| 712.1.13 | 708.2, Exception 12 |
| 712.1.14 | 708.2, Exception 13 |
| 712.1.15 | 708.2, Exception 14 |
| 712.1.16 | 708.2, Exception 15 |
| 712.1.18 | 708.2, Exception 16 |
| 713.3 through 713.14.1.1 | 708.3 through 708.14.1.1 |
| 909.21 through 909.21.11 | 708.14.2 through 708.14.2.11 |
| 1004.1.1.2 | 1004.6 |
| 1008.1.9.8 | 1008.1.4.4 |
| 1013.8 | 1405.13.2 |
| 1028.10.1 | 1017.4 |

| <i>continued</i> | |
|------------------|---------------|
| 2012 LOCATION | 2009 LOCATION |
| 1028.10.1.1 | 1017.4.1 |
| 1028.10.1.1 | 1017.4.2 |
| 1028.10.1.2 | 1017.4.3 |
| 1210.3.1 | 2903.1 |
| 1210.3.2 | 2903.2 |
| 1406.2.1 | 1406.2.1.1 |
| 1406.2.2 | 1406.2.1 |
| 1607.6 | 1605.4 |
| 1704.3 | 1705.1 |
| 1704.4 | 1709.1 |
| 1704.5 | 1710.1 |
| 1705.1.1 | 1704.15 |
| 1705.4.2 | 1704.11 |
| 1705.10 | 1706.1 |
| 1705.11 | 1707.1 |
| 1705.12 | 1708.1 |
| 3313.1 | 3311.4 |

Code Development Committee Responsibilities (Letter Designations in Front of Section Numbers)

In each code development cycle, proposed changes to the code are considered at the Code Development Hearings by the applicable International Building Code Development Committee (IBC-Fire Safety, General, Means of Egress or Structural). Proposed changes to a code section that has a number beginning with a letter in brackets are considered by a different code development committee. For example, proposed changes to code sections that have [F] in front of them (e.g., [F] 903.1.1.1) are considered by the International Fire Code Development Committee during the portion of the code development hearings when the International Fire Code Development Committee meets.

The content of sections in this code that begin with a letter designation is maintained by another code development committee in accordance with the following:

- [A] Administrative Code Development Committee;
- [E] International Energy Conservation Code Development Committee (Commercial Energy Committee or Residential Energy Committee, as applicable);
- [EB] International Existing Building Code Development Committee;
- [F] International Fire Code Development Committee;
- [FG] International Fuel Gas Code Development Committee;
- [M] = International Mechanical Code Development Committee; and
- [P] = International Plumbing Code Development Committee.

EFFECTIVE USE OF THE IBC/CBC

Distilling the code review process down to a methodical, sequential list of considerations is generally problematic. In many cases, related provisions from various chapters of the code must be considered simultaneously, or reconsidered later in the process to arrive at the correct classification or determination. Any number of acceptable alternatives may exist for construction of the building and its specific features. Each choice provided by the code must be evaluated for its specific impact on other aspects of the building's analysis. With a basic understanding of the interrelationship of the various chapters, the practiced code user will make an initial assessment of the building as a first step of the code review process. The following outline may be helpful as a guide for the effective use of the IBC, with the understanding that final resolution of each step is often dependant on subsequent steps.

The following process begins with a brief discussion of the key administrative areas of the code. The process addressing technical provisions is divided into two distinct areas of analysis, the nonstructural provisions of the IBC and the structural provisions. Although reference is not made to all provisions set forth in the IBC, the process is intended to be representative of an approach to using the IBC in an effective manner.

Administrative Provisions

Prior to any analysis based on the technical provisions of the IBC, it is important that the fundamental administrative aspects of the code be reviewed. It is critical that the basis of technical decisions be consistent with the approach established in IBC Chapter 1, including:

- Scope of the IBC
- Intent of the IBC
- Applicability of the IBC
- Duties and powers of the building official
- Alternate materials, designs and methods of construction

Nonstructural Provisions

1. Classify the building for occupancy and construction type. The first step in analyzing a building for code compliance is its proper classification based on anticipated use(s) and construction features.

Identify the distinct and varied uses of the building. The uses that will occur within the building must be identified, evaluated and classified into one or more of the distinct occupancy classifications established in the IBC. Some buildings will be classified as single-occupancy, where there is only one applicable occupancy classification. Others will be considered as mixed-occupancy due to the presence of two or more uses that are classified into different occupancy groups.

Sec. 302.1 Classify the building into one or more occupancy groups. Although there are 10 general occupancy groups, many of the groups are subdivided into sub-groups to allow for a more exacting analysis of the building under consideration.

| | |
|----------|---------|
| Sec. 303 | Group A |
| Sec. 304 | Group B |
| Sec. 305 | Group E |
| Sec. 306 | Group F |
| Sec. 307 | Group H |
| Sec. 308 | Group I |
| Sec. 309 | Group M |
| Sec. 310 | Group R |
| Sec. 311 | Group S |
| Sec. 312 | Group U |

Identify the building's type of construction based on the materials of construction and degree of fire-resistance for the building's major elements. The primary structural frame, exterior walls, interior walls, floor construction and roof construction, as applicable, must be evaluated in regard to their degree of fire-resistance and materials of construction in order to classify the building based upon type of construction.

Sec. 602.1 Classify the building into a single type of construction. Five general types of construction have been established and further subdivided into nine specific construction types. The classification of construction type is based on a combination of the degree of fire-resistance and the type of materials of the key building elements.

- Sec. 602 Type of construction based on materials of construction
- Table 601 Type of construction based on fire rating of the building elements
- Sec. 603 Combustible materials in Type I and II buildings

Sec. 1505 Verify classification of roof covering. Roof coverings are typically required to provide protection against moderate or light fire exposures from the exterior. Their minimum required classification is based upon the type of construction of the building.

2. Determine if the building is to be fully sprinklered. Many of the code provisions vary based upon the presence of an automatic sprinkler system throughout, or in specific portions of, the building.

Sec. 903.2 Determine if the building requires a fire sprinkler system. Many of the mandates for the installation of a sprinkler system are based upon the occupancy or occupancies that occur within the building. The provisions will often require some degree of occupant load and fire area determination. Other conditions may also trigger a required sprinkler installation, such as building height or the lack of exterior openings.

If a sprinkler system is not required, review for potential code modifications if a sprinkler system is installed. There are a significant number of benefits provided by the code if a sprinkler system is installed. An initial analysis of the building will typically allow for an early determination of the value of such sprinkler benefits, including:

- Sec. 504.2 Story and height increase (reduced type of construction)
- Sec. 506.3 Allowable area increase (reduced type of construction)
- Sec. 507.3 Unlimited area building (reduced type of construction)
- Sec. 1018.1 Elimination of corridor fire-resistance rating

3. Locate the building on the site. The location of the building(s) on the lot is fundamental to the degree of fire exposure to and from adjoining buildings and lots. In addition, the building's location influences the amount of fire department access that can be provided from the exterior of the building.

Sec. 503.1.2 Determine the number of buildings on the site. Where two or more buildings are located on the same lot, they can be evaluated as a single building or multiple buildings. The type of construction requirements may differ based upon which of the two methods is utilized.

Sec. 602.1 Determine minimum required fire rating of exterior walls. The fire separation distance is the measurement used in evaluating the necessary fire rating for exterior walls. It is measured from the building to the lot line, to the center line of a public way, or to an imaginary assumed line between two buildings on the same lot. Projections and parapets, if applicable, are also regulated.

Sec. 704.8 Determine exterior opening protection requirements. Openings in exterior walls are regulated by the fire separation distance and the rating of the exterior wall in which they are located.

Sec. 506.2 Determine frontage increase for allowable area purposes. Utilized primarily for fire department access, open space adjacent to a building's perimeter provides for an increase in the allowable area.

4. Verify building's construction type by determining the allowable building size. The permitted types of construction are primarily based upon the occupancy classifications involved, the building's height and the building's floor area. Other conditions may also affect the appropriate construction types, including the building's location on the lot and the intended materials of construction. In buildings with mixed-occupancy conditions, the methods of addressing the relationship between the multiple occupancies indirectly affect construction type.

Sec. 202 and 502 Calculate actual height of building in both 'feet' and 'stories above grade plane'. The code specifically describes the method for assigning a building height, measure both in the number of feet and the number of stories above grade plane. The actual height must be compared with the allowable height to determine if the building's type of construction is acceptable.

Sec. 504 Determine allowable height permitted for 'feet' and 'stories'

Sec. 505 Determine if mezzanine provisions are applicable

Sec. 504.3 Determine if any rooftop structures are in compliance

Sec. 502 Calculate actual floor area of each story of building. The building area is typically the entire floor area that occurs within the surrounding exterior walls. The building area for each individual story must be calculated, as well as for the building as a whole.

Sec. 507 Determine if building qualifies as an unlimited area building**Sec. 506 Determine allowable area permitted for each story and building as a whole if:**

- Sec. 506 Single-occupancy building
- Sec. 508.2 Multi-occupancy w/accessory occupancies
- Sec. 508.3 Multi-occupancy building w/nonseparated occupancies
- Sec. 508.4 Multi-occupancy building w/separated occupancies
- Sec. 706.1 Use of fire walls

Sec. 509 Determine if special provisions are to be applied for height and/or area. The general requirements for allowable height and area may be modified under limited conditions, typically where a parking garage is located in a building with other occupancies.

5. Identify extent of any special detailed occupancy requirements. Special types of buildings, special uses that occur within buildings, and special elements of a building are further regulated through specific requirements found in Chapter 4. Since these provisions are specific in nature, they apply in lieu of the general requirements found elsewhere in the code.

Chapter 4. Determine special detailed requirements based on occupancy. A number of the special provisions are applicable to a specific occupancy or group of similar occupancies.

- Sec. 402 Covered mall buildings
- Sec. 403 High-rise buildings
- Sec. 404 Atriums
- Sec. 405 Underground buildings
- Sec. 406 Motor-vehicle-related occupancies
- Sec. 407 Group I-2 occupancies
- Sec. 408 Group I-3 occupancies
- Sec. 411 Special amusement buildings
- Sec. 412 Aircraft-related occupancies
- Sec. 415 Group H occupancies
- Sec. 419 Live/work units
- Sec. 420 Groups I-1, R-1, R-2 and R-3
- Sec. 422 Ambulatory health care facilities

Table 508.2.5 Determine if building contains any incidental accessory occupancies. The uses identified in Table 508.5.2 are considered as a portion of the occupancy in which they are located, but special conditions required that they be addressed in a more specific manner.

Sec. 508.2.5 Provide fire separation and/or fire-extinguishing system

6. Identify and evaluate fire and smoke protective elements. Where fire-resistance-rated construction and/or smoke protection is mandated by other provisions of the code, the provisions of Chapter 7 identify the appropriate methods for gaining compliance.

Chapter 7. Verify compliance w/details of fire and smoke resistance. The various elements of fire-resistance-rated and smoke-resistant construction are detailed, including walls, horizontal assemblies, shaft enclosures, including openings such as doors and windows, as well as the penetration of such elements by conduit, ducts, piping and other items.

- Sec. 704 Structural members
- Sec. 707 Fire barriers
- Sec. 709 Fire partitions
- Sec. 710 Smoke barriers
- Sec. 711 Smoke partitions
- Sec. 712 Horizontal assemblies
- Sec. 708 Shaft enclosures
- Sec. 713 Penetrations
- Sec. 714 Joint systems
- Sec. 715 Opening protectives
- Sec. 716 Ducts and air transfer openings

7. Identify additional fire protection systems that may be required. In addition to automatic sprinkler systems, there are several other types of fire protection systems that may be required in a building.

Sec. 907.2. Determine compliance with fire alarm provisions. Fire alarm systems are typically mandated based upon the occupancy classification and the number of occupants.

Sec. 905.3. Determine if standpipe system is required. A standpipe system is required in buildings once a specified height is reached to provide for a more effective means of fighting a fire within the building.

Sec. 905.4.6. Verify location of standpipe hose connections.

8. Identify and evaluate materials utilized as interior floor, wall and ceiling finishes. Finish materials within the building are primarily regulated for flame spread and smoke development characteristics.

Sec. 803.9. Verify compliance of wall and ceiling finishes. Interior wall and ceiling finishes are regulated based upon the occupancy classification of the space and their location within the means of egress system. The classification may typically be reduced where sprinkler protection is provided.

Sec. 804.4. Verify compliance of floor finishes. While regulated differently than wall and ceiling finishes, floor finishes comprised of fibers are also controlled based upon their use in the egress system, the occupancy classification, and the presence of a sprinkler system.

9. Evaluate means of egress system based on anticipated occupant loads. The expected occupant load is the basis for the design of the means of egress system. The egress elements must provide for a direct, continuous, obvious, undiminished and unobstructed path of travel from any occupiable point in the building to the public way.

Sec. 1004. Determine the design occupant load. Although the primary use of an occupant load is in the design of the building's means of egress system, occupant load is also occasionally an important factor in occupancy classification, sprinkler system and fire alarm system requirements, and plumbing fixture counts.

Chapter 10. Verify compliance with means of egress provisions. The means of egress system is intended to provide the primary occupant protection from fire and other hazards. The system consists of two major components, egress components and egress design.

- Sec. 1005.1 Egress width and distribution
- Sec. 1006.3 Emergency lighting
- Sec. 1007 Accessible means of egress
- Sec. 1008.1.2 Door swing
- Sec. 1008.1.9 Door operations
- Sec. 1008.1.10Panic hardware
- Sec. 1009.1 Stairway width
- Sec. 1009.4 Stairway treads and risers
- Sec. 1011 Exit signs
- Sec. 1012 Stairway and ramp handrails
- Sec. 1013 Guards
- Sec. 1014.2 Egress through intervening spaces
- Sec. 1014.3 Common path of egress travel
- Sec. 1015.1 Number of exit or exit access doorways
- Sec. 1015.2 Egress separation
- Sec. 1016.1 Travel distance
- Sec. 1018.1 Corridor construction
- Sec. 1021 Number of exits
- Sec. 1022 Vertical exit enclosures
- Sec. 1023 Exit passageways
- Sec. 1025 Horizontal exits
- Sec. 1026 Exterior exit stairways
- Sec. 1027 Exit discharge
- Sec. 1028 Egress from assembly occupancies

10. Identify any special use features of the building. The activities that occur within the building pose varying risks to the occupants. Special conditions are applicable when such activities are anticipated.

Chapter 4. Verify compliance with special detailed requirements. These provisions are often an extension of the general requirements found elsewhere in the code.

- Sec. 410 Stages and platforms
- Sec. 413 Combustible storage
- Sec. 414 Hazardous materials
- Sec. 416 Application of flammable finishes

11. Determine areas of building and site required to be accessible. In general, access to persons with disabilities is required for all buildings.

Chapter 11A and/or 11B. Verify compliance with accessibility provisions. In order to be considered as accessible, buildings and their individual elements must comply with the applicable technical provisions of Chapters 11A and/or 11B.

12. Determine extent of other miscellaneous provisions. Additional provisions may be applicable based upon each individual building and its characteristics.

Sec. 2406.3. Verify safety glazing provided in hazardous locations. Safety glazing must be appropriately identified to ensure the proper glazing material is installed in areas considered as subject to human impact.

Chapter 12. Interior environment. Provisions regulating ventilation, temperature control, lighting, sound transmission, room dimensions and surrounding materials associated with interior spaces.

Chapter 14 Exterior walls. Requirements for installation of wall coverings and the permissible use of combustible materials on the exterior side of exterior walls.

Chapter 24. Glass and glazing. General provisions for the installation of glazing materials and skylights.

Chapter 30. Elevators. Elevator hoistway provisions, including enclosure of hoistways, emergency operations and hoistway venting.

Chapter 31. Special construction. A variety of special conditions are addressed, including membrane structures, temporary structures, pedestrian walkways and tunnels, awnings and canopies, marquees, signs and swimming pool enclosures.

Structural Provisions

General Requirements

1. Design Loads.

The 2012 IBC references the national load standard, Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7—10) with Supplement Number 2.

Determine the applicable design loads that the building structure is expected to be subjected to. Code prescribed loads are given in Chapter 16 and the referenced standard, ASCE/SEI 7. The code prescribed minimum live loads are given in IBC Table 1607.1.

The various code prescribed loads are probabilistic in nature. Environmental loads, such as flood, rain, snow, seismic and wind vary based on the location of the building site. The following table gives the IBC section and ASCE/SEI 7 chapter for various types of load.

| REFERENCED IBC SECTIONS AND ASCE/SEI 7 CHAPTERS FOR LOADS | | |
|---|----------------------------|--------------------|
| TYPE OF LOAD | IBC SECTION | ASCE/SEI 7 CHAPTER |
| Dead loads | Section 1606 | Chapter 3 |
| Live loads | Section 1607, Table 1607.1 | Chapter 4 |
| Snow loads | Section 1608 | Chapter 7 |
| Wind loads | Section 1609 | Chapter 6 |
| Soil lateral loads | Section 1610 | Chapter 3 |
| Rain loads | Section 1611 | Chapter 8 |
| Flood loads | Section 1612 | Chapter 51 |
| Earthquake loads | Section 1613 | Chapter 11-22 |

1. Section 1612 references ASCE 24 which references Chapter 5 of ASCE/SEI 7

2. Structural Materials.

The structural design begins with the selection of the type of structural materials to be used to support the building. Structural framing systems are constructed of concrete, masonry, steel or wood. Some miscellaneous or specialty structures and components, such as awnings, canopies and cladding, are often constructed of aluminum.

The design of various structural materials is covered in specific material chapters in the code which in turn reference design standards for the type of material involved. The referenced standards in the 2012 IBC for the structural materials are shown in the following table:

| STRUCTURAL DESIGN STANDARDS FOR STRUCTURAL MATERIALS ¹ | | |
|---|-----------------|---|
| MATERIAL | IBC/CBC CHAPTER | REFERENCED STANDARD |
| Concrete | 19 | ACI 318—11 Building Code Requirements for Structural Concrete |
| Aluminum | 20 | ADM 1—10 Aluminum Design Manual |
| Masonry | 21 | TMS 402-11/ACI 530-11/ASCE 5-11 Building Code Requirements and Specification for Masonry Structures (MSJC Code) |
| Steel | 22 | AISC 360—10 Specification for Structural Steel Buildings AISC 341—10 Seismic Provisions for Structural Steel Buildings AISI S100—07/S2-10 North American Specification for the Design of Cold-Formed Steel Structural Members, with Supplement 1, dated 2010. |
| Wood | 23 | AF&PA NDS—12 National Design Specification (NDS) for Wood Construction with 2012 Supplement AF&PA SDPWS—08 Special Design Provisions for Wind and Seismic |

1. The above table shows the main structural design standards for these structural materials. For a complete list of referenced standards, see IBC Chapter 35.

3. Structural Analysis, Design and Detailing.

Once the applicable loads are determined, the structural system of the building must be analyzed to determine the effects of the governing gravity and lateral loads that act on the structure. The structural system of a typical building consists of the roof and floor systems, walls, beams and columns, and the foundation. From the structural analysis, the next step is to design the structural members, elements and systems to provide the minimum level of resistance in accordance with the various load combinations prescribed in Section 1605.

Once the structural elements and systems are designed, the next step is to detail the load transfer connections to provide a complete load path from the point of origin to the resisting element. In general, the ultimate resisting element of buildings and structures is the foundation and supporting ground. The final step is to prepare a complete set of construction documents as required by Sections 107 and 1603. Construction documents are defined in Section 202 as “Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.” In general, construction documents consist of plans, specifications and calculations.

Section 1603.1 requires construction documents to show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. Design loads required by Sections 1603.1.1 through 1603.1.9 must be indicated on the construction documents. If complete construction documents consisting of plans, specifications and calculations are provided, the items listed in Sections 1603.1.1 through 1603.9 are generally included.

The exception permits construction documents for buildings constructed in accordance with the conventional light-frame construction provisions of Section 2308 need only indicate the following:

- Floor and roof live loads
- Ground snow load, P_g .
- Basic (3-second gust) wind speed (mph) and wind exposure category.
- Seismic design category and site class.
- Flood design data where sited in flood hazard areas
- Design load-bearing values of soils.

General Requirements

1. Occupancy Category (IBC/CBC Table 1604.5).

Determine the occupancy category of the building based on Table 1604.5.

Where a structure is occupied by two or more occupancies that are not the same occupancy category, the building must be classified in the highest occupancy category corresponding to the various occupancies.

Where structures have two or more portions that are structurally separated, each separate portion should be separately classified.

Where a separated portion of a structure provides required access or egress from another portion of the building with a higher occupancy category, both portions of the building must be assigned the higher occupancy category.

Where a separated portion of a structure shares life safety components with another portion of the building with a higher occupancy category, both portions of the building must be assigned the higher occupancy category.

2. Floor and roof live loads (IBC/CBC Table 1607.1).

Determine uniformly distributed and concentrated floor live load for the floor areas of the building in accordance with Section 1603.1.1 and Table 1607.1.

Floor live load reduction in accordance with Section 1607.9 should be indicated for each type of live load that is reduced.

Determine the roof live load for roof areas in accordance with Section 1607.11.

Roof live load reduction in accordance with Section 1607.11.2 should be indicated for roof live loads that are reduced.

3. Snow load (IBC/CBC Section 1608, ASCE/SEI 7 Section 7).

Determine the ground snow load, P_g , based on the location of the building site in accordance with Figure 1608.2 for the contiguous United States and Table 1608.2 for Alaska.

In areas where the ground snow load, P_g , exceeds 10 psf, the following information should be determined:

1. Flat-roof snow load, P_f
2. Snow exposure factor, C_e
3. Snow load importance factor, I .
4. Thermal factor, C_r .

4. Wind speed and wind exposure category.

Determine the following information related to wind loads in accordance with Section 1603.1.4:

1. Basic 3-second gust wind speed (mph).
2. Wind importance factor, I .
3. Wind exposure category (B, C, D). If more than one wind exposure is used, the wind exposure for each wind direction should be determined.
4. The applicable internal pressure coefficient.
5. The design wind pressure (psf) used for the design of exterior component and cladding materials not specifically designed by the registered design professional should be indicated.

5. Earthquake design requirements.

Determine the following information related to seismic loads regardless of whether seismic loads govern the design of the lateral-force-resisting system of the building:

1. Seismic importance factor, I , based on occupancy category.
2. Mapped spectral response accelerations, S_s and S_I .
3. Site class.
4. Design spectral response coefficients, S_{Ds} and S_{Di} .
5. Seismic design category.
6. Basic seismic-force-resisting system(s).
7. Design base shear.
8. Seismic response coefficient(s), C_s .
9. Response modification factor(s), R .
10. Analysis procedure used.

6. Geotechnical information.

The design load bearing values of soils shall be shown on the construction documents in accordance with Section 1603.1.6.

7. Special loads.

Determine any special loads that are applicable to the design of the building, structure or portions thereof along with the specific section of the code that addresses the special loading condition in accordance with Section 1603.1.8.

8. Load combinations.

Buildings and other structures and portions thereof are required to be designed to resist the load combinations specified in Section 1605.2 or 1605.3 and Chapters 18 through 23, and the special seismic load combinations with overstrength as required by Section 1605.1 and ASCE/SEI 7.

9. Wind and seismic detailing.

Lateral-force-resisting systems are required to conform to the seismic detailing requirements of the code and ASCE/SEI 7 (excluding Chapter 14 and Appendix 11A) even when wind load effects are greater than seismic load effects. See Section 1604.10.

10. Serviceability.

Structural systems and members shall be designed to have adequate stiffness to limit deflections and lateral drift. The deflection of structural members shall not exceed the more restrictive of the limitations of Sections 1604.3.2 through 1604.3.6 or that permitted by Table 1604.3. Structural systems shall be designed to have adequate stiffness to limit deformation and lateral drift due to earthquake loading in accordance with Section 12.12.1 of ASCE/SEI 7.

11. Foundation.

A foundation system must be designed that provides adequate support for gravity and lateral loads. Walls of buildings of conventional light frame construction, as defined in Section 202, are permitted to be supported by footings constructed in accordance with Table 1809.7. Otherwise, the foundation system must be designed in accordance with other provisions of Chapter 18. The following table gives a summary of applicable sections for foundation systems.

| FOUNDATION REQUIREMENTS | |
|--|--------------------|
| SUBJECT | IBC SECTION |
| Presumptive load-bearing values of soils | 1806, Table 1806.2 |
| Foundation walls, retaining walls and embedded posts & poles | 1807 |
| General requirements for foundations | 1808 |
| Minimum concrete specified concrete strength | Table 1808.8.1 |
| Minimum concrete cover | Table 1808.8.2 |
| Shallow foundations (footings) | 1809 |
| Prescriptive footings for light frame walls | Table 1809.7 |
| Deep foundations | 1810 |

A geotechnical investigation is required where required by Section 1803.2 unless the building official determines that a soils investigation is not required in accordance with the exception. A geotechnical investigation is required for buildings assigned to Seismic Design Categories C, D, E and F in accordance with Sections 1803.5.11 and 1803.5.12.

12. Excavation, grading and fill

Requirements for excavation, grading and fill related to foundation construction are covered in Section 1804. General requirements for site grading are covered in Appendix J.

13. Flood design data.

Where required by Section 1612.5, buildings located in flood hazard areas as established in Section 1612.3 are required to provide documentation that includes the following information regardless of whether flood loads govern the design of the building:

1. In flood hazard areas not subject to high-velocity wave action, the elevation of the proposed lowest floor, including the basement; and the elevation to which any nonresidential building will be dry flood proofed.
2. In flood hazard areas not subject to high-velocity wave action, the elevation to which any nonresidential building will be dry floodproofed.
3. In flood hazard areas subject to high-velocity wave action, the proposed elevation of the bottom of the lowest horizontal structural member of the lowest floor, including the basement.

14. Special inspection.

Where special inspection, special inspection for seismic resistance, or structural testing for seismic resistance is required by Section 1704, 1707 or 1708, the registered design professional in responsible charge is required to prepare a statement of special inspections in accordance with Section 1705. The statement of special inspections must be submitted by the permit applicant as a condition of permit issuance in accordance with Section 106.1.

A statement of special inspections is not required for structures designed and constructed in accordance with the conventional construction provisions of Section 2308 unless specific components in the structure require special inspection.

The statement of special inspections is permitted to be prepared by a qualified person approved by the building official for construction not designed by a registered design professional.

| SPECIAL INSPECTION REQUIREMENTS | | |
|--|---------------------------|---|
| TYPE OF SPECIAL INSPECTION | APPLICABLE SECTION | REQUIRED VERIFICATION AND INSPECTION |
| Steel construction | 1704.3 | Table 1704.3 |
| Concrete construction | 1704.4 | Table 1704.4 |
| Masonry construction | | |
| Level 1 | 1704.5 | Table 1704.5.1 |
| Level 2 | | Table 1704.5.3 |
| Wood construction | 1704.6 | — |
| Soils | 1704.7 | Table 1704.7 |
| Driven deep foundations | 1704.8 | Table 1704.8 |
| Cast in place deep foundations | 1704.9 | Table 1704.9 |
| Helical pile foundations | 1704.10 | — |
| Vertical masonry foundations | 1704.11 1704.5 | — |
| Sprayed fire resistant materials | 1704.12 | — |
| Mastic and intumescent fire resistive coatings | 1704.13 | — |
| Exterior insulation and finish (EIFS) systems | 1704.14 | — |
| Special cases | 1704.15 | — |
| Smoke control systems | 1704.16 | — |

Where required by the provisions of Section 1709.2 or 1709.3, the owner shall employ a registered design professional to perform structural observations as defined in Section 1702. At the conclusion of the work included in the permit, the structural observer shall submit a written statement to the building official that identifies any reported deficiencies that have not been resolved.

15. Special inspection for wind and seismic resistance.

Section 1706.1 requires special inspections for wind requirements based on wind speed and exposure category as prescribed in Sections 1706.2 through 1706.4, unless exempted by the exceptions to Section 1704.1.

Section 1707.1 requires special inspections for seismic resistance based on seismic design category as prescribed in Sections 1707.2 through 1707.9, unless exempted by the exceptions of Section 1704.1 or 1705.3.

16. Structural testing for seismic resistance.

Section 1708.1 requires specific testing and qualification for seismic resistance as prescribed in Sections 1708.2 through 1708.5, unless exempted from special inspections by the exceptions of Section 1704.1 and 1705.3.

17. Structural observation.

Where required by the provisions of Section 1710.2 or 1710.3 the owner is required to employ a registered design professional to perform structural observations as defined in Section 1702. Section 1710.2 requires structural observations for seismic resistance for certain structures assigned to Seismic Design Category D, E or F; Section 1710.3 requires structural observations for wind requirements for certain structures sited where the wind speed exceeds 110 mph.

At the conclusion of the work included in the permit, the structural observer is required to submit a written statement to the building official that identifies any reported deficiencies that have not been resolved.

Prior to the commencement of observations, the structural observer is required to submit a written statement to the building official identifying the structural observations.

At the conclusion of the work included in the permit, the structural observer is required to submit a written statement to the building official indicating what site visits have been made, identifies any deficiencies that have not been resolved.

18. Contractor responsibility.

Section 1709 requires each contractor responsible for the construction of a main wind- or seismic-force-resisting system, designated seismic system or a wind- or seismic-resisting component listed in the statement of special inspections is required to submit a written statement of responsibility to the building official and the owner prior to the commencement of work on the system or component. (The term “designated seismic system” is defined in Section 1702 and Section 11.2 of ASCE/SEI 7). The contractor’s statement of responsibility is required to acknowledge awareness of the special requirements contained in the statement of special inspections.

19. Phased approvals.

Construction of foundations or other part of a building is permitted before the construction documents for the whole building or structure have been submitted, provided adequate information has been filed. The holder of such permit for the foundation or other part of a building proceeds at their own risk and without assurance that a permit for the entire structure will be granted.

20. Amended construction documents.

Work must be constructed in accordance with the approved construction documents and any changes made during construction that are not in compliance with the approved construction documents must be resubmitted for approval as amended construction documents.

21. Deferred submittals.

Deferred submittals are items that are not submitted at the time of permit application and must have the prior approval of the building official in accordance with Section 107.3.4.2. The registered design professional in responsible charge is required to list the deferred submittals on the construction documents for review by the building official. Documents for deferred submittal items must be reviewed by the registered design professional in responsible charge who will forward them to the building official with a notation indicating that they have been reviewed and are in general conformance with the design of the building.

How to Distinguish Between Model Code Language and California Amendments

To distinguish between model code language and the incorporated California amendments, including exclusive California standards, California amendments will appear in italic font print.

[BSC] This is an example of a state agency acronym used to identify an adoption or amendment by the agency. The acronyms will appear at California Amendments and in the Matrix Adoption Tables. Sections 1.2 through 1.14 in Chapter 1, Division 1 of this code, explain the used acronyms, the application of state agency adoptions to building occupancies or building features, the enforcement agency as designated by state law (may be the state adopting agency or local building or fire official), the authority in state law for the state agency to make the adoption, and the specific state law being implemented by the agency's adoption. The following acronyms are used in Title 24 to identify the state adopting agency making an adoption.

Legend of Acronyms of Adopting State Agencies

| | |
|------------------|--|
| BSC | <i>California Building Standards Commission (see Section 1.2)</i> |
| BSCC | <i>Board of State and Community Corrections (see Section 1.3)</i> |
| SFM | <i>Office of the State Fire Marshal (see Section 1.11)</i> |
| HCD 1 | <i>Department of Housing and Community Development (see Section 1.8.2.1.1)</i> |
| HCD 2 | <i>Department of Housing and Community Development (see Section 1.8.2.1.3)</i> |
| HCD 1/AC | <i>Department of Housing and Community Development (see Section 1.8.2.1.2)</i> |
| DSA-AC | <i>Division of the State Architect-Access Compliance (see Section 1.9.1)</i> |
| DSA-SS | <i>Division of the State Architect-Structural Safety (see Section 1.9.2)</i> |
| DSA-SS/CC | <i>Division of the State Architect-Structural Safety/Community Colleges (see Section 1.9.2.2)</i> |
| OSHPD 1 | <i>Office of Statewide Health Planning and Development (see Section 1.10.1)</i> |
| OSHPD 2 | <i>Office of Statewide Health Planning and Development (see Section 1.10.2)</i> |
| OSHPD 3 | <i>Office of Statewide Health Planning and Development (see Section 1.10.3)</i> |
| OSHPD 4 | <i>Office of Statewide Health Planning and Development (see Section 1.10.4)</i> |
| DPH | <i>Department of Public Health (see Section 1.7)</i> |
| AGR | <i>Department of Food and Agriculture (see Section 1.6)</i> |
| CEC | <i>California Energy Commission (see Section 100 in Part 2, the California Energy Code)</i> |
| CA | <i>Department of Consumer Affairs (see Section 1.6): Board of Barbering and Cosmetology Board of Examiners in Veterinary Medicine Board of Pharmacy Acupuncture Board Bureau of Home Furnishings Structural Pest Control Board</i> |
| SL | <i>State Library (see Section 1.12)</i> |
| SLC | <i>State Lands Commission (see Section 1.14)</i> |
| DWR | <i>Department of Water Resources (see Section 1.12 of Chapter 1 of the California Plumbing Code in Part 2 of Title 24)</i> |

The state agencies are available to answer questions about their adoptions. Contact information is provided on page iv of this code. To learn more about the use of this code refer to pages xvii and xviii. Training materials on the application and use of this code are available at the website of the California Building Standards Commission www.bsc.ca.gov.

California Matrix Adoption Tables

Format of the California Matrix Adoption Tables

The matrix adoption tables, examples of which follow, are non-regulatory aids intended to show the user which state agencies have adopted and/or amended given sections of the model code. An agency's statutory authority for certain occupancies or building applications determines which chapter or section may be adopted, repealed, amended or added. See Chapter 1, Division I, Sections 1.2 through 1.14 for agency authority, building applications and enforcement responsibilities.

The side headings identify the scope of state agencies' adoption as follows:

Adopt the entire IBC chapter without state amendments.

If there is an "X" under a particular state agency's acronym on this row; this means that particular state agency has adopted the entire model code chapter without any state amendments.

Example:

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE
(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building application.)

CHAPTER 2 – DEFINITIONS AND ABBREVIATIONS

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt entire chapter | | X | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | S | A | M | P | L | E | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

Adopt the entire IBC chapter as amended, state-amended sections are listed below:

If there is an "X" under a particular state agency's acronym on this row, it means that particular state agency has adopted the entire model code chapter; with state amendments.

Each state-amended section that the agency has added to that particular chapter is listed. There will be an "X" in the column, by that particular section, under the agency's acronym, as well as an "X" by each section that the agency has adopted.

Example:

CHAPTER 2 – DEFINITIONS AND ABBREVIATIONS

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | X | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | S | A | M | P | L | E | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 202 | | X | | | | | | | | | | | | | | | | | |

Adopt only those sections that are listed below:

If there is an "X" under a particular state agency's acronym on this row, it means that particular state agency is adopting only specific model code or state-amended sections within this chapter. There will be an "X" in the column under the agency's acronym, as well as an "X" by each section that the agency has adopted.

Example:**CHAPTER 2 – DEFINITIONS AND ABBREVIATIONS**

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | X | X | | S | A | M | P | L | E | | | | | | | | |
| Chapter 1 | | | | | | | | | | | | | | | | | | | |
| 202 | | | X | X | | S | A | M | P | L | E | | | | | | | | |
| 202 | | | X | X | | C | O | N | T. | | | | | | | | | | |
| 203 | | | X | X | | | | | | | | | | | | | | | |
| 203 | | | X | X | | | | | | | | | | | | | | | |

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CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 16 – STRUCTURAL DESIGN

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | X | | X | X | | | | | X | | X | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | X | X | | | | | | | | | | | | X | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 1601.1.1 | | | | | | | | | X | | | | | | | | | | | |
| 1601.1.2 | | | | | | | | | | X | | | | | | | | | | |
| 1601.1.3 | | | | | | | | | | X | | | | | | | | | | |
| 1601.1.4 | | | | | | | | | | X | | | | | | | | | | |
| 1601.2 | | | | | | | | | | X | X | | | | | | | | | |
| 1601.3 | | | | | | | | | | X | | | | | | | | | | |
| 1602.1 | | | | | | | | | | | | | | | | | | | | |
| 1603.1 | | | | | | | | | | | X | | | | | | | | | |
| 1607.1, Table 1607.1 | | | | | | | | | | | X | | | | | | | | | |
| 1607.8 | | | | X | X | X | | | | | | | | | | | | | | |
| 1607.8.2 | | | | X | X | X | X | | | | | | | | | | | | | |
| 1612.3 | | | | | | | | | | | | X | | | | | | | | |
| 1613.1 | | | | | | | | | | | | X | | | | | | | | |
| 1613.1.1 | | | | | | | | | | | | | | | | | | | X | |
| 1613.1.2 | X | | | | | | | | | | | | | | | | | | | |
| 1613.1.3 | X | | | | | | | | | | | | | | | | | | | |
| 1613.3.1 | | | | | | | | | | | X | | | | | | | | | |
| 1613.3.2 | | | | | | | | | | | | X | | | | | | | | |
| 1613.3.5 | | | | | | | | | | | X | | | | | | | | | |
| 1613.3.5.1 | | | | | | | | | | | X | | | | | | | | | |
| 1613.3.5.2 | | | | | | | | | | | X | | | | | | | | | |
| 1613.3.6.1 | | | | | | | | | | | | | | | | | | | | |
| 1613.3.6.2 | | | | | | | | | | | | | | | | | | | | |
| 1613.5 | X | | X | X | | | | | | | | X | | | | | | | | |
| 1613.5.1 | X | | X | X | | | | | | | | X | | | | | | | | |
| 1613.5.2 | X | | X | X | | | | | | | | X | | | | | | | | |
| 1613.6 | X | | | | | | | | | | | | | | | | | | | |
| 1616 | | | | | | | | | X | | | | | | | | | | | |

CHAPTER 16

STRUCTURAL DESIGN

SECTION 1601 GENERAL

1601.1 Scope. The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code.

1601.1.1 Application. [DSA-SS/CC] The scope of application of Chapter 16 is as follows:

Community college buildings regulated by the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC), as listed in Section 1.9.2.2.

1601.1.2 Identification of amendments. [DSA-SS/CC] Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC) amendments appear in this chapter preceded with the appropriate acronym, as follows:

Division of the State Architect - Structural Safety/Community Colleges: [DSA-SS/CC] - For community college buildings listed in Section 1.9.2.2

1601.1.3 Reference to other chapters. [DSA-SS/CC] Where reference within this chapter is made to sections in Chapters 17 and 18, the provisions in Chapters 17A and 18A respectively shall apply instead.

1601.1.4 Amendments. [DSA-SS/CC] See Section 1616 for additional requirements.

1601.2 Enforcement agency approval. [DSA-SS/CC, OSHPD 2] In addition to requirements of the California Administrative Code and the California Building Code, any aspect of project design, construction, quality assurance or quality control programs for which this code requires approval by the design professional, are also subject to approval by the enforcement agency.

SECTION 1602 DEFINITIONS AND NOTATIONS

1602.1 Definitions. The following terms are defined in Chapter 2:

ALLOWABLE STRESS DESIGN.

DEAD LOADS.

DESIGN STRENGTH.

DIAPHRAGM.

Diaphragm, blocked.

Diaphragm boundary.

Diaphragm chord.

Diaphragm flexible.

Diaphragm, rigid.

DURATION OF LOAD.

ENFORCEMENT AGENT. [OSHPD 2] That individual within the agency or organization charged with responsibility for agency or organization compliance with the requirements of this code. Used interchangeably with "Building Official" or "Code Official."

ESSENTIAL FACILITIES.

FABRIC PARTITION.

FACTORED LOAD.

HELIPAD.

ICE-SENSITIVE STRUCTURE.

IMPACT LOAD.

LIMIT STATE.

LIVE LOAD.

LIVE LOAD (ROOF).

LOAD AND RESISTANCE FACTOR DESIGN (LRFD).

LOAD EFFECTS.

LOAD FACTOR.

LOADS.

NOMINAL LOADS.

OTHER STRUCTURES.

PANEL (PART OF A STRUCTURE).

RESISTANCE FACTOR.

RISK CATEGORY.

STRENGTH, NOMINAL.

STRENGTH, REQUIRED.

STRENGTH DESIGN.

SUSCEPTIBLE BAY.

VEHICLE BARRIER.

NOTATIONS.

D = Dead load.

D_i = Weight of ice in accordance with Chapter 10 of ASCE 7.

E = Combined effect of horizontal and vertical earthquake induced forces as defined in Section 12.4.2 of ASCE 7.

F = Load due to fluids with well-defined pressures and maximum heights.

F_a = Flood load in accordance with Chapter 5 of ASCE 7.

H = Load due to lateral earth pressures, ground water pressure or pressure of bulk materials.

L = Roof live load greater than 20 psf (0.96 kN/m^2) and floor live load.

L_r = Roof live load of 20 psf (0.96 kN/m^2) or less.

R = Rain load.

- S = Snow load.
 T = Self-straining load.
 V_{asd} = Nominal design wind speed (3-second gust), miles per hour (mph) (km/hr) where applicable.
 V_{ult} = Ultimate design wind speeds (3-second gust), miles per hour (mph) (km/hr) determined from Figures 1609A, 1609B, or 1609C or ASCE 7.
 W = Load due to wind pressure.
 W_i = Wind-on-ice in accordance with Chapter 10 of ASCE 7.

SECTION 1603 CONSTRUCTION DOCUMENTS

1603.1 General. Construction documents shall show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be indicated on the construction documents.

Exception: Construction documents for buildings constructed in accordance with the conventional light-frame construction provisions of Section 2308 shall indicate the following structural design information:

1. Floor and roof live loads.
2. Ground snow load, P_g .
3. Ultimate design wind speed, V_{ult} , (3-second gust), miles per hour (mph) (km/hr) and nominal design wind speed, V_{asd} , as determined in accordance with Section 1609.3.1 and wind exposure.
4. Seismic design category and site class.
5. Flood design data, if located in flood hazard areas established in Section 1612.3.
6. Design load-bearing values of soils.

[OSHPD 2] Additional requirements are included in Sections 7-115 and 7-125 of the California Administrative Code (Part 1, Title 24, C.C.R.).

1603.1.1 Floor live load. The uniformly distributed, concentrated and impact floor live load used in the design shall be indicated for floor areas. Use of live load reduction in accordance with Section 1607.10 shall be indicated for each type of live load used in the design.

1603.1.2 Roof live load. The roof live load used in the design shall be indicated for roof areas (Section 1607.12).

1603.1.3 Roof snow load data. The ground snow load, P_g , shall be indicated. In areas where the ground snow load, P_g , exceeds 10 pounds per square foot (psf) (0.479 kN/m²), the following additional information shall also be provided, regardless of whether snow loads govern the design of the roof:

1. Flat-roof snow load, P_f .
2. Snow exposure factor, C_e .
3. Snow load importance factor, I .
4. Thermal factor, C_r .

1603.1.4 Wind design data. The following information related to wind loads shall be shown, regardless of whether wind loads govern the design of the lateral force-resisting system of the structure:

1. Ultimate design wind speed, V_{ult} , (3-second gust), miles per hour (km/hr) and nominal design wind speed, V_{asd} , as determined in accordance with Section 1609.3.1.
2. Risk category.
3. Wind exposure. Where more than one wind exposure is utilized, the wind exposure and applicable wind direction shall be indicated.
4. The applicable internal pressure coefficient.
5. Components and cladding. The design wind pressures in terms of psf (kN/m²) to be used for the design of exterior component and cladding materials not specifically designed by the registered design professional.

1603.1.5 Earthquake design data. The following information related to seismic loads shall be shown, regardless of whether seismic loads govern the design of the lateral force-resisting system of the structure:

1. Risk category.
2. Seismic importance factor, I_e .
3. Mapped spectral response acceleration parameters, S_s and S_I .
4. Site class.
5. Design spectral response acceleration parameters, S_{DS} and S_{DI} .
6. Seismic design category.
7. Basic seismic force-resisting system(s).
8. Design base shear(s).
9. Seismic response coefficient(s), C_s .
10. Response modification coefficient(s), R .
11. Analysis procedure used.

1603.1.6 Geotechnical information. The design load-bearing values of soils shall be shown on the construction documents.

1603.1.7 Flood design data. For buildings located in whole or in part in flood hazard areas as established in Section 1612.3, the documentation pertaining to design, if required in Section 1612.5, shall be included and the following information, referenced to the datum on the community's Flood Insurance Rate Map (FIRM), shall be shown, regardless of whether flood loads govern the design of the building:

1. In flood hazard areas not subject to high-velocity wave action, the elevation of the proposed lowest floor, including the basement.
2. In flood hazard areas not subject to high-velocity wave action, the elevation to which any nonresidential building will be dry flood proofed.

3. In flood hazard areas subject to high-velocity wave action, the proposed elevation of the bottom of the lowest horizontal structural member of the lowest floor, including the basement.

1603.1.8 Special loads. Special loads that are applicable to the design of the building, structure or portions thereof shall be indicated along with the specified section of this code that addresses the special loading condition.

1603.1.9 Systems and components requiring special inspections for seismic resistance. Construction documents or specifications shall be prepared for those systems and components requiring special inspection for seismic resistance as specified in Section 1705.11 by the registered design professional responsible for their design and shall be submitted for approval in accordance with Section 107.1, *Chapter 1, Division II*. Reference to seismic standards in lieu of detailed drawings is acceptable.

SECTION 1604 GENERAL DESIGN REQUIREMENTS

1604.1 General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

1604.2 Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this code without exceeding the appropriate strength limit states for the materials of construction. Alternatively, buildings and other structures, and parts thereof, shall be designed and constructed to support safely the nominal loads in load combinations defined in this code without exceeding the appropriate specified allowable stresses for the materials of construction.

Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the building official.

1604.3 Serviceability. Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift. See Section 12.12.1 of ASCE 7 for drift limits applicable to earthquake loading.

1604.3.1 Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604.3.2 through 1604.3.5 or that permitted by Table 1604.3.

1604.3.2 Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

1604.3.3 Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI S100, ASCE 8, SJI CJ-1.0, SJI JG-1.1, SJI K-1.1 or SJI LH/DLH-1.1, as applicable.

TABLE 1604.3
DEFLECTION LIMITS^{a, b, c, h, i}

| CONSTRUCTION | L | S or W ^f | D + L ^{d, g} |
|---|-------|---------------------|-----------------------|
| Roof members: ^e | | | |
| Supporting plaster or stucco ceiling | I/360 | I/360 | I/240 |
| Supporting nonplaster ceiling | I/240 | I/240 | I/180 |
| Not supporting ceiling | I/180 | I/180 | I/120 |
| Floor members | I/360 | — | I/240 |
| Exterior walls and interior partitions: | | | |
| With plaster or stucco finishes | — | I/360 | — |
| With other brittle finishes | — | I/240 | — |
| With flexible finishes | — | I/120 | — |
| Farm buildings | — | — | I/180 |
| Greenhouses | — | — | I/120 |

For SI: 1 foot = 304.8 mm.

- For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed I/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed I/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed I/90. For roofs, this exception only applies when the metal sheets have no roof covering.
- Interior partitions not exceeding 6 feet in height and flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.14.
- See Section 2403 for glass supports.
- For wood structural members having a moisture content of less than 16 percent at time of installation and used under dry conditions, the deflection resulting from $L + 0.5D$ is permitted to be substituted for the deflection resulting from $L + D$.
- The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Section 1611 for rain and ponding requirements and Section 1503.4 for roof drainage requirements.
- The wind load is permitted to be taken as 0.42 times the "component and cladding" loads for the purpose of determining deflection limits herein.
- For steel structural members, the dead load shall be taken as zero.
- For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed I/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed I/175 for each glass lite or I/60 for the entire length of the member, whichever is more stringent. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed I/120.
- For cantilever members, l shall be taken as twice the length of the cantilever.

1604.3.4 Masonry. The deflection of masonry structural members shall not exceed that permitted by TMS 402/ACI 530/ASCE 5.

1604.3.5 Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

1604.3.6 Limits. The deflection limits of Section 1604.3.1 shall be used unless more restrictive deflection limits are required by a referenced standard for the element or finish material.

1604.4 Analysis. Load effects on structural members and their connections shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during their service life.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

The total lateral force shall be distributed to the various vertical elements of the lateral force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements assumed not to be a part of the lateral force-resisting system are permitted to be incorporated into buildings provided their effect on the action of the system is considered and provided for in the design. Except where diaphragms are flexible, or are permitted to be analyzed as flexible, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral force-resisting system.

Every structure shall be designed to resist the overturning effects caused by the lateral forces specified in this chapter. See Section 1609 for wind loads, Section 1610 for lateral soil loads and Section 1613 for earthquake loads.

1604.5 Risk category. Each building and structure shall be assigned a risk category in accordance with Table 1604.5. Where a referenced standard specifies an occupancy category, the risk category shall not be taken as lower than the occupancy category specified therein.

1604.5.1 Multiple occupancies. Where a building or structure is occupied by two or more occupancies not included in the same risk category, it shall be assigned the classification of the highest risk category corresponding to the various occupancies. Where buildings or structures have two or more portions that are structurally separated, each portion shall be separately classified. Where a separated portion of a building or structure provides required access to, required egress from or shares life safety components with another

portion having a higher risk category, both portions shall be assigned to the higher risk category.

1604.6 In-situ load tests. The building official is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with Section 1709.

1604.7 Preconstruction load tests. Materials and methods of construction that are not capable of being designed by approved engineering analysis or that do not comply with the applicable referenced standards, or alternative test procedures in accordance with Section 1707, shall be load tested in accordance with Section 1710.

1604.8 Anchorage. Buildings and other structures, and portions thereof, shall be provided with anchorage in accordance with Sections 1604.8.1 through 1604.8.3, as applicable.

1604.8.1 General. Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed loads.

1604.8.2 Structural walls. Walls that provide vertical load-bearing resistance or lateral shear resistance for a portion of the structure shall be anchored to the roof and to all floors and members that provide lateral support for the wall or that are supported by the wall. The connections shall be capable of resisting the horizontal forces specified in Section 1.4.4 of ASCE 7 for walls of structures assigned to Seismic Design Category A and to Section 12.11 of ASCE 7 for walls of structures assigned to all other seismic design categories. Required anchors in masonry walls of hollow units or cavity walls shall be embedded in a reinforced grouted structural element of the wall. See Sections 1609 for wind design requirements and 1613 for earthquake design requirements.

1604.8.3 Decks. Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads as applicable. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. Connections of decks with cantilevered framing members to exterior walls or other framing members shall be designed for both of the following:

1. The reactions resulting from the dead load and live load specified in Table 1607.1, or the snow load specified in Section 1608, in accordance with Section 1605, acting on all portions of the deck.
2. The reactions resulting from the dead load and live load specified in Table 1607.1, or the snow load specified in Section 1608, in accordance with Section 1605, acting on the cantilevered portion of the deck, and no live load or snow load on the remaining portion of the deck.

TABLE 1604.5
RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

| RISK CATEGORY | NATURE OF OCCUPANCY |
|---------------|---|
| I | Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: <ul style="list-style-type: none"> • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities. |
| II | Buildings and other structures except those listed in Risk Categories I, III and IV |
| III | Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: <ul style="list-style-type: none"> • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-2 occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000^a. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: <ul style="list-style-type: none"> Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the <i>California Fire Code</i>; and Are sufficient to pose a threat to the public if released^b. |
| IV | Buildings and other structures designated as essential facilities, including but not limited to: <ul style="list-style-type: none"> • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: <ul style="list-style-type: none"> Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the <i>California Fire Code</i>; and Are sufficient to pose a threat to the public if released^b. • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression. |

- a. For purposes of occupant load calculation, occupancies required by Table 1004.1.2 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.
- b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II, provided it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

1604.9 Counteracting structural actions. Structural members, systems, components and cladding shall be designed to resist forces due to earthquakes and wind, with consideration of overturning, sliding and uplift. Continuous load paths shall be provided for transmitting these forces to the foundation. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

1604.10 Wind and seismic detailing. Lateral force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7, excluding Chapter 14 and Appendix 11A, even when wind load effects are greater than seismic load effects.

SECTION 1605 LOAD COMBINATIONS

1605.1 General. Buildings and other structures and portions thereof shall be designed to resist:

1. The load combinations specified in Section 1605.2, 1605.3.1 or 1605.3.2;
2. The load combinations specified in Chapters 18 through 23; and
3. The seismic load effects including overstrength factor in accordance with Section 12.4.3 of ASCE 7 where required by Section 12.2.5.2, 12.3.3.3 or 12.10.2.1 of

ASCE 7. With the simplified procedure of ASCE 7 Section 12.14, the seismic load effects including overstrength factor in accordance with Section 12.14.3.2 of ASCE 7 shall be used.

Applicable loads shall be considered, including both earthquake and wind, in accordance with the specified load combinations. Each load combination shall also be investigated with one or more of the variable loads set to zero.

Where the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7 apply, they shall be used as follows:

1. The basic combinations for strength design with overstrength factor in lieu of Equations 16-5 and 16-7 in Section 1605.2.
2. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16-12, 16-14 and 16-16 in Section 1605.3.1.
3. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16-21 and 16-22 in Section 1605.3.2.

1605.1.1 Stability. Regardless of which load combinations are used to design for strength, where overall structure stability (such as stability against overturning, sliding, or buoyancy) is being verified, use of the load combinations specified in Section 1605.2 or 1605.3 shall be permitted. Where the load combinations specified in Section 1605.2 are used, strength reduction factors applicable to soil resistance shall be provided by a registered design professional. The stability of retaining walls shall be verified in accordance with Section 1807.2.3.

1605.2 Load combinations using strength design or load and resistance factor design. Where strength design or load and resistance factor design is used, buildings and other structures, and portions thereof, shall be designed to resist the most critical effects resulting from the following combinations of factored loads:

$$1.4(D + F) \quad (\text{Equation 16-1})$$

$$1.2(D + F) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16-2})$$

$$1.2(D + F) + 1.6(L_r \text{ or } S \text{ or } R) + 1.6H + (f_1L \text{ or } 0.5W) \quad (\text{Equation 16-3})$$

$$1.2(D + F) + 1.0W + f_1L + 1.6H + 0.5(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16-4})$$

$$1.2(D + F) + 1.0E + f_1L + 1.6H + f_2S \quad (\text{Equation 16-5})$$

$$0.9D + 1.0W + 1.6H \quad (\text{Equation 16-6})$$

$$0.9(D + F) + 1.0E + 1.6H \quad (\text{Equation 16-7})$$

where:

$f_1 = 1$ for places of public assembly live loads in excess of 100 pounds per square foot (4.79 kN/m^2), and parking garages; and 0.5 for other live loads.

$f_2 = 0.7$ for roof configurations (such as saw tooth) that do not shed snow off the structure, and 0.2 for other roof configurations.

Exceptions:

1. Where other factored load combinations are specifically required by other provisions of this code, such combinations shall take precedence.
2. Where the effect of H resists the primary variable load effect, a load factor of 0.9 shall be included with H where H is permanent and H shall be set to zero for all other conditions.

1605.2.1 Other loads. Where flood loads, F_a , are to be considered in the design, the load combinations of Section 2.3.3 of ASCE 7 shall be used. Where self-straining loads, T , are considered in design, their structural effects in combination with other loads shall be determined in accordance with Section 2.3.5 of ASCE 7. Where an ice-sensitive structure is subjected to loads due to atmospheric icing, the load combinations of Section 2.3.4 of ASCE 7 shall be considered.

1605.3 Load combinations using allowable stress design.

1605.3.1 Basic load combinations. Where allowable stress design (working stress design), as permitted by this code, is used, structures and portions thereof shall resist the most critical effects resulting from the following combinations of loads:

$$D + F \quad (\text{Equation 16-8})$$

$$D + H + F + L \quad (\text{Equation 16-9})$$

$$D + H + F + (L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16-10})$$

$$D + H + F + 0.75(L_r + 0.75(L_r \text{ or } S \text{ or } R)) \quad (\text{Equation 16-11})$$

$$D + H + F + (0.6W \text{ or } 0.7E) \quad (\text{Equation 16-12})$$

$$D + H + F + 0.75(0.6W) + 0.75L + 0.75(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16-13})$$

$$D + H + F + 0.75(0.7E) + 0.75L + 0.75S \quad (\text{Equation 16-14})$$

$$0.6D + 0.6W + H \quad (\text{Equation 16-15})$$

$$0.6(D + F) + 0.7E + H \quad (\text{Equation 16-16})$$

Exceptions:

1. Crane hook loads need not be combined with roof live load or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 30 psf (1.44 kN/m^2) or less and roof live loads of 30 psf (1.44 kN/m^2) or less need not be combined with seismic loads. Where flat roof snow loads exceed 30 psf (1.44 kN/m^2), 20 percent shall be combined with seismic loads.

3. Where the effect of H resists the primary variable load effect, a load factor of 0.6 shall be included with H where H is permanent and H shall be set to zero for all other conditions.
4. In Equation 16-15, the wind load, W , is permitted to be reduced in accordance with Exception 2 of Section 2.4.1 of ASCE 7.
5. In Equation 16-16, 0.6 D is permitted to be increased to 0.9 D for the design of special reinforced masonry shear walls complying with Chapter 21.

1605.3.1.1 Stress increases. Increases in allowable stresses specified in the appropriate material chapter or the referenced standards shall not be used with the load combinations of Section 1605.3.1, except that increases shall be permitted in accordance with Chapter 23.

1605.3.1.2 Other loads. Where flood loads, F_a , are to be considered in design, the load combinations of Section 2.4.2 of ASCE 7 shall be used. Where self-straining loads, T , are considered in design, their structural effects in combination with other loads shall be determined in accordance with Section 2.4.4 of ASCE 7. Where an ice-sensitive structure is subjected to loads due to atmospheric icing, the load combinations of Section 2.4.3 of ASCE 7 shall be considered.

1605.3.2 Alternative basic load combinations. In lieu of the basic load combinations specified in Section 1605.3.1, structures and portions thereof shall be permitted to be designed for the most critical effects resulting from the following combinations. When using these alternative basic load combinations that include wind or seismic loads, allowable stresses are permitted to be increased or load combinations reduced where permitted by the material chapter of this code or the referenced standards. For load combinations that include the counteracting effects of dead and wind loads, only two-thirds of the minimum dead load likely to be in place during a design wind event shall be used. When using allowable stresses which have been increased or load combinations which have been reduced as permitted by the material chapter of this code or the referenced standards, where wind loads are calculated in accordance with Chapters 26 through 31 of ASCE 7, the coefficient (ω) in the following equations shall be taken as 1.3. For other wind loads, (ω) shall be taken as 1. When allowable stresses have not been increased or load combinations have not been reduced as permitted by the material chapter of this code or the referenced standards, (w) shall be taken as 1. When using these alternative basic load combinations to evaluate sliding, overturning and soil bearing at the soil-structure interface, the reduction of foundation overturning from Section 12.13.4 in ASCE 7 shall not be used. When using these alternative basic load combinations for proportioning foundations for loadings, which include seismic loads, the vertical seismic load effect, E_v , in Equation 12.4-4 of ASCE 7 is permitted to be taken equal to zero.

$$D + L + (L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16-17})$$

$$D + L + 0.6 \omega W \quad (\text{Equation 16-18})$$

$$D + L + 0.6 \omega W + S/2$$

(Equation 16-19)

$$D + L + S + 0.6 \omega W/2$$

(Equation 16-20)

$$D + L + S + E/1.4$$

(Equation 16-21)

$$0.9D + E/1.4$$

(Equation 16-22)

Exceptions:

1. Crane hook loads need not be combined with roof live loads or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 30 psf (1.44 kN/m²) or less and roof live loads of 30 psf (1.44 kN/m²) or less need not be combined with seismic loads. Where flat roof snow loads exceed 30 psf (1.44 kN/m²), 20 percent shall be combined with seismic loads.

1605.3.2.1 Other loads. Where F , H or T are to be considered in the design, each applicable load shall be added to the combinations specified in Section 1605.3.2. Where self-straining loads, T , are considered in design, their structural effects in combination with other loads shall be determined in accordance with Section 2.4.4 of ASCE 7.

SECTION 1606 DEAD LOADS

1606.1 General. Dead loads are those loads defined in Section 1602.1. Dead loads shall be considered permanent loads.

1606.2 Design dead load. For purposes of design, the actual weights of materials of construction and fixed service equipment shall be used. In the absence of definite information, values used shall be subject to the approval of the building official.

SECTION 1607 LIVE LOADS

1607.1 General. Live loads are those loads defined in Section 1602.1.

1607.2 Loads not specified. For occupancies or uses not designated in Table 1607.1, the live load shall be determined in accordance with a method approved by the building official.

1607.3 Uniform live loads. The live loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy but shall in no case be less than the minimum uniformly distributed live loads given in Table 1607.1.

1607.4 Concentrated live loads. Floors and other similar surfaces shall be designed to support the uniformly distributed live loads prescribed in Section 1607.3 or the concentrated live loads, in pounds (kiloNewtons), given in Table 1607.1, whichever produces the greater load effects. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area of 2 $\frac{1}{2}$ feet by 2 $\frac{1}{2}$ feet (762 mm by 762 mm) and shall be located so as to produce the maximum load effects in the structural members.

STRUCTURAL DESIGN

**TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND
MINIMUM CONCENTRATED LIVE LOADS^d**

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (lbs.) |
|--|--|------------------------|
| 1. Apartments (see residential) | — | — |
| 2. Access floor systems | | |
| Office use | 50 | 2,000 |
| Computer use | 100 | 2,000 |
| 3. Armories and drill rooms | 150 ^m | — |
| 4. Assembly areas | | |
| Fixed seats (fastened to floor) | 60 ^m | |
| Follow spot, projections and control rooms | 50 | — |
| Lobbies | 100 ^m | |
| Movable seats | 100 ^m | |
| Stage floors | 150 ^m | |
| Platforms (assembly) | 100 ^m | |
| Other assembly areas | 100 ^m | |
| 5. Balconies and decks ^h | Same as occupancy served | — |
| 6. Catwalks | 40 | 300 |
| 7. Cornices | 60 | — |
| 8. Corridors | | |
| First floor | 100 | |
| Other floors | Same as occupancy served except as indicated | — |
| 9. Dining rooms and restaurants | 100 ^m | — |
| 10. Dwellings (see residential) | — | — |
| 11. Elevator machine room grating (on area of 2 inches by 2 inches) | — | 300 |
| 12. Finish light floor plate construction (on area of 1 inch by 1 inch) | — | 200 |
| 13. Fire escapes | | |
| On single family dwellings only | 100 40 | — |
| 14. Garages (passenger vehicles only) | 40 ^m | Note a |
| Trucks and buses | | See Section 1607.7 |
| 15. Handrails, guards and grab bars | | See Section 1607.8 |
| 16. Helipads | | See Section 1607.6 |
| 17. Hospitals | | |
| Corridors above first floor | 80 | 1,000 |
| Operating rooms, laboratories | 60 | 1,000 |
| Patient rooms | 40 | 1,000 |
| 18. Hotels (see residential) | — | — |
| 19. Libraries | | |
| Corridors above first floor | 80 | 1,000 |
| Reading rooms | 60 | 1,000 |
| Stack rooms | 150 ^{b, m} | 1,000 |
| 20. Manufacturing | | |
| Heavy | 250 ^m | 3,000 |
| Light | 125 ^m | 2,000 |
| 21. Marquees | 75 | — |
| 22. Office buildings | | |
| Corridors above first floor | 80 | 2,000 |
| File and computer rooms shall be designed for heavier loads based on anticipated occupancy | — | — |
| Lobbies and first floor corridors | 100 | 2,000 |
| Offices | 50 | 2,000 |

**TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND
MINIMUM CONCENTRATED LIVE LOADS^g**

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (lbs.) |
|--|---------------------|------------------------|
| 23. Penal institutions | | |
| Cell blocks | 40 | — |
| Corridors | 100 | — |
| 24. Recreational uses: | | |
| Bowling alleys, poolrooms and similar uses | 75 ^m | |
| Dance halls and ballrooms | 100 ^m | — |
| Gymnasiums | 100 ^m | — |
| Reviewing stands, grandstands and bleachers | 100 ^{c, m} | |
| Stadiums and arenas with fixed seats (fastened to floor) | 60 ^{c, m} | |
| 25. Residential | | |
| One and two family dwellings | 10 | |
| Uninhabitable attics without storage ⁱ | 20 | |
| Uninhabitable attics with storage ^{j, k} | 30 | |
| Habitable attics and sleeping areas ^k | 40 | |
| All other areas | | — |
| Hotels and multifamily dwellings | | |
| Private rooms and corridors serving them | 40 | |
| Public rooms ^m and corridors serving them | 100 | |
| 26. Roofs | | |
| All roof surfaces subject to maintenance workers | | 300 |
| Awnings and canopies: | | |
| Fabric construction supported by a skeleton structure | 5 | nonreducible |
| All other construction | 20 | |
| Ordinary flat, pitched, and curved roofs (that are not occupiable) | 20 | |
| Where primary roof members are exposed to a work floor, at single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs: | | |
| Over manufacturing, storage ware houses, and repair garages | | |
| All other primary roof members | | |
| Occupiable roofs: | | |
| Roof gardens | 100 | |
| Assembly areas | 100 ^m | |
| All other similar areas | Note 1 | Note 1 |
| 27. Schools | | |
| Classrooms | 40 | 1,000 |
| Corridors above first floor | 80 | 1,000 |
| First floor corridors | 100 | 1,000 |
| 28. Scuttles, skylight ribs and accessible ceilings | — | 200 |
| 29. Sidewalks, vehicular drive ways and yards, subject to trucking | 250 ^{d, m} | 8,000 ^e |
| 30. Stairs and exits | | |
| One and two family dwellings | 40 | 300 ^f |
| All other | 100 | 300 ^f |
| 31. Storage warehouses (shall be designed for heavier loads if required for anticipated storage) | | |
| Heavy | 250 ^m | — |
| Light | 125 ^m | — |

(continued)

TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND
MINIMUM CONCENTRATED LIVE LOADS^g

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (lbs.) |
|--|-------------------------------|-------------------------|
| 32. Stores Retail First floor Upper floors Wholesale, all floors | 100 75 125 ^m | 1,000 1,000 1,000 |
| 33. Vehicle barriers | See Section 1607.8.3 | — |
| 34. Walkways and elevated platforms (other than exitways) | 60 | — |
| 35. Yards and terraces, pedestrians | 100 ^m | — |
| 36. [OSHPD 2] Storage racks and wall hung cabinets. | Total loads ⁿ | — |

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm²,
1 square foot = 0.0929 m²,
1 pound per square foot = 0.0479 kN/m², 1 pound = 0.004448 kN,
1 pound per cubic foot = 16 kg/m³.

- a. Floors in garages or portions of buildings used for the storage of motor vehicles shall be designed for the uniformly distributed live loads of Table 1607.1 or the following concentrated loads: (1) for garages restricted to passenger vehicles accommodating not more than nine passengers, 3,000 pounds acting on an area of 4.5 inches by 4.5 inches; (2) for mechanical parking structures without slab or deck that are used for storing passenger vehicles only, 2,250 pounds per wheel.
 - b. The loading applies to stack room floors that support nonmobile, double faced library book stacks, subject to the following limitations:
 - 1. The nominal bookstack unit height shall not exceed 90 inches;
 - 2. The nominal shelf depth shall not exceed 12 inches for each face; and
 - 3. Parallel rows of double faced book stacks shall be separated by aisles not less than 36 inches wide.
 - c. Design in accordance with ICC 300.
 - d. Other uniform loads in accordance with an approved method containing provisions for truck loadings shall also be considered where appropriate.
 - e. The concentrated wheel load shall be applied on an area of 4.5 inches by 4.5 inches.
 - f. The minimum concentrated load on stair treads shall be applied on an area of 2 inches by 2 inches. This load need not be assumed to act concurrently with the uniform load.
 - g. Where snow loads occur that are in excess of the design conditions, the structure shall be designed to support the loads due to the increased loads caused by drift buildup or a greater snow design determined by the building official (see Section 1608).
 - h. See Section 1604.8.3 for decks attached to exterior walls.
 - i. Uninhabitable attics without storage are those where the maximum clear height between the joists and rafters is less than 42 inches, or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. This live load need not be assumed to act concurrently with any other live load requirements.
 - j. Uninhabitable attics with storage are those where the maximum clear height between the joists and rafters is 42 inches or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses.
- The live load need only be applied to those portions of the joists or truss bottom chords where both of the following conditions are met:
- i. The attic area is accessible from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the attic is a minimum of 30 inches; and
 - ii. The slopes of the joists or truss bottom chords are no greater than two units vertical in 12 units horizontal.
- The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 lb./ft².
- k. Attic spaces served by stairways other than the pull down type shall be designed to support the minimum live load specified for habitable attics and sleeping rooms.

TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND
MINIMUM CONCENTRATED LIVE LOADS^g

l. Areas of occupiable roofs, other than roof gardens and assembly areas, shall be designed for appropriate loads as approved by the building official. Unoccupied landscaped areas of roofs shall be designed in accordance with Section 1607.12.3.

m. Live load reduction is not permitted unless specific exceptions of Section 1607.10 apply.

n. [OSHPD] The minimum vertical design live load shall be as follows:

Paper media:

12 inch deep (305 mm) shelf 33 pounds per lineal foot (482 N/m)
15 inch deep (381 mm) shelf 41 pounds per lineal foot (598 N/m), or
33 pounds per cubic foot (5183 N/m³) per total volume of the rack or cabinet, whichever is less.

Film media:

18 inch deep (457 mm) shelf 100 pounds per lineal foot (1459 N/m), or
50 pounds per cubic foot (7853 N/m³) per total volume of the rack or cabinet, whichever is less.

Other media:

20 pounds per cubic foot (311 N/m³) or 20 pounds per square foot (958 Pa), whichever is less, but not less than actual loads.

1607.5 Partition loads. In office buildings and in other buildings where partition locations are subject to change, provisions for partition weight shall be made, whether or not partitions are shown on the construction documents, unless the specified live load exceeds 80 psf (3.83 kN/m²). The partition load shall not be less than a uniformly distributed live load of 15 psf (0.72 kN/m²).

1607.6 Helipads. Helipads shall be designed for the following live loads:

1. A uniform live load, L , as specified below. This load shall not be reduced.
 - 1.1. 40 psf (1.92 kN/m²) where the design basis helicopter has a maximum take-off weight of 3,000 pounds (13.35 kN) or less.
 - 1.2. 60 psf (2.87 kN/m²) where the design basis helicopter has a maximum take-off weight greater than 3,000 pounds (13.35 kN).
2. A single concentrated live load, L , of 3,000 pounds (13.35 kN) applied over an area of 4.5 inches by 4.5 inches (114 mm by 114 mm) and located so as to produce the maximum load effects on the structural elements under consideration. The concentrated load is not required to act concurrently with other uniform or concentrated live loads.
3. Two single concentrated live loads, L , 8 feet (2438 mm) apart applied on the landing pad (representing the helicopter's two main landing gear, whether skid type or wheeled type), each having a magnitude of 0.75 times the maximum take-off weight of the helicopter, and located so as to produce the maximum load effects on the structural elements under consideration. The concentrated loads shall be applied over an area of 8 inches by 8 inches (203 mm by 203 mm) and are not required to act concurrently with other uniform or concentrated live loads.

Landing areas designed for a design basis helicopter with maximum take-off weight of 3,000 pounds (13.35 kN) shall be identified with a 3,000 pound (13.34 kN) weight limita-

tion. The landing area weight limitation shall be indicated by the numeral "3" (kips) located in the bottom right corner of the landing area as viewed from the primary approach path. The indication for the landing area weight limitation shall be a minimum 5 feet (1524 mm) in height.

1607.7 Heavy vehicle loads. Floors and other surfaces that are intended to support vehicle loads greater than a 10,000 pound (4536 kg) gross vehicle weight rating shall comply with Sections 1607.7.1 through 1607.7.5.

1607.7.1 Loads. Where any structure does not restrict access for vehicles that exceed a 10,000-pound (4536 kg) gross vehicle weight rating, those portions of the structure subject to such loads shall be designed using the vehicular live loads, including consideration of impact and fatigue, in accordance with the codes and specifications required by the jurisdiction having authority for the design and construction of the roadways and bridges in the same location of the structure.

1607.7.2 Fire truck and emergency vehicles. Where a structure or portions of a structure are accessed and loaded by fire department access vehicles and other similar emergency vehicles, the structure shall be designed for the greater of the following loads:

1. The actual operational loads, including outrigger reactions and contact areas of the vehicles as stipulated and approved by the building official; or
2. The live loading specified in Section 1607.7.1.

1607.7.3 Heavy vehicle garages. Garages designed to accommodate vehicles that exceed a 10,000 pound (4536 kg) gross vehicle weight rating, shall be designed using the live loading specified by Section 1607.7.1. For garages the design for impact and fatigue is not required.

Exception: The vehicular live loads and load placement are allowed to be determined using the actual vehicle weights for the vehicles allowed onto the garage floors, provided such loads and placement are based on rational engineering principles and are approved by the building official, but shall not be less than 50 psf (2.9 kN/m²). This live load shall not be reduced.

1607.7.4 Forklifts and movable equipment. Where a structure is intended to have forklifts or other movable equipment present, the structure shall be designed for the total vehicle or equipment load and the individual wheel loads for the anticipated vehicles as specified by the owner of the facility. These loads shall be posted per Section 1607.7.5.

1607.7.4.1 Impact and fatigue. Impact loads and fatigue loading shall be considered in the design of the supporting structure. For the purposes of design, the vehicle and wheel loads shall be increased by 30 percent to account for impact.

1607.7.5 Posting. The maximum weight of the vehicles allowed into or on a garage or other structure shall be posted by the owner in accordance with Section 106.1.

1607.8 Loads on handrails, guards, grab bars, shower seats, dressing room bench seats and vehicle barriers.

Handrails, guards, grab bars, accessible seats, accessible benches and vehicle barriers shall be designed and constructed to the structural loading conditions set forth in this section.

1607.8.1 Handrails and guards. Handrails and guards shall be designed to resist a linear load of 50 pounds per linear foot (plf) (0.73 kN/m) in accordance with Section 4.5.1 of ASCE 7. Glass handrail assemblies and guards shall also comply with Section 2407.

Exceptions:

1. For one- and two-family dwellings, only the single concentrated load required by Section 1607.8.1.1 shall be applied.
2. In Group I-3, F, H and S occupancies, for areas that are not accessible to the general public and that have an occupant load less than 50, the minimum load shall be 20 pounds per foot (0.29 kN/m).

1607.8.1.1 Concentrated load. Handrails and guards shall also be designed to resist a concentrated load of 200 pounds (0.89 kN) in accordance with Section 4.5.1 of ASCE 7.

1607.8.1.2 Intermediate rails. Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to resist a concentrated load of 50 pounds (0.22 kN) in accordance with Section 4.5.1 of ASCE 7.

1607.8.2 Grab bars, shower seats and dressing room bench seats. Grab bars, shower seats and dressing room bench seat systems shall be designed to resist a single concentrated load of 250 pounds (1.11 kN) applied in any direction at any point on the grab bar or seat so as to produce the maximum load effects. (**DSA-AC & HCD 1-AC**) See Chapter 11A, Section 1127A.4, Chapter 11B, Sections 11B-609.8, 11B-610.4 and 11B-903.6 for grab bars, shower seats and dressing room bench seats, as applicable.

1607.8.3 Vehicle barriers. Vehicle barriers for passenger vehicles shall be designed to resist a concentrated load of 6,000 pounds (26.70 kN) in accordance with Section 4.5.3 of ASCE 7. Garages accommodating trucks and buses shall be designed in accordance with an approved method that contains provisions for traffic railings.

1607.9 Impact loads. The live loads specified in Sections 1607.3 through 1607.8 shall be assumed to include adequate allowance for ordinary impact conditions. Provisions shall be made in the structural design for uses and loads that involve unusual vibration and impact forces.

1607.9.1 Elevators. Members, elements and components subject to dynamic loads from elevators shall be designed for impact loads and deflection limits prescribed by ASME A17.1.

1607.9.2 Machinery. For the purpose of design, the weight of machinery and moving loads shall be increased as follows to allow for impact: (1) light machinery, shaft- or motor-driven, 20 percent; and (2) reciprocating machinery or power-driven units, 50 percent. Percentages shall be increased where specified by the manufacturer.

- | **1607.10 Reduction in uniform live loads.** Except for uniform live loads at roofs, all other minimum uniformly distributed live loads, L_o , in Table 1607.1 are permitted to be reduced in accordance with Section 1607.10.1 or 1607.10.2.
| Uniform live loads at roofs are permitted to be reduced in accordance with Section 1607.12.2.

- | **1607.10.1 Basic uniform live load reduction.** Subject to the limitations of Sections 1607.10.1.1 through 1607.10.1.3 and Table 1607.1, members for which a value of $K_{LL}A_T$ is 400 square feet (37.16 m^2) or more are permitted to be designed for a reduced uniformly distributed live load, L , in accordance with the following equation:

$$L = L_o \left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}} \right) \quad (\text{Equation 16-23})$$

$$\text{For SI: } L = L_o \left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}} \right)$$

where:

L = Reduced design live load per square foot (m^2) of area supported by the member.

L_o = Unreduced design live load per square foot (m^2) of area supported by the member (see Table 1607.1).

K_{LL} = Live load element factor (see Table 1607.10.1).

A_T = Tributary area, in square feet (m^2).

L shall not be less than $0.50L_o$ for members supporting one floor and L shall not be less than $0.40L_o$ for members supporting two or more floors.

**TABLE 1607.10.1
LIVE LOAD ELEMENT FACTOR, K_{LL}**

| ELEMENT | K_{LL} |
|--|----------|
| Interior columns | 4 |
| Exterior columns without cantilever slabs | 4 |
| Edge columns with cantilever slabs | 3 |
| Corner columns with cantilever slabs | 2 |
| Edge beams without cantilever slabs | 2 |
| Interior beams | 2 |
| All other members not identified above including: Edge beams with cantilever slabs Cantilever beams One-way slabs Two-way slabs Members without provisions for continuous shear transfer normal to their span | 1 |

1607.10.1.1 One-way slabs. The tributary area, A_T , for use in Equation 16-23 for one-way slabs shall not exceed an area defined by the slab span times a width normal to the span of 1.5 times the slab span.

1607.10.1.2 Heavy live loads. Live loads that exceed 100 psf (4.79 kN/m^2) shall not be reduced.

Exceptions:

1. The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall

not be less than L as calculated in Section 1607.10.1.

2. For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

1607.10.1.3 Passenger vehicle garages. The live loads shall not be reduced in passenger vehicle garages.

Exception: The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607.10.1.

1607.10.2 Alternative uniform live load reduction. As an alternative to Section 1607.10.1 and subject to the limitations of Table 1607.1, uniformly distributed live loads are permitted to be reduced in accordance with the following provisions. Such reductions shall apply to slab systems, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted where the live load exceeds 100 psf (4.79 kN/m^2) except that the design live load for members supporting two or more floors is permitted to be reduced by a maximum of 20 percent.

Exception: For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

2. A reduction shall not be permitted in passenger vehicle parking garages except that the live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent.
3. For live loads not exceeding 100 psf (4.79 kN/m^2), the design live load for any structural member supporting 150 square feet (13.94 m^2) or more is permitted to be reduced in accordance with Equation 16-24.
4. For one-way slabs, the area, A , for use in Equation 16-24 shall not exceed the product of the slab span and a width normal to the span of 0.5 times the slab span.

$$R = 0.08(A - 150) \quad (\text{Equation 16-24})$$

$$\text{For SI: } R = 0.861(A - 13.94)$$

Such reduction shall not exceed the smallest of:

1. 40 percent for horizontal members;
2. 60 percent for vertical members; or
3. R as determined by the following equation.

$$R = 23.1(1 + D/L_o) \quad (\text{Equation 16-25})$$

where:

A = Area of floor supported by the member, square feet (m^2).

D = Dead load per square foot (m^2) of area supported.

L_o = Unreduced live load per square foot (m^2) of area supported.

R = Reduction in percent.

1607.11 Distribution of floor loads. Where uniform floor live loads are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full dead loads on all spans in combination with the floor live loads on spans selected to produce the greatest load effect at each location under consideration. Floor live loads are permitted to be reduced in accordance with Section 1607.10.

1607.12 Roof loads. The structural supports of roofs and marquees shall be designed to resist wind and, where applicable, snow and earthquake loads, in addition to the dead load of construction and the appropriate live loads as prescribed in this section, or as set forth in Table 1607.1. The live loads acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

1607.12.1 Distribution of roof loads. Where uniform roof live loads are reduced to less than 20 psf (0.96 kN/m^2) in accordance with Section 1607.12.2.1 and are applied to the design of structural members arranged so as to create continuity, the reduced roof live load shall be applied to adjacent spans or to alternate spans, whichever produces the most unfavorable load effect. See Section 1607.12.2 for reductions in minimum roof live loads and Section 7.5 of ASCE 7 for partial snow loading.

1607.12.2 General. The minimum uniformly distributed live loads of roofs and marquees, L_o , in Table 1607.1 are permitted to be reduced in accordance with Section 1607.12.2.1.

1607.12.2.1 Ordinary roofs, awnings and canopies. Ordinary flat, pitched and curved roofs, and awnings and canopies other than of fabric construction supported by a skeleton structure, are permitted to be designed for a reduced uniformly distributed roof live load, L_r , as specified in the following equations or other controlling combinations of loads as specified in Section 1605, whichever produces the greater load effect.

In structures such as greenhouses, where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof load than specified in the following equations shall not be used unless approved by the building official. Such structures shall be designed for a minimum roof live load of 12 psf (0.58 kN/m^2).

$$L_r = L_o R_1 R_2 \quad (\text{Equation 16-26})$$

where: $12 \leq L_r \leq 20$

$$\text{For SI: } L_r = L_o R_1 R_2$$

where: $0.58 \leq L_r \leq 0.96$

L_o = Unreduced roof live load per square foot (m^2) of horizontal projection supported by the member (see Table 1607.1).

L_r = Reduced roof live load per square foot (m^2) of horizontal projection supported by the member.

The reduction factors R_1 and R_2 shall be determined as follows:

$$R_1 = 1 \text{ for } A_t \leq 200 \text{ square feet (18.58 m}^2) \quad (\text{Equation 16-27})$$

$$R_1 = 1.2 - 0.001A_t \text{ for } 200 \text{ square feet} \\ < A_t < 600 \text{ square feet} \quad (\text{Equation 16-28})$$

$$\text{For SI: } 1.2 - 0.011A_t \text{ for } 18.58 \text{ square meters} < A_t < 55.74 \text{ square meters}$$

$$R_1 = 0.6 \text{ for } A_t \geq 600 \text{ square feet (55.74 m}^2) \quad (\text{Equation 16-29})$$

where:

A_t = Tributary area (span length multiplied by effective width) in square feet (m^2) supported by the member, and

$$R_2 = 1 \text{ for } F \leq 4 \quad (\text{Equation 16-30})$$

$$R_2 = 1.2 - 0.05F \text{ for } 4 < F < 12 \quad (\text{Equation 16-31})$$

$$R_2 = 0.6 \text{ for } F \geq 12 \quad (\text{Equation 16-32})$$

where:

F = For a sloped roof, the number of inches of rise per foot (for SI: $F = 0.12 \times \text{slope}$, with slope expressed as a percentage), or for an arch or dome, the rise-to-span ratio multiplied by 32.

1607.12.3 Occupiable roofs. Areas of roofs that are occupiable, such as roof gardens, or for assembly or other similar purposes, and marquees are permitted to have their uniformly distributed live loads reduced in accordance with Section 1607.10.

1607.12.3.1 Landscaped roofs. The uniform design live load in unoccupied landscaped areas on roofs shall be 20 psf (0.958 kN/m^2). The weight of all landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil.

1607.12.4 Awnings and canopies. Awnings and canopies shall be designed for uniform live loads as required in Table 1607.1 as well as for snow loads and wind loads as specified in Sections 1608 and 1609.

1607.13 Crane loads. The crane live load shall be the rated capacity of the crane. Design loads for the runway beams, including connections and support brackets, of moving bridge cranes and monorail cranes shall include the maximum wheel loads of the crane and the vertical impact, lateral and longitudinal forces induced by the moving crane.

1607.13.1 Maximum wheel load. The maximum wheel loads shall be the wheel loads produced by the weight of the bridge, as applicable, plus the sum of the rated capacity and the weight of the trolley with the trolley positioned on its runway at the location where the resulting load effect is maximum.

1607.13.2 Vertical impact force. The maximum wheel loads of the crane shall be increased by the percentages

shown below to determine the induced vertical impact or vibration force:

| | |
|--|------------|
| Monorail cranes (powered)..... | 25 percent |
| Cab-operated or remotely operated bridge cranes (powered)..... | 25 percent |
| Pendant-operated bridge cranes (powered) | 10 percent |
| Bridge cranes or monorail cranes with hand-gearied bridge, trolley and hoist. | 0 percent |

1607.13.3 Lateral force. The lateral force on crane runway beams with electrically powered trolleys shall be calculated as 20 percent of the sum of the rated capacity of the crane and the weight of the hoist and trolley. The lateral force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction perpendicular to the beam, and shall be distributed with due regard to the lateral stiffness of the runway beam and supporting structure.

1607.13.4 Longitudinal force. The longitudinal force on crane runway beams, except for bridge cranes with hand-gearied bridges, shall be calculated as 10 percent of the maximum wheel loads of the crane. The longitudinal force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction parallel to the beam.

1607.14 Interior walls and partitions. Interior walls and partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the loads to which they are subjected but not less than a horizontal load of 5 psf (0.240 kN/m²).

Exception: Fabric partitions complying with Section 1607.14.1 shall not be required to resist the minimum horizontal load of 5 psf (0.24 kN/m²).

1607.14.1 Fabric partitions. Fabric partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the following load conditions:

1. A horizontal distributed load of 5 psf (0.24 kN/m²) applied to the partition framing. The total area used to determine the distributed load shall be the area of the fabric face between the framing members to which the fabric is attached. The total distributed load shall be uniformly applied to such framing members in proportion to the length of each member.
2. A concentrated load of 40 pounds (0.176 kN) applied to an 8-inch diameter (203 mm) area [50.3 square inches (32 452 mm²)] of the fabric face at a height of 54 inches (1372 mm) above the floor.

SECTION 1608 SNOW LOADS

1608.1 General. Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but the design roof load shall not be less than that determined by Section 1607.

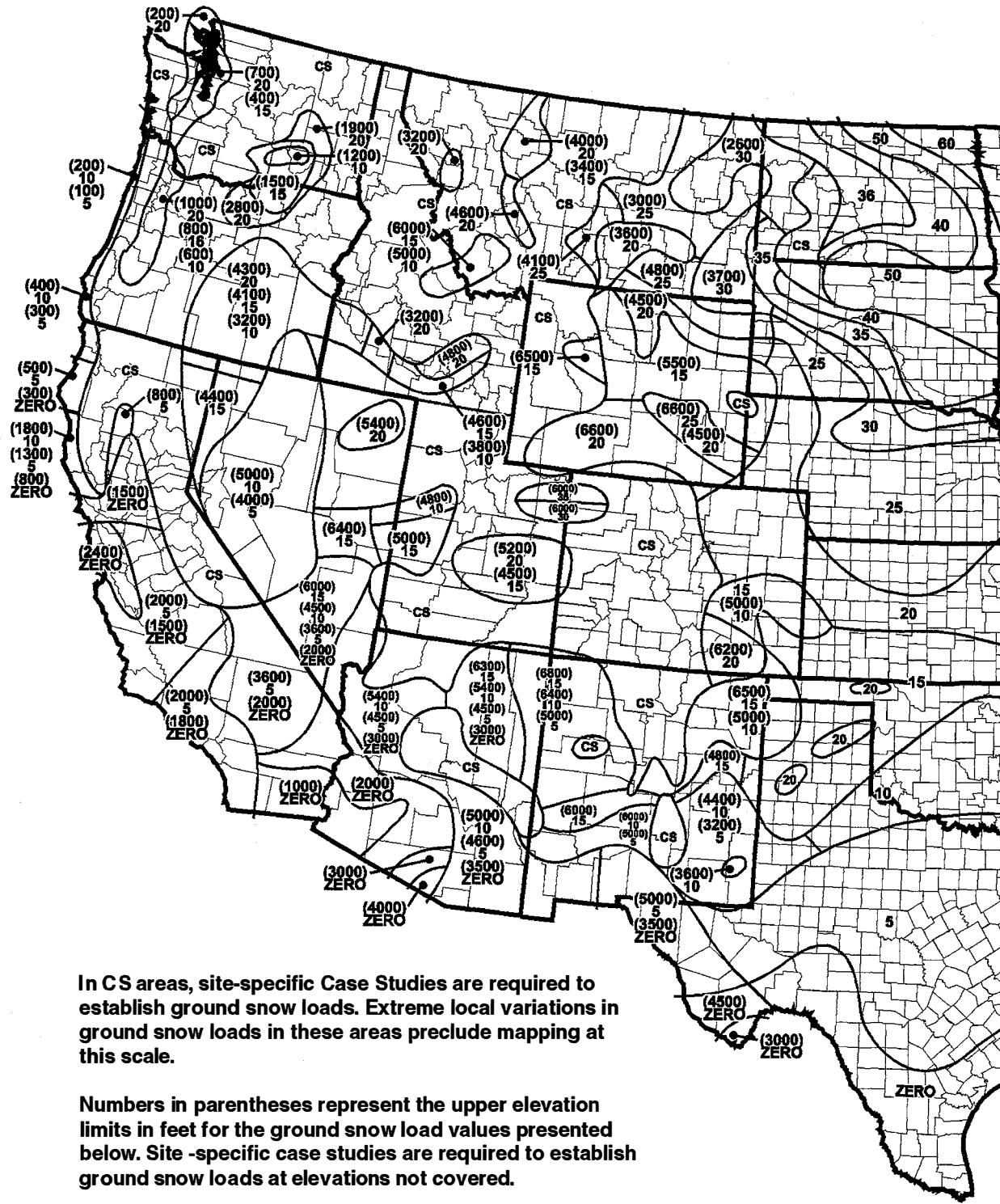
1608.2 Ground snow loads. The ground snow loads to be used in determining the design snow loads for roofs shall be determined in accordance with ASCE 7 or Figure 1608.2 for the contiguous United States and Table 1608.2 for Alaska. Site-specific case studies shall be made in areas designated "CS" in Figure 1608.2. Ground snow loads for sites at elevations above the limits indicated in Figure 1608.2 and for all sites within the CS areas shall be approved. Ground snow load determination for such sites shall be based on an extreme value statistical analysis of data available in the vicinity of the site using a value with a 2-percent annual probability of being exceeded (50-year mean recurrence interval). Snow loads are zero for Hawaii, except in mountainous regions as approved by the building official.

1608.3 Ponding instability. Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Section 7.11 of ASCE 7.

TABLE 1608.2
GROUND SNOW LOADS, p_g , FOR ALASKAN LOCATIONS

| LOCATION | POUNDS PER SQUARE FOOT | LOCATION | POUNDS PER SQUARE FOOT | LOCATION | POUNDS PER SQUARE FOOT |
|---------------|------------------------|----------|------------------------|------------------|------------------------|
| Adak | 30 | Galena | 60 | Petersburg | 150 |
| Anchorage | 50 | Gulkana | 70 | St. Paul Islands | 40 |
| Angoon | 70 | Homer | 40 | Seward | 50 |
| Barrow | 25 | Juneau | 60 | Shemya | 25 |
| Barter Island | 35 | Kenai | 70 | Sitka | 50 |
| Bethel | 40 | Kodiak | 30 | Talkeetna | 120 |
| Big Delta | 50 | Kotzebue | 60 | Unalakleet | 50 |
| Cold Bay | 25 | McGrath | 70 | Valdez | 160 |
| Cordova | 100 | Nenana | 80 | Whittier | 300 |
| Fairbanks | 60 | Nome | 70 | Wrangell | 60 |
| Fort Yukon | 60 | Palmer | 50 | Yakutat | 150 |

For SI: 1 pound per square foot = 0.0479 kN/m².



**FIGURE 1608.2
GROUND SNOW LOADS, p_g , FOR THE UNITED STATES (psf)**



FIGURE 1608.2—continued
GROUND SNOW LOADS, p_g , FOR THE UNITED STATES (psf)

SECTION 1609 WIND LOADS

1609.1 Applications. Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternate all-heights method in Section 1609.6. The type of opening protection required, the ultimate design wind speed, V_{ult} , and the exposure category for a site is permitted to be determined in accordance with Section 1609 or ASCE 7. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. Subject to the limitations of Section 1609.1.1.1, the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AF&PA WFCM.
3. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AISI S230.
4. Designs using NAAMM FP 1001.
5. Designs using TIA-222 for antenna-supporting structures and antennas, provided the horizontal extent of Topographic Category 2 escarpments in Section 2.6.6.2 of TIA-222 shall be 16 times the height of the escarpment.
6. Wind tunnel tests in accordance with Chapter 31 of ASCE 7.

The wind speeds in Figures 1609A, 1609B and 1609C are ultimate design wind speeds, V_{ult} , and shall be converted in accordance with Section 1609.3.1 to nominal design wind speeds, V_{asd} , when the provisions of the standards referenced in Exceptions 1 through 5 are used.

1609.1.1.1 Applicability. The provisions of ICC 600 are applicable only to buildings located within Exposure B or C as defined in Section 1609.4. The provisions of ICC 600, AF&PA WFCM and AISI S230 shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting the following conditions:

1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C;
2. The maximum average slope of the hill exceeds 10 percent; and
3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a

distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is greater.

1609.1.2 Protection of openings. In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant standard or ASTM E 1996 and ASTM E 1886 referenced herein as follows:

1. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the large missile test of ASTM E 1996.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the small missile test of ASTM E 1996.

Exceptions:

1. Wood structural panels with a minimum thickness of $\frac{7}{16}$ inch (11.1 mm) and maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in one- and two-story buildings classified as Group R-3 or R-4 occupancy. Panels shall be precut so that they shall be attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method and shall be secured with the attachment hardware provided. Attachments shall be designed to resist the components and cladding loads determined in accordance with the provisions of ASCE 7, with corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table 1609.1.2 with corrosion-resistant attachment hardware provided and anchors permanently installed on the building is permitted for buildings with a mean roof height of 45 feet (13 716 mm) or less where V_{asd} determined in accordance with Section 1609.3.1 does not exceed 140 mph (63 m/s).

2. Glazing in Risk Category I buildings as defined in Section 1604.5, including greenhouses that are occupied for growing plants on a production or research basis, without public access shall be permitted to be unprotected.

3. Glazing in Risk Category II, III or IV buildings located over 60 feet (18 288 mm) above the ground and over 30 feet (9144 mm) above aggregate surface roofs located within 1,500 feet (458 m) of the building shall be permitted to be unprotected.

1609.1.2.1 Louvers. Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of AMCA 54.

TABLE 1609.1.2
WIND-BORNE DEBRIS PROTECTION FASTENING SCHEDULE
FOR WOOD STRUCTURAL PANELS^{a, b, c, d}

| FASTENER TYPE | FASTENER SPACING (inches) | | |
|--|---------------------------|---------------------------------|---------------------------------|
| | Panel Span ≤ 4 feet | 4 feet < Panel Span ≤ 6 feet | 6 feet < Panel Span ≤ 8 feet |
| No. 8 wood-screw-based anchor with 2-inch embedment length | 16 | 10 | 8 |
| No. 10 wood-screw-based anchor with 2-inch embedment length | 16 | 12 | 9 |
| $\frac{1}{4}$ -inch diameter lag-screw-based anchor with 2-inch embedment length | 16 | 16 | 16 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N, 1 mile per hour = 0.447 m/s.

- a. This table is based on 140 mph wind speeds and a 45 foot mean roof height.
- b. Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located a minimum of 1 inch from the edge of the panel.
- c. Anchors shall penetrate through the exterior wall covering with an embedment length of 2 inches minimum into the building frame. Fasteners shall be located a minimum of $2\frac{1}{2}$ inches from the edge of concrete block or concrete.
- d. Where panels are attached to masonry or masonry/stucco, they shall be attached using vibration resistant anchors having a minimum ultimate withdrawal capacity of 1,500 pounds.

1609.1.2.2 Application of ASTM E 1996. The text of Section 6.2.2 of ASTM E 1996 shall be substituted as follows:

6.2.2 Unless otherwise specified, select the wind zone based on the strength design wind speed, V_{ult} , as follows:

6.2.2.1 *Wind Zone 1*—130 mph ≤ ultimate design wind speed, $V_{ult} < 140$ mph.

6.2.2.2 *Wind Zone 2*—140 mph ≤ ultimate design wind speed, $V_{ult} < 150$ mph at greater than one mile (1.6 km) from the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.3 *Wind Zone 3*—150 mph (58 m/s) ≤ ultimate design wind speed, $V_{ult} \leq 160$ mph (63 m/s), or 140 mph (54 m/s) ≤ ultimate design wind speed, $V_{ult} \leq 160$ mph (63 m/s) and within one mile (1.6 km) of the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.4 *Wind Zone 4*—ultimate design wind speed, $V_{ult} > 160$ mph (63 m/s).

1609.1.2.3 Garage doors. Garage door glazed opening protection for wind-borne debris shall meet the requirements of an approved impact-resisting standard or ANSI/DASMA 115.

1609.2 Definitions. For the purposes of Section 1609 and as used elsewhere in this code, the following terms are defined in Chapter 2.

HURRICANE-PRONE REGIONS.

WIND-BORNE DEBRIS REGION.

WIND SPEED, V_{ult} .

WIND SPEED, V_{asd} .

1609.3 Basic wind speed. The ultimate design wind speed, V_{ult} , in mph, for the determination of the wind loads shall be determined by Figures 1609A, 1609B and 1609C. The ultimate design wind speed, V_{ult} , for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609A. The ultimate design wind speed, V_{ult} , for use in the design of Risk Category III and IV buildings and structures shall be obtained from Figure 1609B. The ultimate design wind speed, V_{ult} , for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609C. The ultimate design wind speed, V_{ult} , for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The ultimate design wind speeds, V_{ult} , determined by the local jurisdiction shall be in accordance with Section 26.5.1 of ASCE 7.

In nonhurricane-prone regions, when the ultimate design wind speed, V_{ult} , is estimated from regional climatic data, the ultimate design wind speed, V_{ult} , shall be determined in accordance with Section 26.5.3 of ASCE 7.

1609.3.1 Wind speed conversion. When required, the ultimate design wind speeds of Figures 1609A, 1609B and 1609C shall be converted to nominal design wind speeds, V_{asd} , using Table 1609.3.1 or Equation 16-33.

$$V_{asd} = V_{ult} \sqrt{0.6} \quad (\text{Equation 16-33})$$

where:

V_{asd} = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609.1.1.

V_{ult} = ultimate design wind speeds determined from Figures 1609A, 1609B or 1609C.

TABLE 1609.3.1
WIND SPEED CONVERSIONS^{a, b, c}

| | | | | | | | | | | | |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| V_{ult} | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 |
| V_{asd} | 78 | 85 | 93 | 101 | 108 | 116 | 124 | 132 | 139 | 147 | 155 |

For SI: 1 mile per hour = 0.44 m/s.

a. Linear interpolation is permitted.

b. V_{asd} = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609.1.1.

c. V_{ult} = ultimate design wind speeds determined from Figures 1609A, 1609B, or 1609C.

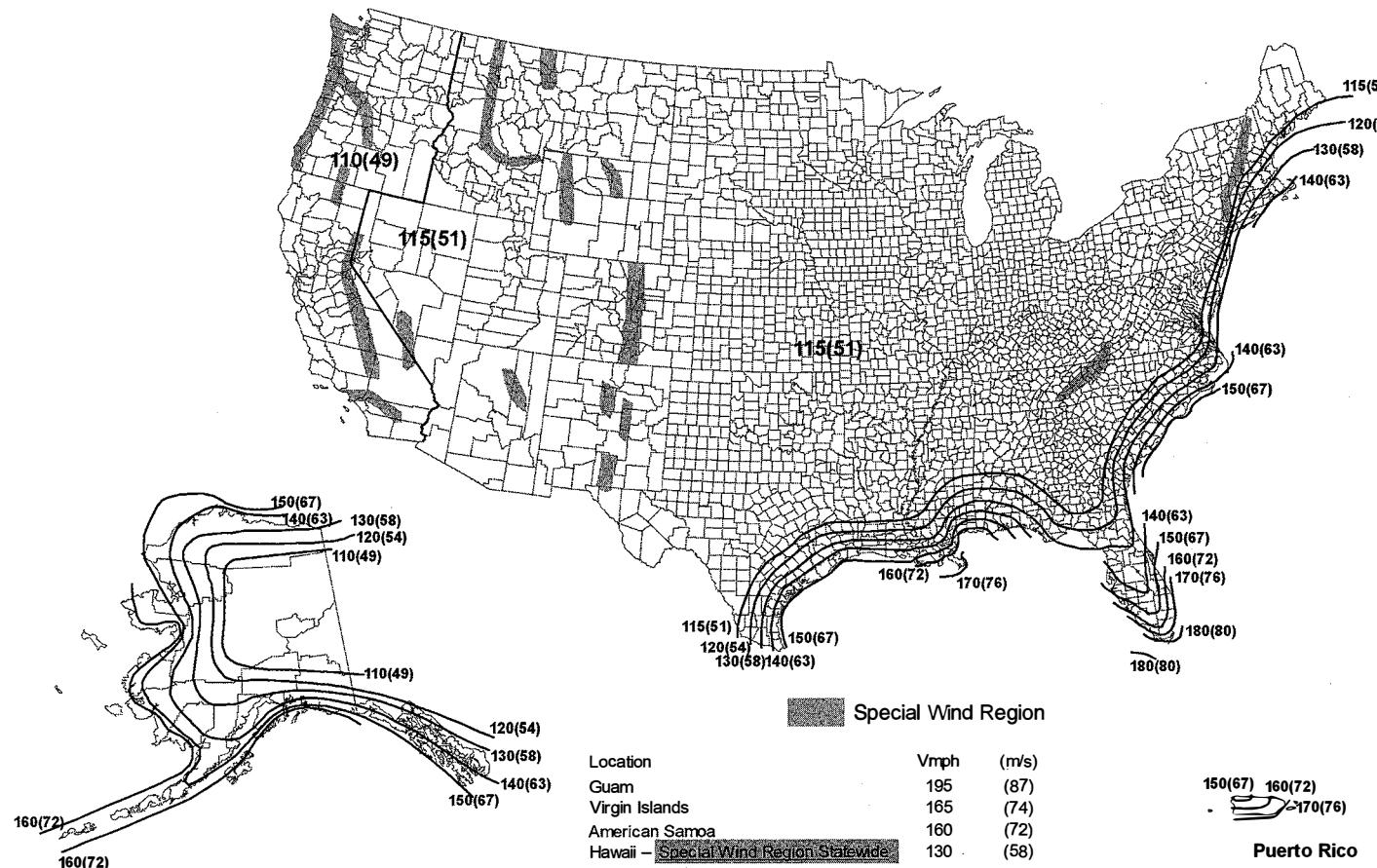
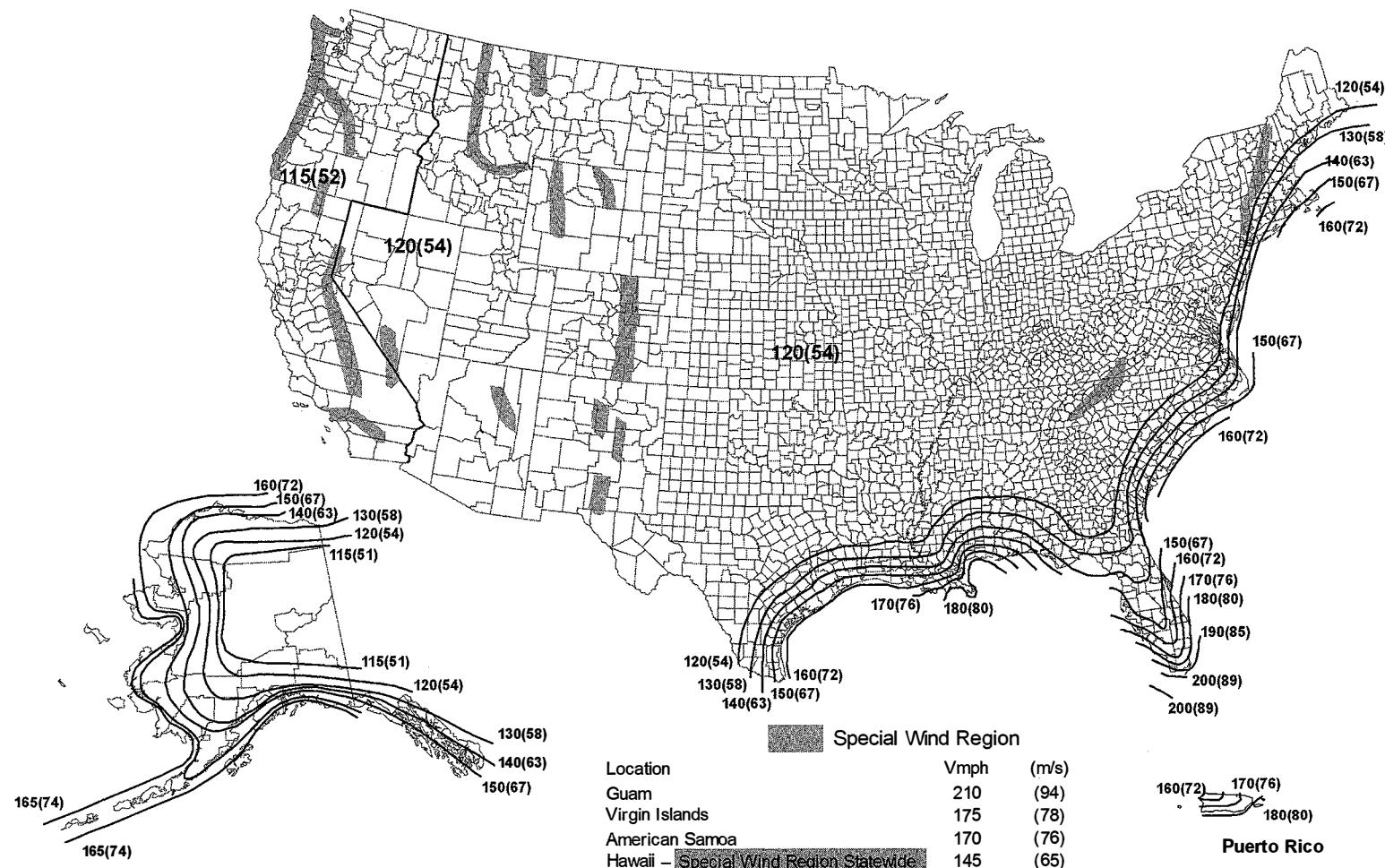
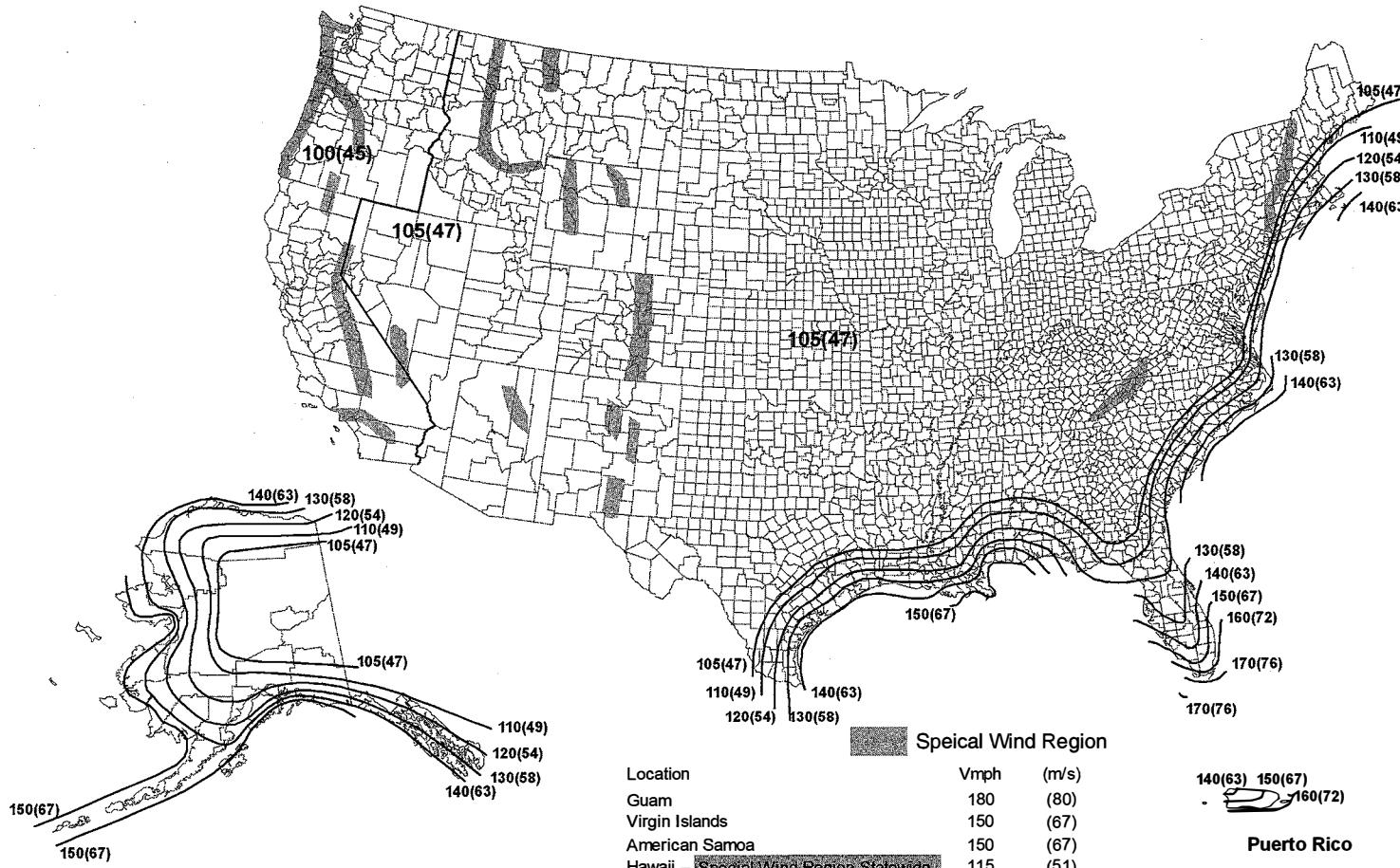


FIGURE 1609A
ULTIMATE DESIGN WIND SPEEDS, V_{ult} , FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES

**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 Years).

FIGURE 1609B
ULTIMATE DESIGN WIND SPEEDS, V_{ULT} , FOR RISK CATEGORY III AND IV BUILDINGS AND OTHER STRUCTURES



1609.4 Exposure category. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features.

1609.4.1 Wind directions and sectors. For each selected wind direction at which the wind loads are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1609.4.2 Surface roughness categories. A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1609.4.3 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1609.4.3.

Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, and grasslands.

Surface Roughness D. Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice.

1609.4.3 Exposure categories. An exposure category shall be determined in accordance with the following:

Exposure B. For buildings with a mean roof height of less than or equal to 30 feet (9144 mm), Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 1,500 feet (457 m). For buildings with a mean roof height greater than 30 feet (9144 mm), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.

Exposure C. Exposure C shall apply for all cases where Exposures B or D do not apply.

Exposure D. Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of at least 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 feet (183 m) or 20 times the building

height, whichever is greater, from an exposure D condition as defined in the previous sentence.

1609.5 Roof systems. Roof systems shall be designed and constructed in accordance with Sections 1609.5.1 through 1609.5.3, as applicable.

1609.5.1 Roof deck. The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609.5.2 Roof coverings. Roof coverings shall comply with Section 1609.5.1.

Exception: Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609.5.1 are permitted to be designed in accordance with Section 1609.5.3.

Asphalt shingles installed over a roof deck complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1507.2.7.1.

1609.5.3 Rigid tile. Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:

$$M_a = q_h C_L bLL_a [1.0 - GC_p] \quad (\text{Equation 16-34})$$

For SI:

$$M_a = \frac{q_h C_L bLL_a [1.0 - GC_p]}{1,000}$$

where:

b = Exposed width, feet (mm) of the roof tile.

C_L = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1711.2.

GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.

L = Length, feet (mm) of the roof tile.

L_a = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

M_a = Aerodynamic uplift moment, foot-pounds (N-mm) acting to raise the tail of the tile.

q_h = Wind velocity pressure, psf (kN/m^2) determined from Section 27.3.2 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be either loose laid on battens, mechanically fastened, mortar set or adhesive set.
2. The roof tiles shall be installed on solid sheathing which has been designed as components and cladding.
3. An underlayment shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).
7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).
8. Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.

1609.6 Alternate all-heights method. The alternate wind design provisions in this section are simplifications of the ASCE 7 Directional Procedure.

1609.6.1 Scope. As an alternative to ASCE 7 Chapters 27 and 30, the following provisions are permitted to be used to determine the wind effects on regularly shaped buildings, or other structures that are regularly shaped, which meet all of the following conditions:

1. The building or other structure is less than or equal to 75 feet (22 860 mm) in height with a height-to-least-width ratio of 4 or less, or the building or other structure has a fundamental frequency greater than or equal to 1 hertz.
2. The building or other structure is not sensitive to dynamic effects.
3. The building or other structure is not located on a site for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.
4. The building shall meet the requirements of a simple diaphragm building as defined in ASCE 7 Section 26.2, where wind loads are only transmitted to the main windforce-resisting system (MWFRS) at the diaphragms.
5. For open buildings, multispan gable roofs, stepped roofs, sawtooth roofs, domed roofs, roofs with

slopes greater than 45 degrees (0.79 rad), solid free-standing walls and solid signs, and rooftop equipment, apply ASCE 7 provisions.

1609.6.1.1 Modifications. The following modifications shall be made to certain subsections in ASCE 7: in Section 1609.6.2, symbols and notations that are specific to this section are used in conjunction with the symbols and notations in ASCE 7 Section 26.3.

1609.6.2 Symbols and notations. Coefficients and variables used in the alternative all-heights method equations are as follows:

C_{net} = Net-pressure coefficient based on K_d [$(G)(C_p) - (GC_{pi})$], in accordance with Table 1609.6.2.

G = Gust effect factor for rigid structures in accordance with ASCE 7 Section 26.9.1.

K_d = Wind directionality factor in accordance with ASCE 7 Table 26-6.

P_{net} = Design wind pressure to be used in determination of wind loads on buildings or other structures or their components and cladding, in psf (kN/m^2).

1609.6.3 Design equations. When using the alternative all-heights method, the MWFRS, and components and cladding of every structure shall be designed to resist the effects of wind pressures on the building envelope in accordance with Equation 16-35.

$$P_{net} = 0.00256V^2K_zC_{net}K_{zt} \quad (\text{Equation 16-35})$$

Design wind forces for the MWFRS shall not be less than 16 psf (0.77 kN/m^2) multiplied by the area of the structure projected on a plane normal to the assumed wind direction (see ASCE 7 Section 27.4.7 for criteria). Design net wind pressure for components and cladding shall not be less than 16 psf (0.77 kN/m^2) acting in either direction normal to the surface.

1609.6.4 Design procedure. The MWFRS and the components and cladding of every building or other structure shall be designed for the pressures calculated using Equation 16-35.

1609.6.4.1 Main windforce-resisting systems. The MWFRS shall be investigated for the torsional effects identified in ASCE 7 Figure 27.4.6.

1609.6.4.2 Determination of K_z and K_{zt} . Velocity pressure exposure coefficient, K_z , shall be determined in accordance with ASCE 7 Section 27.3.1 and the topographic factor, K_{zt} , shall be determined in accordance with ASCE 7 Section 26.8.

1. For the windward side of a structure, K_z and K_{zt} shall be based on height z .
2. For leeward and sidewalls, and for windward and leeward roofs, K_z and K_{zt} shall be based on mean roof height h .

**TABLE 1609.6.2
NET PRESSURE COEFFICIENTS, C_{net} ^{a,b}**

| STRUCTURE OR PART THEREOF | DESCRIPTION | C_{net} FACTOR | | | |
|--|---------------------------------------|------------------------------|---------------------|---------------------|---------------------|
| | | Enclosed | | Partially enclosed | |
| | | + Internal pressure | - Internal pressure | + Internal pressure | - Internal pressure |
| 1. Main windforce-resisting frames and systems | Walls: | | | | |
| | | Windward wall | 0.43 | 0.73 | 0.11 |
| | | Leeward wall | -0.51 | -0.21 | -0.83 |
| | | Sidewall | -0.66 | -0.35 | -0.97 |
| | Parapet wall | Windward | 1.28 | | 1.28 |
| | | Leeward | -0.85 | | -0.85 |
| | Roofs: | Enclosed | | Partially enclosed | |
| | | Wind perpendicular to ridge | + Internal pressure | - Internal pressure | + Internal pressure |
| | | Leeward roof or flat roof | -0.66 | -0.35 | -0.97 |
| | | Windward roof slopes: | | | |
| | Slope < 2:12 (10°) | Condition 1 | -1.09 | -0.79 | -1.41 |
| | | Condition 2 | -0.28 | 0.02 | -0.60 |
| | Slope = 4:12 (18°) | Condition 1 | -0.73 | -0.42 | -1.04 |
| | | Condition 2 | -0.05 | 0.25 | -0.37 |
| | Slope = 5:12 (23°) | Condition 1 | -0.58 | -0.28 | -0.90 |
| | | Condition 2 | 0.03 | 0.34 | -0.29 |
| | Slope = 6:12 (27°) | Condition 1 | -0.47 | -0.16 | -0.78 |
| | | Condition 2 | 0.06 | 0.37 | -0.25 |
| | Slope = 7:12 (30°) | Condition 1 | -0.37 | -0.06 | -0.68 |
| | | Condition 2 | 0.07 | 0.37 | -0.25 |
| | Slope = 9:12 (37°) | Condition 1 | -0.27 | 0.04 | -0.58 |
| | | Condition 2 | 0.14 | 0.44 | -0.18 |
| | Slope = 12:12 (45°) | | 0.14 | 0.44 | -0.18 |
| | Wind parallel to ridge and flat roofs | | -1.09 | -0.79 | -1.41 |
| Nonbuilding Structures: Chimneys, Tanks and Similar Structures: | | | | | |
| | | h/D | | | |
| | | 1 | | 7 | 25 |
| Square (Wind normal to face) | | 0.99 | | 1.07 | 1.53 |
| Square (Wind on diagonal) | | 0.77 | | 0.84 | 1.15 |
| Hexagonal or Octagonal | | 0.81 | | 0.97 | 1.13 |
| Round | | 0.65 | | 0.81 | 0.97 |
| Open signs and lattice frameworks | | Ratio of solid to gross area | | | |
| | | < 0.1 | | 0.1 to 0.29 | 0.3 to 0.7 |
| Flat | | 1.45 | | 1.30 | 1.16 |
| Round | | 0.87 | | 0.94 | 1.08 |

(continued)

**TABLE 1609.6.2—continued
NET PRESSURE COEFFICIENTS, $C_{net}^{a,b}$**

| STRUCTURE OR PART THEREOF | DESCRIPTION | C_{net} FACTOR | |
|---------------------------|--|------------------|---------------------------|
| | Roof elements and slopes | Enclosed | Partially enclosed |
| | Gable of hipped configurations (Zone 1) | | |
| | Flat $<$ Slope $<$ 6:12 (27°) See ASCE 7 Figure 30.4-2B Zone 1 | | |
| Positive | 10 square feet or less | 0.58 | 0.89 |
| | 100 square feet or more | 0.41 | 0.72 |
| Negative | 10 square feet or less | -1.00 | -1.32 |
| | 100 square feet or more | -0.92 | -1.23 |
| | Overhang: Flat $<$ Slope $<$ 6:12 (27°) See ASCE 7 Figure 30.4-2A Zone 1 | | |
| Negative | 10 square feet or less | -1.45 | |
| | 100 square feet or more | -1.36 | |
| | 500 square feet or more | -0.94 | |
| | 6:12 (27°) $<$ Slope $<$ 12:12 (45°) See ASCE 7 Figure 30.4-2C Zone 1 | | |
| Positive | 10 square feet or less | 0.92 | 1.23 |
| | 100 square feet or more | 0.83 | 1.15 |
| Negative | 10 square feet or less | -1.00 | -1.32 |
| | 100 square feet or more | -0.83 | -1.15 |
| | Monosloped configurations (Zone 1) | Enclosed | Partially enclosed |
| | Flat $<$ Slope $<$ 7:12 (30°) See ASCE 7 Figure 30.4-5B Zone 1 | | |
| Positive | 10 square feet or less | 0.49 | 0.81 |
| | 100 square feet or more | 0.41 | 0.72 |
| Negative | 10 square feet or less | -1.26 | -1.57 |
| | 100 square feet or more | -1.09 | -1.40 |
| | Tall flat-topped roofs $h > 60$ feet | Enclosed | Partially enclosed |
| | Flat $<$ Slope $<$ 2:12 (10°) (Zone 1) See ASCE 7 Figure 30.8-1 Zone 1 | | |
| Negative | 10 square feet or less | -1.34 | -1.66 |
| | 500 square feet or more | -0.92 | -1.23 |
| | Gable or hipped configurations at ridges, eaves and rakes (Zone 2) | | |
| | Flat $<$ Slope $<$ 6:12 (27°) See ASCE 7 Figure 30.4-2B Zone 2 | | |
| Positive | 10 square feet or less | 0.58 | 0.89 |
| | 100 square feet or more | 0.41 | 10.72 |
| Negative | 10 square feet or less | -1.68 | -2.00 |
| | 100 square feet or more | -1.17 | -1.49 |
| | Overhang for Slope Flat $<$ Slope $<$ 6:12 (27°) See ASCE 7 Figure 30.4-2B Zone 2 | | |
| Negative | 10 square feet or less | -1.87 | |
| | 100 square feet or more | -1.87 | |
| | 6:12 (27°) $<$ Slope $<$ 12:12 (45°) Figure 30.4-2C | Enclosed | Partially enclosed |
| Positive | 10 square feet or less | 0.92 | 1.23 |
| | 100 square feet or more | 0.83 | 1.15 |
| Negative | 10 square feet or less | -1.17 | -1.49 |
| | 100 square feet or more | -1.00 | -1.32 |
| | Overhang for 6:12 (27°) $<$ Slope $<$ 12:12 (45°) See ASCE 7 Figure 30.4-2C Zone 2 | | |
| Negative | 10 square feet or less | -1.70 | |
| | 500 square feet or more | -1.53 | |

(continued)

**TABLE 1609.6.2—continued
NET PRESSURE COEFFICIENTS, $C_{net}^{a,b}$**

| STRUCTURE OR PART THEREOF | DESCRIPTION | | C_{net} FACTOR | |
|---|-------------------------|-----------------|------------------------------------|---------------------------|
| Roof elements and slopes | | | Enclosed | Partially enclosed |
| Monosloped configurations at ridges, eaves and rakes (Zone 2) | | | | |
| Flat $< \text{Slope} < 7:12$ (30°) See ASCE 7 Figure 30.4-5B Zone 2 | | | | |
| Positive | 10 square feet or less | 0.49 | 0.81 | |
| | 100 square feet or more | 0.41 | 0.72 | |
| Negative | 10 square feet or less | -1.51 | -1.83 | |
| | 100 square feet or more | -1.43 | -1.74 | |
| Tall flat topped roofs $h > 60$ feet | | Enclosed | Partially enclosed | |
| Flat $< \text{Slope} < 2:12$ (10°) (Zone 2) See ASCE 7 Figure 30.8-1 Zone 2 | | | | |
| Negative | 10 square feet or less | -2.11 | -2.42 | |
| | 500 square feet or more | -1.51 | -1.83 | |
| Gable or hipped configurations at corners (Zone 3) See ASCE 7 Figure 30.4-2B Zone 3 | | | | |
| Flat $< \text{Slope} < 6:12$ (27°) | | Enclosed | Partially enclosed | |
| Positive | 10 square feet or less | 0.58 | 0.89 | |
| | 100 square feet or more | 0.41 | 0.72 | |
| Negative | 10 square feet or less | -2.53 | -2.85 | |
| | 100 square feet or more | -1.85 | -2.17 | |
| Overhang for Slope Flat $< \text{Slope} < 6:12$ (27°) See ASCE 7 Figure 30.4-2B Zone 3 | | | | |
| Negative | 10 square feet or less | | -3.15 | |
| | 100 square feet or more | | -2.13 | |
| 6:12 (27°) $< 12:12$ (45°) See ASCE 7 Figure 30.4-2C Zone 3 | | | | |
| Positive | 10 square feet or less | 0.92 | 1.23 | |
| | 100 square feet or more | 0.83 | 1.15 | |
| Negative | 10 square feet or less | -1.17 | -1.49 | |
| | 100 square feet or more | -1.00 | -1.32 | |
| Overhang for 6:12 (27°) $< \text{Slope} < 12:12$ (45°) | | Enclosed | Partially enclosed | |
| Negative | 10 square feet or less | | -1.70 | |
| | 100 square feet or more | | -1.53 | |
| Monosloped Configurations at corners (Zone 3) See ASCE 7 Figure 30.4-5B Zone 3 | | | | |
| Flat $< \text{Slope} < 7:12$ (30°) | | | | |
| Positive | 10 square feet or less | 0.49 | 0.81 | |
| | 100 square feet or more | 0.41 | 0.72 | |
| Negative | 10 square feet or less | -2.62 | -2.93 | |
| | 100 square feet or more | -1.85 | -2.17 | |
| Tall flat topped roofs $h > 60$ feet | | Enclosed | Partially enclosed | |
| Flat $< \text{Slope} < 2:12$ (10°) (Zone 3) See ASCE 7 Figure 30.8-1 Zone 3 | | | | |
| Negative | 10 square feet or less | -2.87 | -3.19 | |
| | 500 square feet or more | -2.11 | -2.42 | |
| Wall Elements: $h = 60$ feet (Zone 4) Figure 30.4-1 | | Enclosed | Partially enclosed | |
| Positive | 10 square feet or less | 1.00 | 1.32 | |
| | 500 square feet or more | 0.75 | 1.06 | |
| Negative | 10 square feet or less | -1.09 | -1.40 | |
| | 500 square feet or more | -0.83 | -1.15 | |
| Wall Elements: $h > 60$ feet (Zone 4) See ASCE 7 Figure 30.8-1 Zone 4 | | | | |

3. Components and cladding in areas of discontinuities—roofs and overhangs

4. Components and cladding not in areas of discontinuity—walls and parapets (continued)

**TABLE 1609.6.2—continued
NET PRESSURE COEFFICIENTS, C_{net} ^{a, b}**

| STRUCTURE OR PART THEREOF | DESCRIPTION | | C_{net} FACTOR | |
|---|---|-------------------------|------------------|--------------------|
| 4. Components and cladding not in areas of discontinuity-walls and parapets | Negative | 20 square feet or less | -0.92 | -1.23 |
| | | 500 square feet or more | -0.75 | -1.06 |
| | Parapet Walls | | | |
| | Positive | | 2.87 | 3.19 |
| | | | -1.68 | -2.00 |
| | Wall elements: $h \leq 60$ feet (Zone 5) Figure 30.4-1 | | Enclosed | Partially enclosed |
| | Positive | 10 square feet or less | 1.00 | 1.32 |
| | | 500 square feet or more | 0.75 | 1.06 |
| | Negative | 10 square feet or less | -1.34 | -1.66 |
| | | 500 square feet or more | -0.83 | -1.15 |
| 5. Components and cladding in areas of discontinuity—walls and parapets | Wall elements: $h > 60$ feet (Zone 5) See ASCE 7 Figure 30.8-1 Zone 4 | | | |
| | Positive | 20 square feet or less | 0.92 | 1.23 |
| | | 500 square feet or more | 0.66 | 0.98 |
| | Negative | 20 square feet or less | -1.68 | -2.00 |
| | | 500 square feet or more | -1.00 | -1.32 |
| | Parapet walls | | | |
| | Positive | | 3.64 | 3.95 |
| | | | -2.45 | -2.76 |

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929m², 1 degree = 0.0175 rad.

a. Linear interpolation between values in the table is permitted.

b. Some C_{net} values have been grouped together. Less conservative results may be obtained by applying ASCE 7 provisions.

1609.6.4.3 Determination of net pressure coefficients, C_{net} . For the design of the MWFRS and for components and cladding, the sum of the internal and external net pressure shall be based on the net pressure coefficient, C_{net} .

1. The pressure coefficient, C_{net} , for walls and roofs shall be determined from Table 1609.6.2.
2. Where C_{net} has more than one value, the more severe wind load condition shall be used for design.

1609.6.4.4 Application of wind pressures. When using the alternative all-heights method, wind pressures shall be applied simultaneously on, and in a direction normal to, all building envelope wall and roof surfaces.

1609.6.4.4.1 Components and cladding. Wind pressure for each component or cladding element is applied as follows using C_{net} values based on the effective wind area, A , contained within the zones in areas of discontinuity of width and/or length “a,” “2a” or “4a” at: corners of roofs and walls; edge strips for ridges, rakes and eaves; or field areas on walls or roofs as indicated in figures in tables in ASCE 7 as referenced in Table 1609.6.2 in accordance with the following:

1. Calculated pressures at local discontinuities acting over specific edge strips or corner boundary areas.

2. Include “field” (Zone 1, 2 or 4, as applicable) pressures applied to areas beyond the boundaries of the areas of discontinuity.
3. Where applicable, the calculated pressures at discontinuities (Zone 2 or 3) shall be combined with design pressures that apply specifically on rakes or eave overhangs.

SECTION 1610 SOIL LATERAL LOADS

1610.1 General. Foundation walls and retaining walls shall be designed to resist lateral soil loads. Soil loads specified in Table 1610.1 shall be used as the minimum design lateral soil loads unless determined otherwise by a geotechnical investigation in accordance with Section 1803. Foundation walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top shall be permitted to be designed for active pressure. Design lateral pressure from surcharge loads shall be added to the lateral earth pressure load. Design lateral pressure shall be increased if soils at the site are expansive. Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1805.4.2 and 1805.4.3.

Exception: Foundation walls extending not more than 8 feet (2438 mm) below grade and laterally supported at the

top by flexible diaphragms shall be permitted to be designed for active pressure.

SECTION 1611 RAIN LOADS

1611.1 Design rain loads. Each portion of a roof shall be designed to sustain the load of rainwater that will accumulate on it if the primary drainage system for that portion is blocked plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow. The design rainfall shall be based on the 100-year hourly rainfall rate indicated in Figure 1611.1 or on other rainfall rates determined from approved local weather data.

$$R = 5.2(d_s + d_h) \quad (\text{Equation 16-36})$$

$$\text{For SI: } R = 0.0098(d_s + d_h)$$

where:

d_h = Additional depth of water on the undeflected roof above the inlet of secondary drainage system at its design flow (i.e., the hydraulic head), in inches (mm).

d_s = Depth of water on the undeflected roof up to the inlet of secondary drainage system when the primary

drainage system is blocked (i.e., the static head), in inches (mm).

R = Rain load on the undeflected roof, in psf (kN/m^2). When the phrase "undeflected roof" is used, deflections from loads (including dead loads) shall not be considered when determining the amount of rain on the roof.

1611.2 Ponding instability. Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Section 8.4 of ASCE 7.

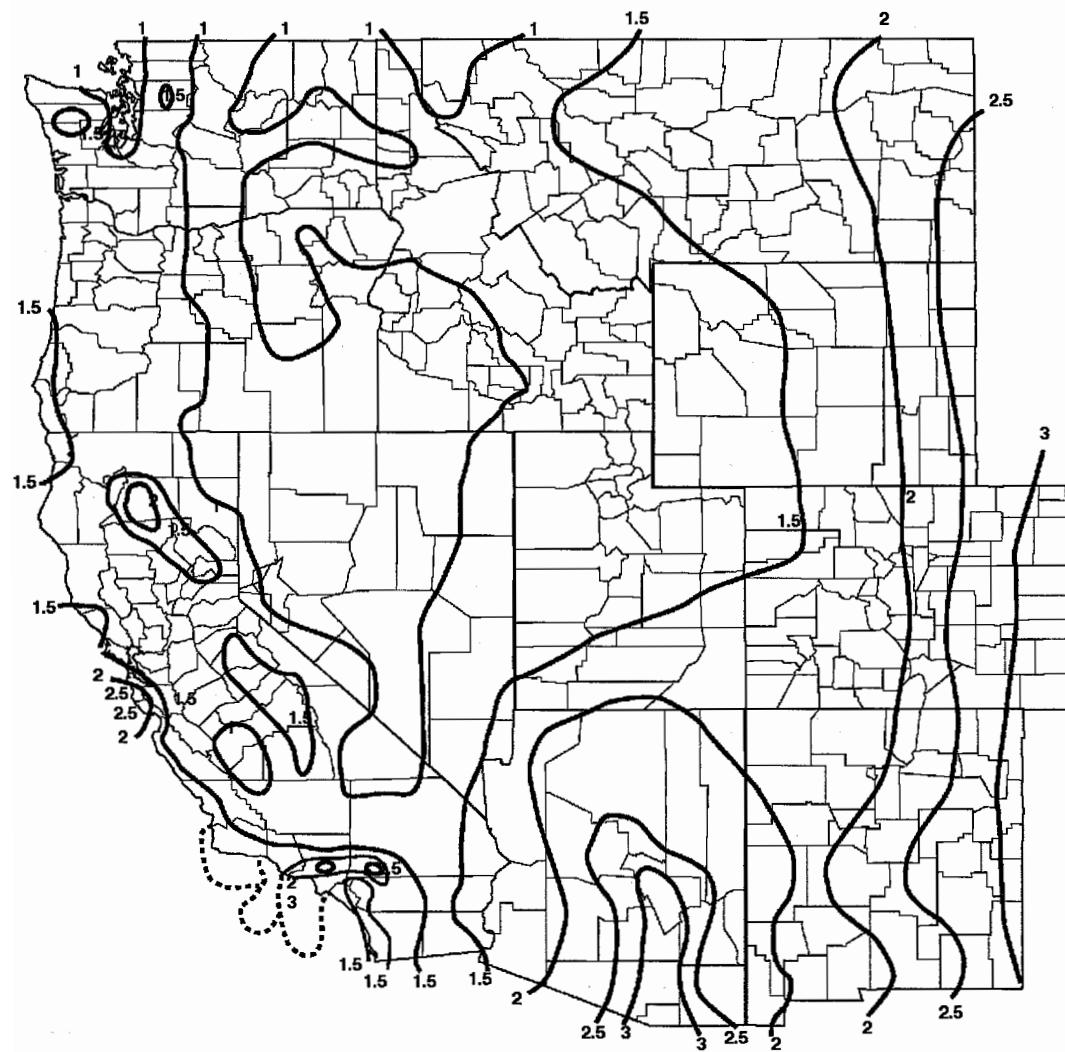
1611.3 Controlled drainage. Roofs equipped with hardware to control the rate of drainage shall be equipped with a secondary drainage system at a higher elevation that limits accumulation of water on the roof above that elevation. Such roofs shall be designed to sustain the load of rainwater that will accumulate on them to the elevation of the secondary drainage system plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow determined from Section 1611.1. Such roofs shall also be checked for ponding instability in accordance with Section 1611.2.

TABLE 1610.1
LATERAL SOIL LOAD

| DESCRIPTION OF BACKFILL MATERIAL ^c | UNIFIED SOIL CLASSIFICATION | DESIGN LATERAL SOIL LOAD ^a (pound per square foot per foot of depth) | |
|---|-----------------------------|--|------------------|
| | | Active pressure | At-rest pressure |
| Well-graded, clean gravels; gravel-sand mixes | GW | 30 | 60 |
| Poorly graded clean gravels; gravel-sand mixes | GP | 30 | 60 |
| Silty gravels, poorly graded gravel-sand mixes | GM | 40 | 60 |
| Clayey gravels, poorly graded gravel-and-clay mixes | GC | 45 | 60 |
| Well-graded, clean sands; gravelly sand mixes | SW | 30 | 60 |
| Poorly graded clean sands; sand-gravel mixes | SP | 30 | 60 |
| Silty sands, poorly graded sand-silt mixes | SM | 45 | 60 |
| Sand-silt clay mix with plastic fines | SM-SC | 45 | 100 |
| Clayey sands, poorly graded sand-clay mixes | SC | 60 | 100 |
| Inorganic silts and clayey silts | ML | 45 | 100 |
| Mixture of inorganic silt and clay | ML-CL | 60 | 100 |
| Inorganic clays of low to medium plasticity | CL | 60 | 100 |
| Organic silts and silt clays, low plasticity | OL | Note b | Note b |
| Inorganic clayey silts, elastic silts | MH | Note b | Note b |
| Inorganic clays of high plasticity | CH | Note b | Note b |
| Organic clays and silty clays | OH | Note b | Note b |

For SI: 1 pound per square foot per foot of depth = 0.157 kPa/m, 1 foot = 304.8 mm.

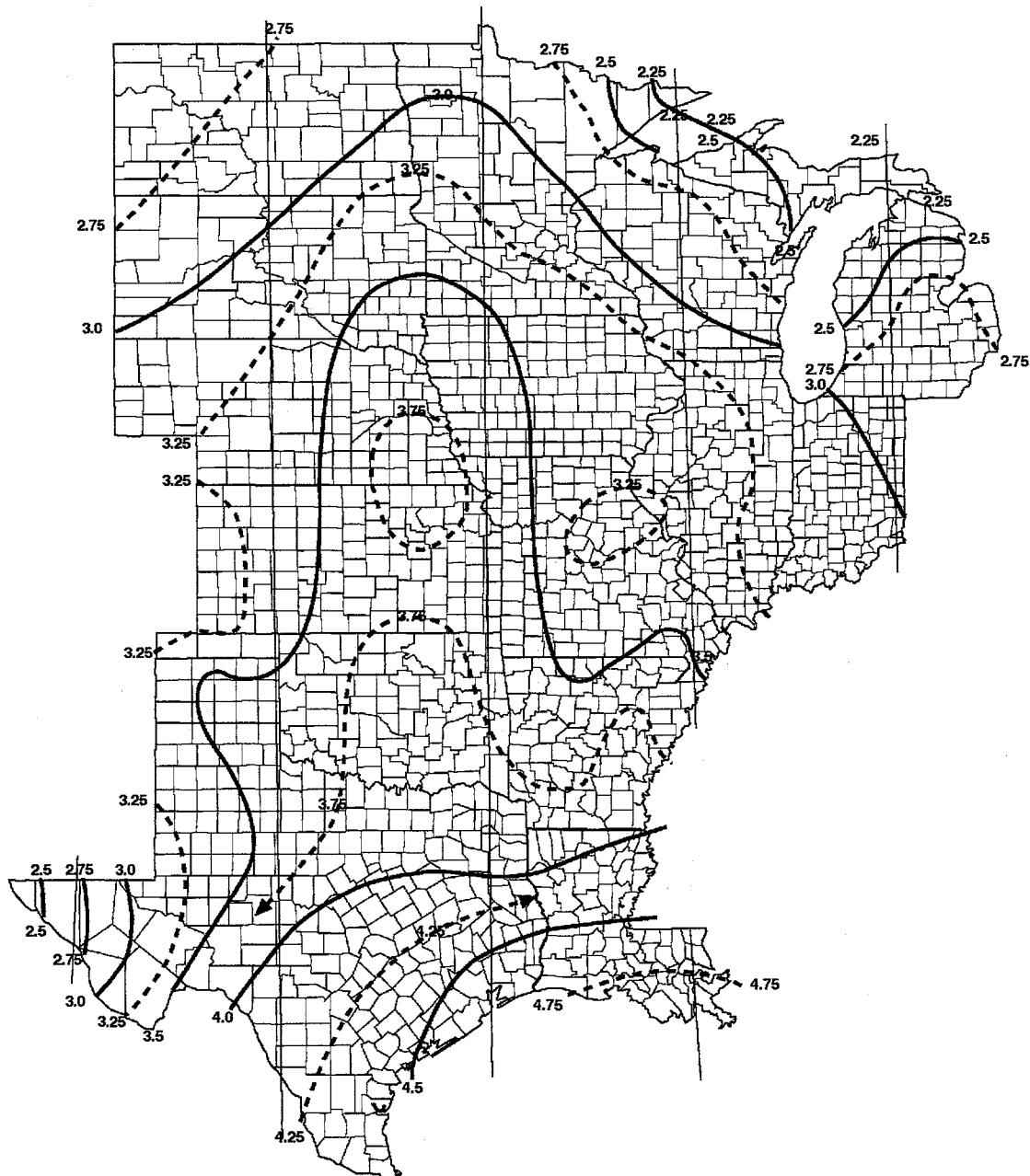
- a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.
- b. Unsuitable as backfill material.
- c. The definition and classification of soil materials shall be in accordance with ASTM D 2487.



[P] FIGURE 1611.1
100-YEAR, 1-HOUR RAINFALL (INCHES) WESTERN UNITED STATES

For SI: 1 inch = 25.4 mm.

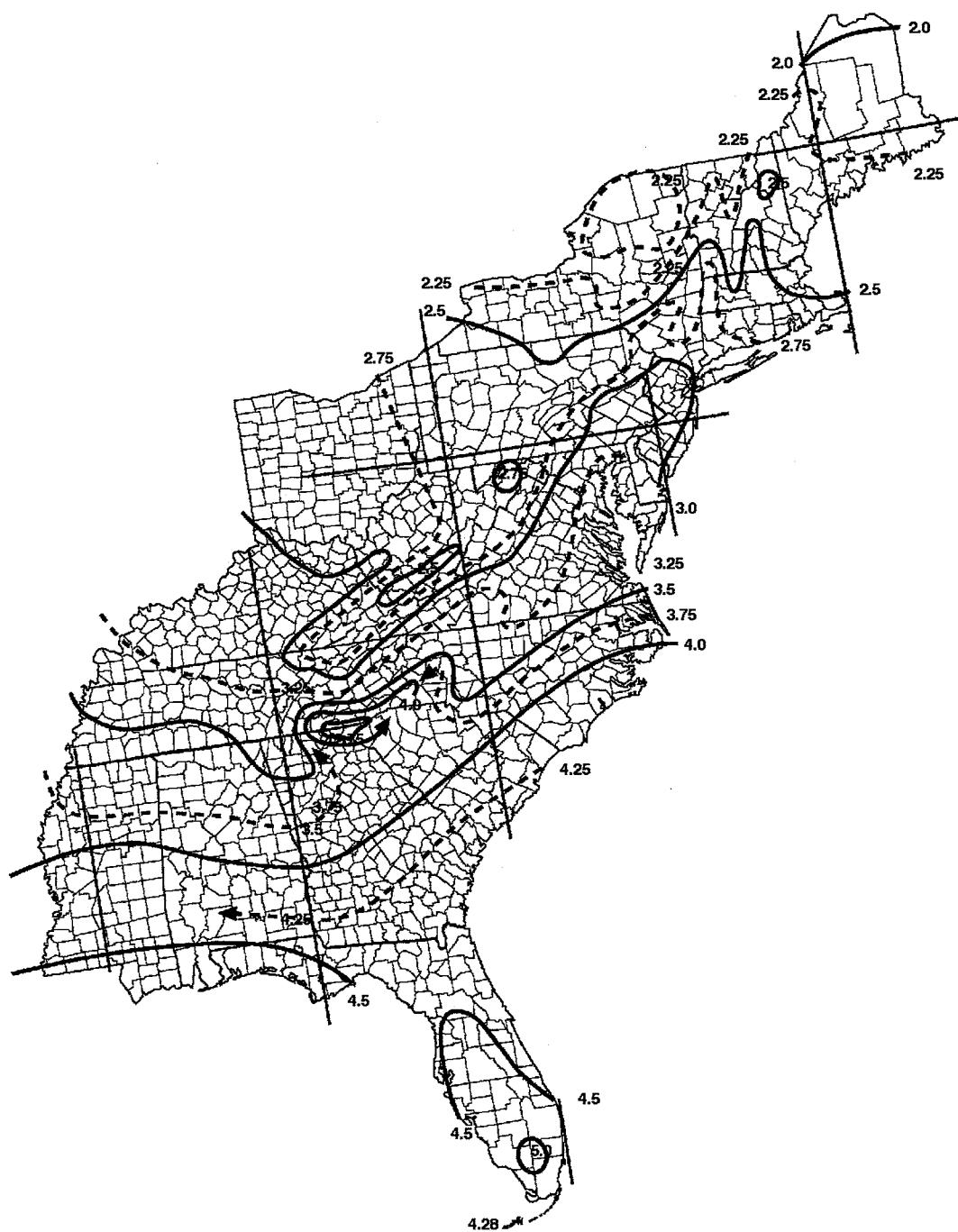
Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) CENTRAL UNITED STATES

For SI: 1 inch = 25.4 mm.

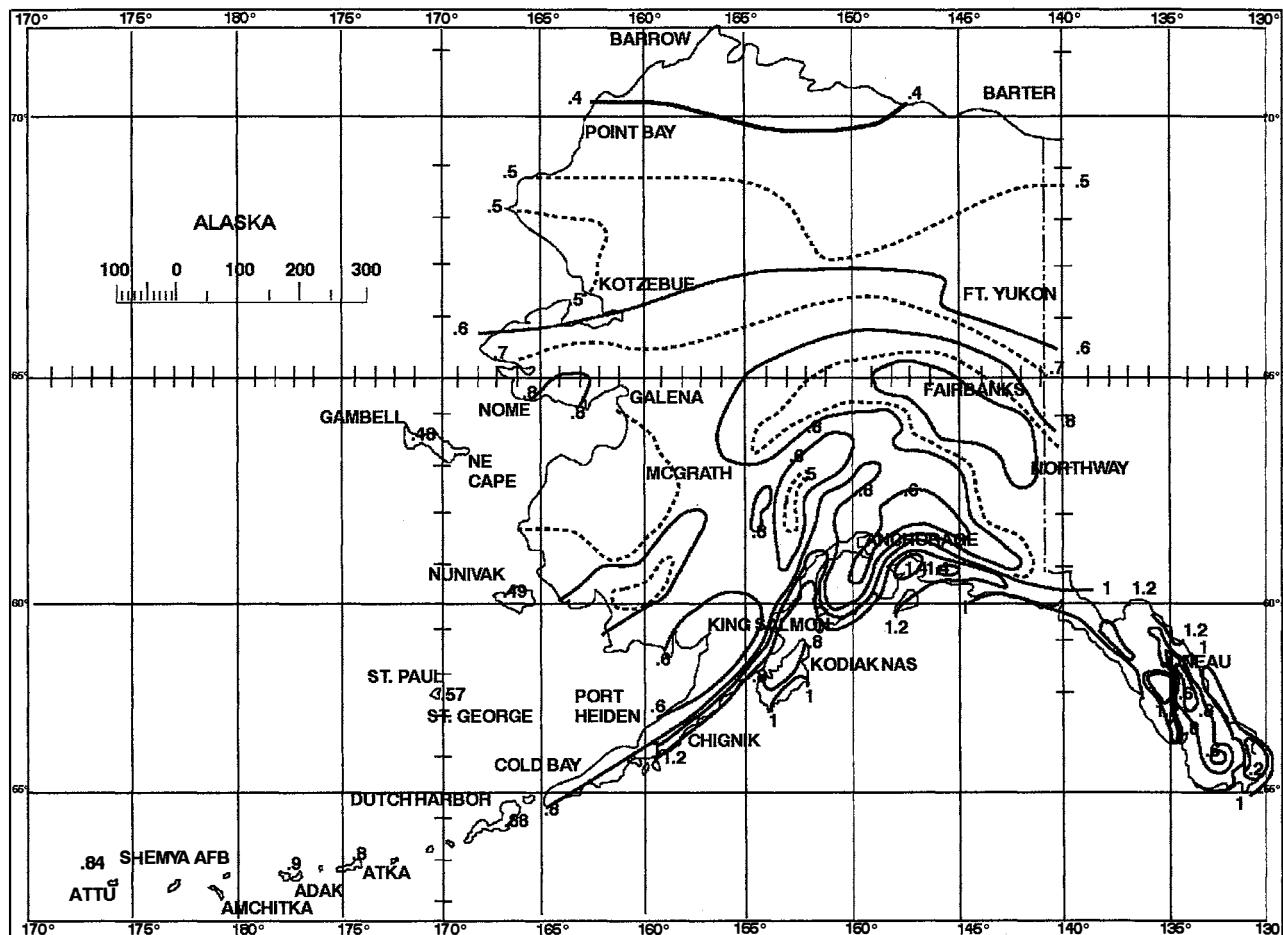
Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) EASTERN UNITED STATES

For SI: 1 inch = 25.4 mm.

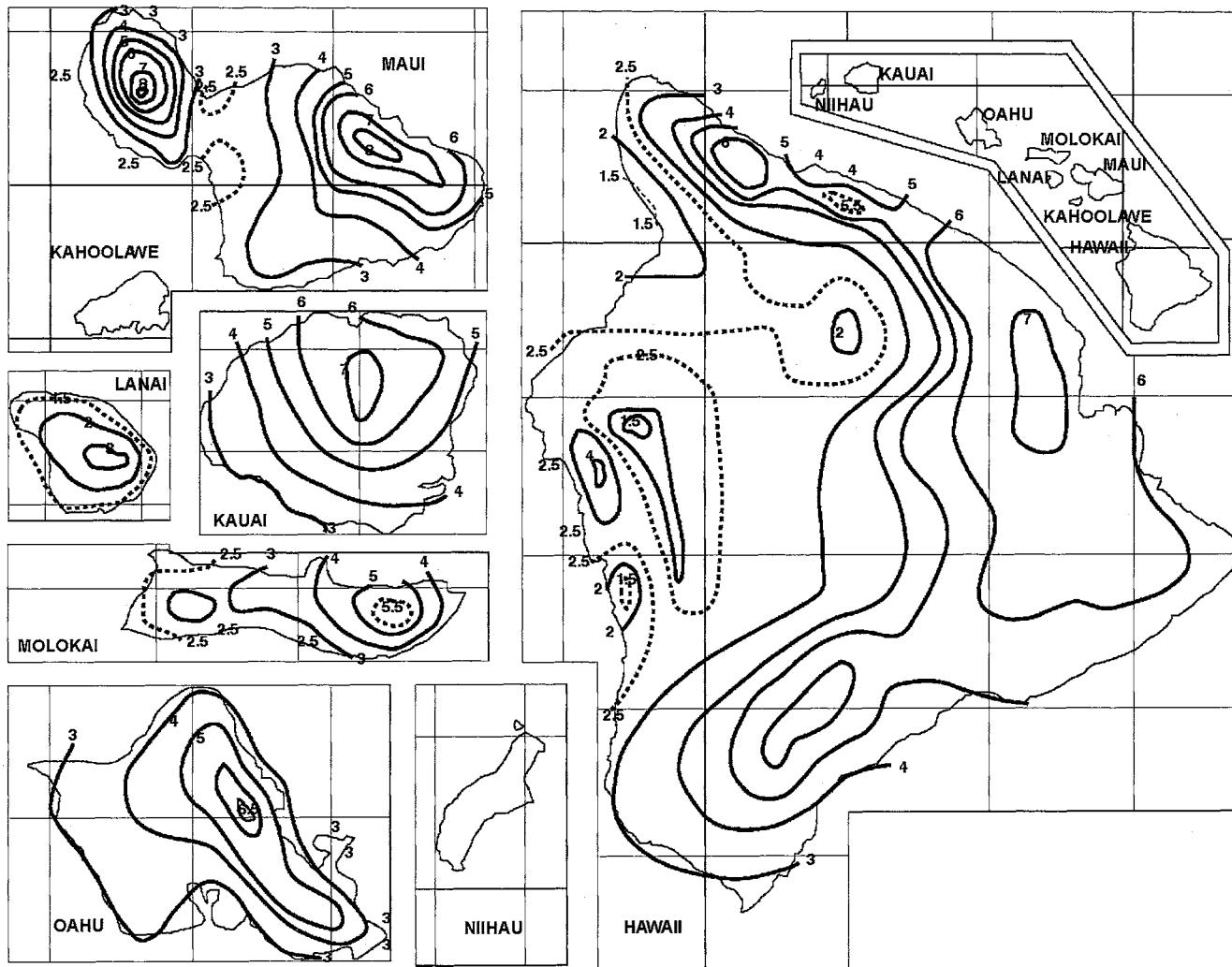
Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) ALASKA

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) HAWAII

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

SECTION 1612 FLOOD LOADS

1612.1 General. Within flood hazard areas as established in Section 1612.3, all new construction of buildings, structures and portions of buildings and structures, including substantial improvement and restoration of substantial damage to buildings and structures, shall be designed and constructed to resist the effects of flood hazards and flood loads. For buildings that are located in more than one flood hazard area, the provisions associated with the most restrictive flood hazard area shall apply.

1612.2 Definitions. The following terms are defined in Chapter 2:

BASE FLOOD.

BASE FLOOD ELEVATION.

BASEMENT.

DESIGN FLOOD.

DESIGN FLOOD ELEVATION.

DRY FLOODPROOFING.

EXISTING CONSTRUCTION.

EXISTING STRUCTURE.

FLOOD or FLOODING.

FLOOD DAMAGE-RESISTANT MATERIALS.

FLOOD HAZARD AREA.

FLOOD HAZARD AREA SUBJECT TO HIGH-VELOCITY WAVE ACTION.

FLOOD INSURANCE RATE MAP (FIRM).

FLOOD INSURANCE STUDY.

FLOODWAY.

LOWEST FLOOR.

SPECIAL FLOOD HAZARD AREA.

START OF CONSTRUCTION.

SUBSTANTIAL DAMAGE.

SUBSTANTIAL IMPROVEMENT.

1612.3 Establishment of flood hazard areas. To establish flood hazard areas, the applicable governing authority shall adopt a flood hazard map and supporting data. The flood hazard map shall include, at a minimum, areas of special flood hazard as identified by the Federal Emergency Management Agency in an engineering report entitled "The Flood Insurance Study for [INSERT NAME OF JURISDICTION]," dated [INSERT DATE OF ISSUANCE], as amended or revised with the accompanying Flood Insurance Rate Map (FIRM) and Flood Boundary and Floodway Map (FBFM) and related supporting data along with any revisions thereto. The adopted flood hazard map and supporting data are hereby adopted by reference and declared to be part of this section.

Exception: [OSHPD 2] The flood hazard map shall include, at a minimum, areas of special flood hazard as identified by the Federal Emergency Management Agency's Flood Insurance Study (FIS) adopted by the

local authority having jurisdiction where the project is located.

1612.3.1 Design flood elevations. Where design flood elevations are not included in the flood hazard areas established in Section 1612.3, or where floodways are not designated, the building official is authorized to require the applicant to:

1. Obtain and reasonably utilize any design flood elevation and floodway data available from a federal, state or other source; or
2. Determine the design flood elevation and/or floodway in accordance with accepted hydrologic and hydraulic engineering practices used to define special flood hazard areas. Determinations shall be undertaken by a registered design professional who shall document that the technical methods used reflect currently accepted engineering practice.

1612.3.2 Determination of impacts. In riverine flood hazard areas where design flood elevations are specified but floodways have not been designated, the applicant shall provide a floodway analysis that demonstrates that the proposed work will not increase the design flood elevation more than 1 foot (305 mm) at any point within the jurisdiction of the applicable governing authority.

1612.4 Design and construction. The design and construction of buildings and structures located in flood hazard areas, including flood hazard areas subject to high-velocity wave action, shall be in accordance with Chapter 5 of ASCE 7 and with ASCE 24.

1612.5 Flood hazard documentation. The following documentation shall be prepared and sealed by a registered design professional and submitted to the building official:

1. For construction in flood hazard areas not subject to high-velocity wave action:
 - 1.1. The elevation of the lowest floor, including the basement, as required by the lowest floor elevation inspection in Section 110.3.3, *Chapter 1, Division II*.
 - 1.2. For fully enclosed areas below the design flood elevation where provisions to allow for the automatic entry and exit of floodwaters do not meet the minimum requirements in Section 2.6.2.1 of ASCE 24, construction documents shall include a statement that the design will provide for equalization of hydrostatic flood forces in accordance with Section 2.6.2.2 of ASCE 24.
 - 1.3. For dry floodproofed nonresidential buildings, construction documents shall include a statement that the dry floodproofing is designed in accordance with ASCE 24.
2. For construction in flood hazard areas subject to high-velocity wave action:
 - 2.1. The elevation of the bottom of the lowest horizontal structural member as required by the

- lowest floor elevation inspection in Section 110.3.3, *Chapter I, Division II*.
- 2.2. Construction documents shall include a statement that the building is designed in accordance with ASCE 24, including that the pile or column foundation and building or structure to be attached thereto is designed to be anchored to resist flotation, collapse and lateral movement due to the effects of wind and flood loads acting simultaneously on all building components, and other load requirements of Chapter 16.
 - 2.3. For breakaway walls designed to have a resistance of more than 20 psf (0.96 kN/m²) determined using allowable stress design, construction documents shall include a statement that the breakaway wall is designed in accordance with ASCE 24.

SECTION 1613 EARTHQUAKE LOADS

1613.1 Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7, excluding Chapter 14 and Appendix 11A. The seismic design category for a structure is permitted to be determined in accordance with Section 1613 or ASCE 7.

Exceptions:

1. Detached one- and two-family dwellings, assigned to Seismic Design Category A, B or C, or located where the mapped short-period spectral response acceleration, S_s , is less than 0.4 g.
2. The seismic force-resisting system of wood-frame buildings that conform to the provisions of Section 2308 are not required to be analyzed as specified in this section. *[OSHPD 2] Not permitted by OSHPD, see Section 2308.*
3. Agricultural storage structures intended only for incidental human occupancy.
4. Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7 and for which other regulations provide seismic criteria, such as vehicular bridges, electrical transmission towers,

hydraulic structures, buried utility lines and their appurtenances and nuclear reactors.

5. [OSHPD 2] Seismic Design Category shall be in accordance with exception to Section 1613.3.5.

1613.1.1 Scope. [SL] For applications listed in Section 1.12 regulated by the State Librarian, only the provisions of ASCE 7 Tables 13.5-1 and 1607.1, as amended, of this code shall apply.

1613.1.2 State-owned buildings. State-owned buildings, including those of the University of California, CSU and Judicial Council, shall not be constructed where any portion of the foundation would be within a mapped area of earthquake-induced liquefaction of landsliding or within 50 feet of a mapped fault rupture hazard as established by Section 1803.7.

1613.1.3 Existing state buildings. Additions, alterations, repairs or change of occupancy category of existing buildings shall be in accordance with Chapter 34.

1613.2 Definitions. The following terms are defined in Chapter 2:

DESIGN EARTHQUAKE GROUND MOTION.

MECHANICAL SYSTEMS.

ORTHOGONAL.

RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATION.

SEISMIC DESIGN CATEGORY.

SEISMIC FORCE-RESISTING SYSTEM.

SITE CLASS.

SITE COEFFICIENTS.

1613.3 Seismic ground motion values. Seismic ground motion values shall be determined in accordance with this section.

1613.3.1 Mapped acceleration parameters. The parameters S_s and S_1 shall be determined from the 0.2 and 1-second spectral response accelerations shown on Figures 1613.3.1(1) through 1613.3.1(6). Where S_1 is less than or equal to 0.04 and S_s is less than or equal to 0.15, the structure is permitted to be assigned to *Seismic Design Category A*. The parameters S_s and S_1 shall be, respectively, 1.5 and 0.6 for Guam and 1.0 and 0.4 for American Samoa.

Exception: [OSHPD 2] Seismic Design Category shall be in accordance with exception to Section 1613.3.5.

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a ^a

| SITE CLASS | MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIOD | | | | |
|------------|---|--------------|--------------|--------------|-----------------|
| | $S_s \leq 0.25$ | $S_s = 0.50$ | $S_s = 0.75$ | $S_s = 1.00$ | $S_s \geq 1.25$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 |
| D | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 |
| E | 2.5 | 1.7 | 1.2 | 0.9 | 0.9 |
| F | Note b | Note b | Note b | Note b | Note b |

a. Use straight line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s .

b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

1613.3.2 Site class definitions. Based on the site soil properties, the site shall be classified as Site Class A, B, C, D, E or F in accordance with Chapter 20 of ASCE 7. Where the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the building official or geotechnical data determines Site Class E or F soils are present at the site.

1613.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. The maximum considered earthquake spectral response acceleration for short periods, S_{MS} , and at 1-second period, S_{M1} , adjusted for site class effects shall be determined by Equations 16-37 and 16-38, respectively:

$$S_{MS} = F_a S_s \quad (\text{Equation 16-37})$$

$$S_{M1} = F_v S_1 \quad (\text{Equation 16-38})$$

where:

F_a = Site coefficient defined in Table 1613.3.3(1).

F_v = Site coefficient defined in Table 1613.3.3(2).

S_s = The mapped spectral accelerations for short periods as determined in Section 1613.3.1.

S_1 = The mapped spectral accelerations for a 1-second period as determined in Section 1613.3.1.

1613.3.4 Design spectral response acceleration parameters. Five-percent damped design spectral response acceleration at short periods, S_{DS} , and at 1-second period, S_{D1} , shall be determined from Equations 16-39 and 16-40, respectively:

$$S_{DS} = \frac{2}{3} S_{MS} \quad (\text{Equation 16-39})$$

$$S_{D1} = \frac{2}{3} S_{M1} \quad (\text{Equation 16-40})$$

where:

S_{MS} = The maximum considered earthquake spectral response accelerations for short period as determined in Section 1613.3.3.

S_{M1} = The maximum considered earthquake spectral response accelerations for 1-second period as determined in Section 1613.3.3.

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v ^a

| SITE CLASS | MAPPED SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD | | | | |
|------------|--|-------------|-------------|-------------|----------------|
| | $S_1 \leq 0.1$ | $S_1 = 0.2$ | $S_1 = 0.3$ | $S_1 = 0.4$ | $S_1 \geq 0.5$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 |
| D | 2.4 | 2.0 | 1.8 | 1.6 | 1.5 |
| E | 3.5 | 3.2 | 2.8 | 2.4 | 2.4 |
| F | Note b | Note b | Note b | Note b | Note b |

a. Use straight line interpolation for intermediate values of mapped spectral response acceleration at 1 second period, S_1 .

b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATIONS

| VALUE OF S_{DS} | RISK CATEGORY | | |
|------------------------------|---------------|-----|----|
| | I or II | III | IV |
| $S_{DS} < 0.167g$ | A | A | A |
| $0.167g \leq S_{DS} < 0.33g$ | B | B | C |
| $0.33g \leq S_{DS} < 0.50g$ | C | C | D |
| $0.50g \leq S_{DS}$ | D | D | D |

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

| VALUE OF S_{D1} | RISK CATEGORY | | |
|-------------------------------|---------------|-----|----|
| | I or II | III | IV |
| $S_{D1} < 0.067g$ | A | A | A |
| $0.067g \leq S_{D1} < 0.133g$ | B | B | C |
| $0.133g \leq S_{D1} < 0.20g$ | C | C | D |
| $0.20g \leq S_{D1}$ | D | D | D |

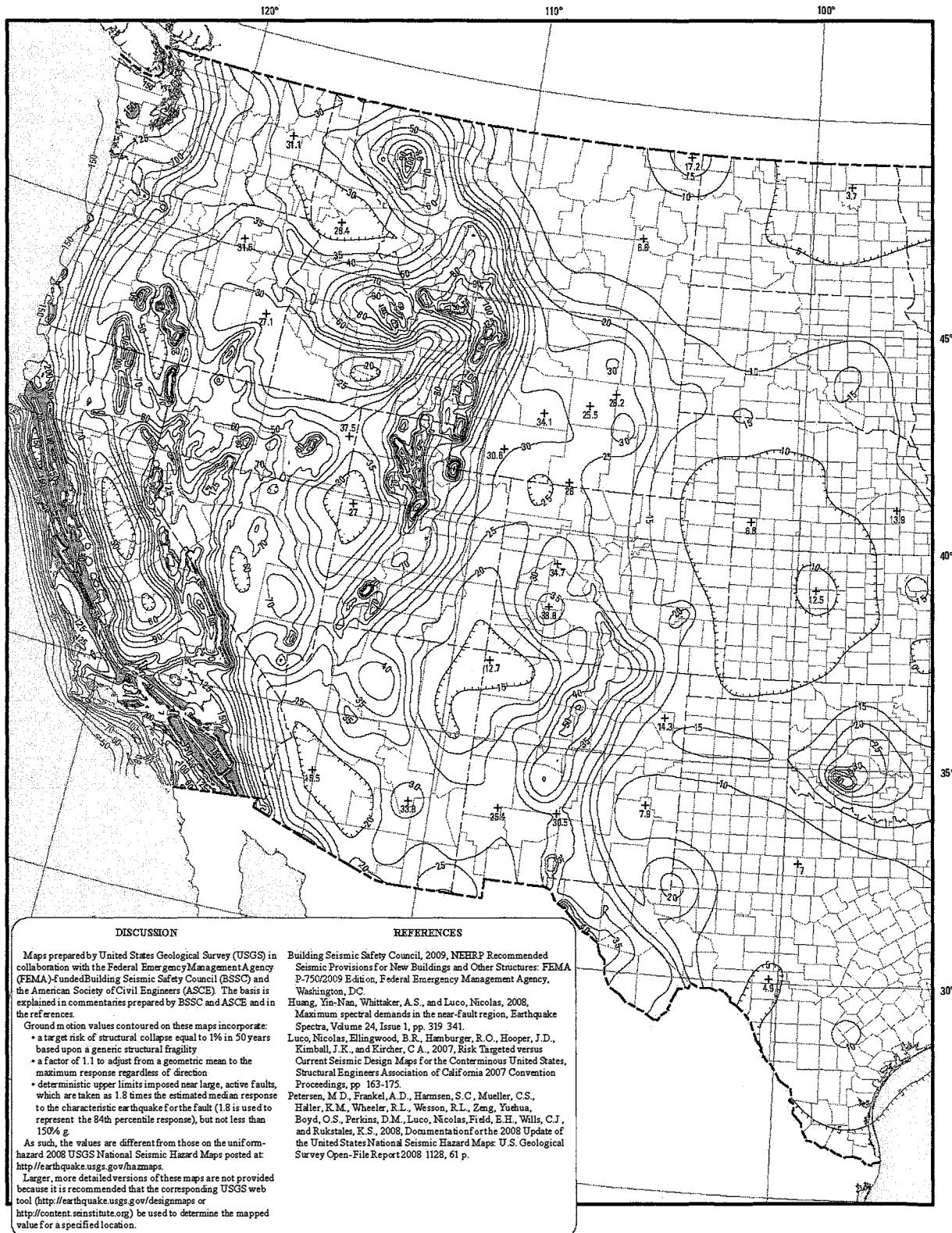


FIGURE 1613.3.1(1)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B
(continued)

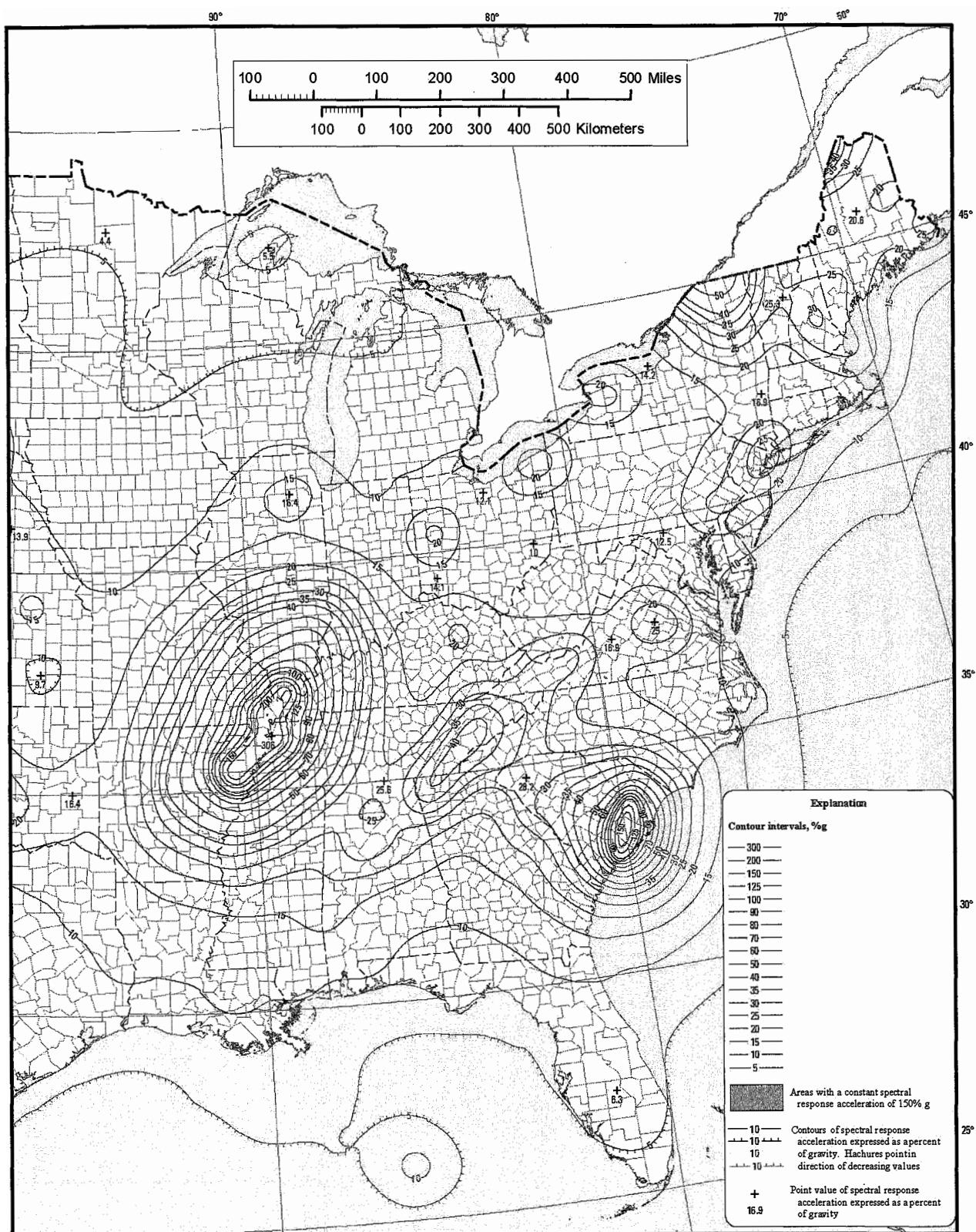


FIGURE 1613.3.1(1)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_r) GROUND MOTION RESPONSE ACCELERATIONS
FOR THE CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION
(5% OF CRITICAL DAMPING), SITE CLASS B

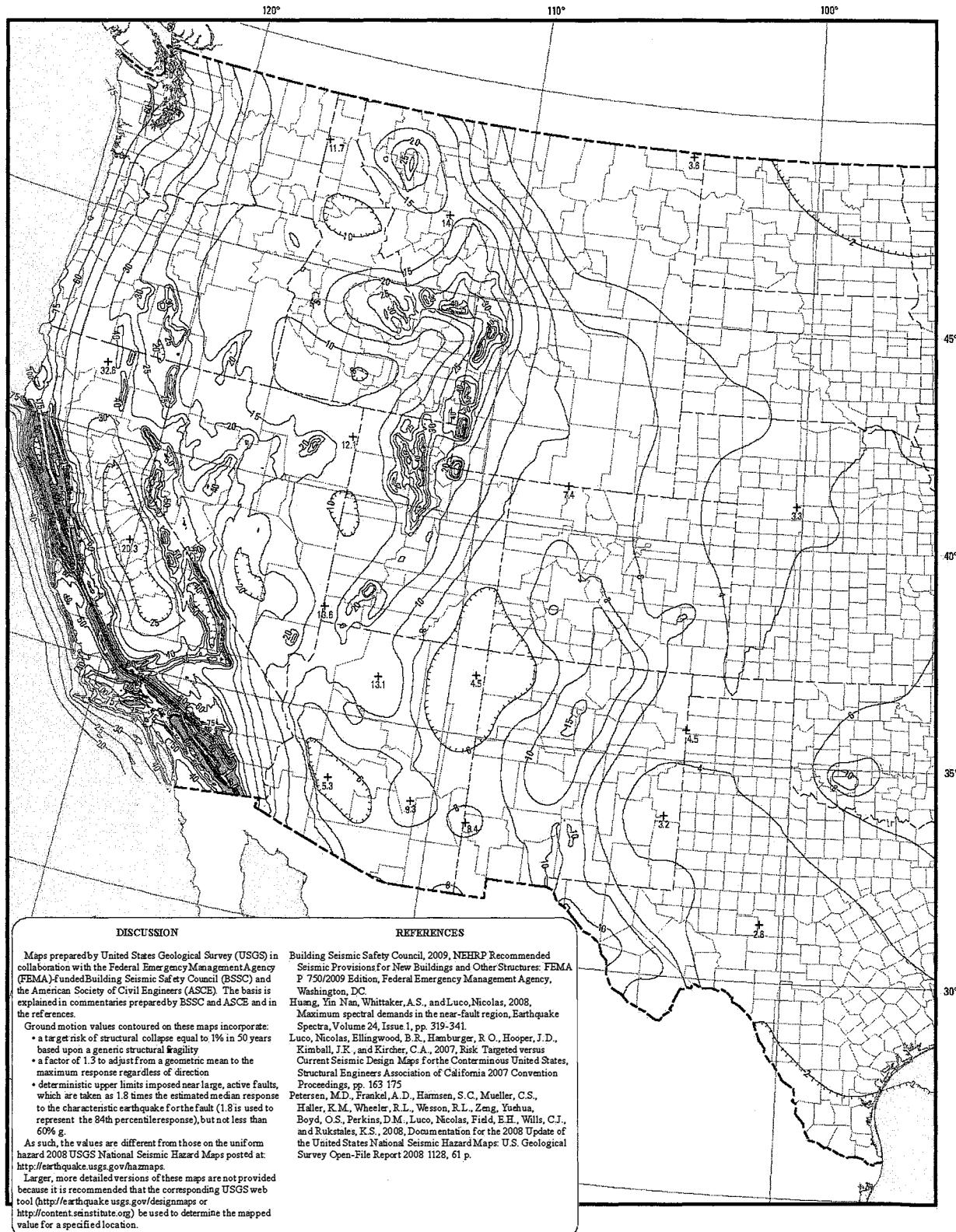


FIGURE 1613.3.1(2)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_r) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

(continued)

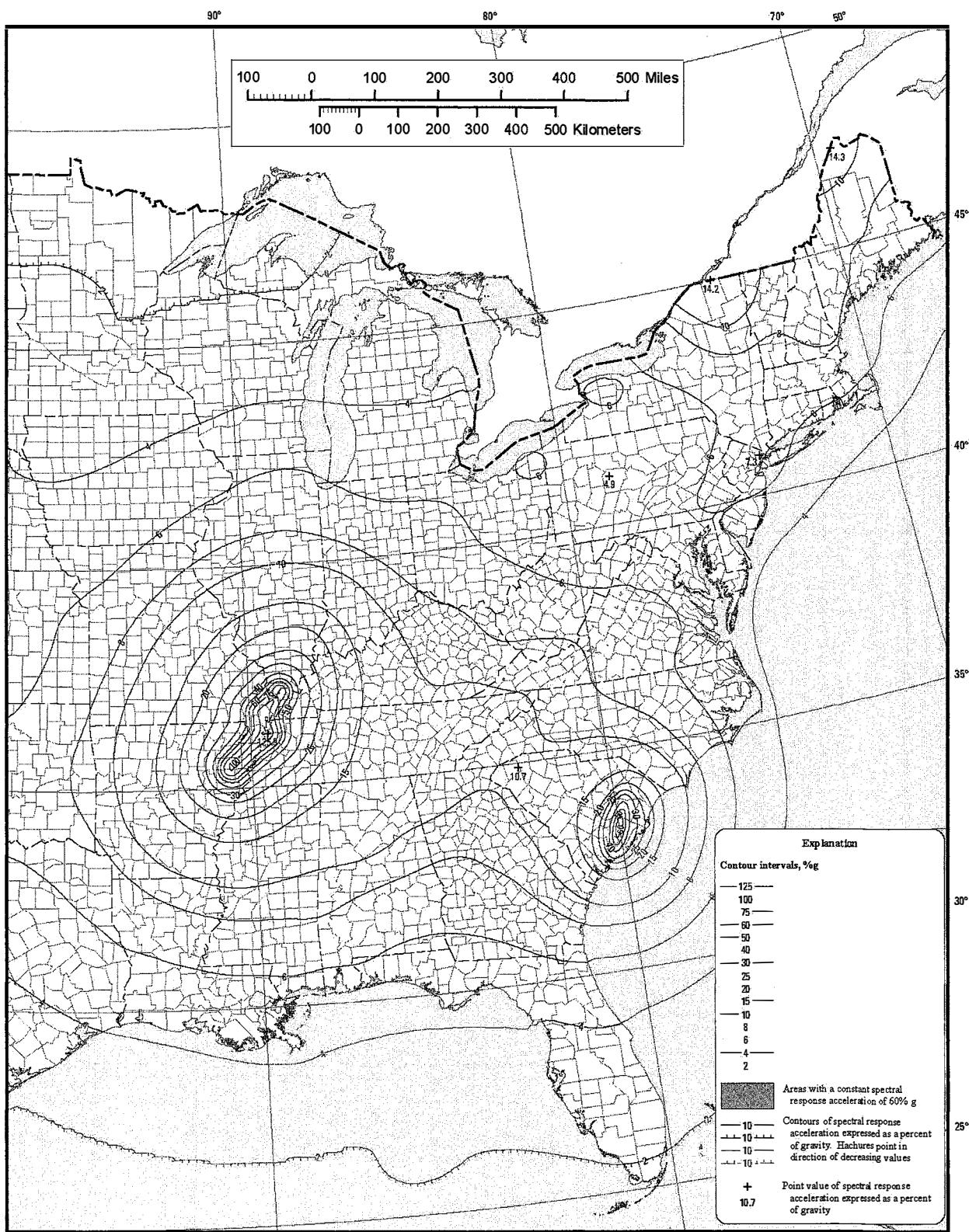
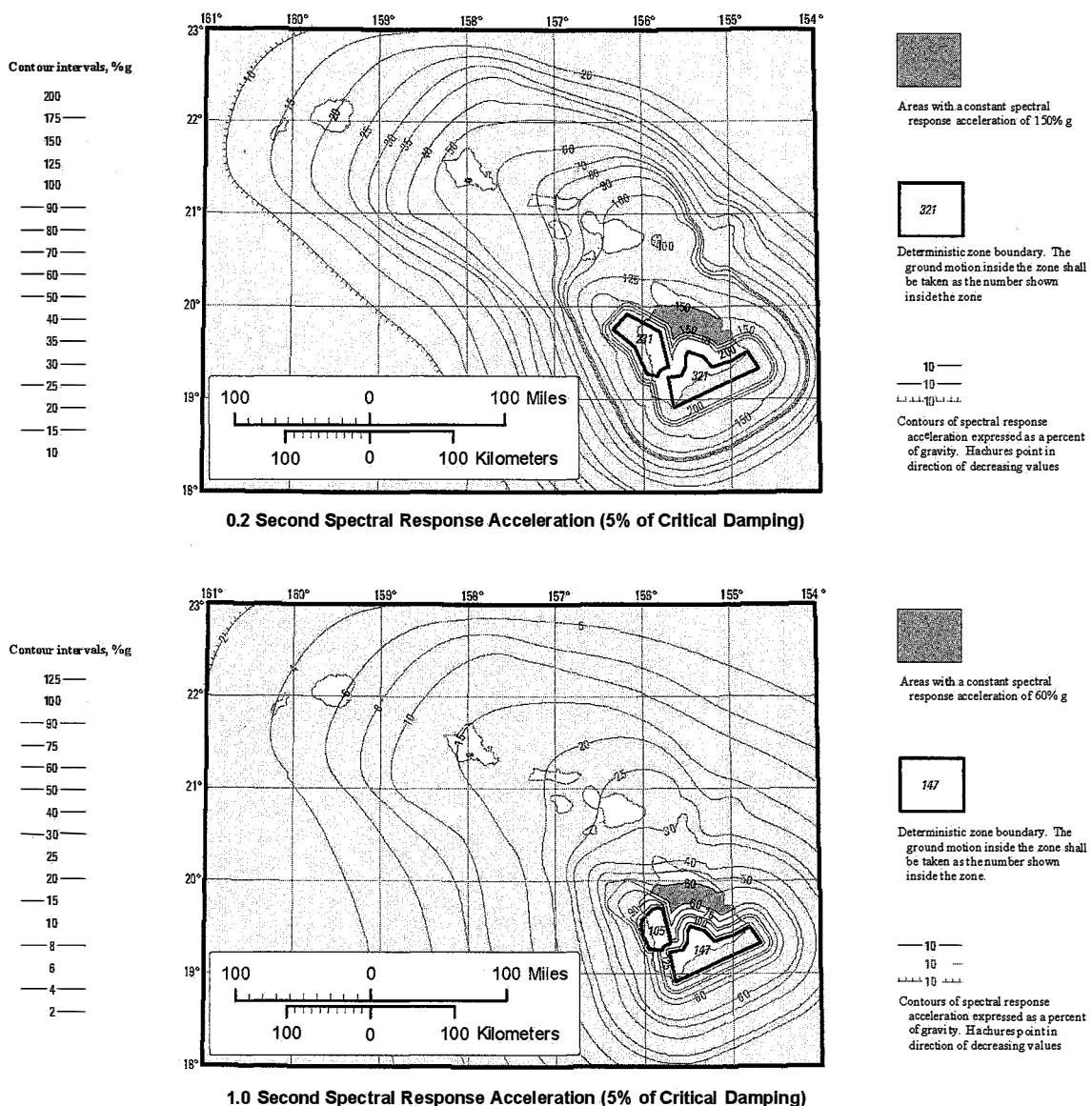


FIGURE 1613.3.1(2)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS
FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION
(5% OF CRITICAL DAMPING), SITE CLASS B



DISCUSSION

Maps prepared by United States Geological Survey (USGS) in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council (BSSC) and the American Society of Civil Engineers (ASCE). The basis is explained in commentaries prepared by BSSC and ASCE and in the references.

Ground motion values contoured on these maps incorporate:

- a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility
- deterministic upper limits imposed near large, active faults, which are taken as 1.8 times the estimated median response to the characteristic earthquake for the fault (1.8 is used to represent the 84th percentile response), but not less than 150% and 60% g for 0.2 and 1.0 sec, respectively.

As such, the values are different from those on the uniform hazard 1998 USGS National Seismic Hazard Maps for Hawaii posted at <http://earthquake.usgs.gov/hazmaps/>.

Larger, more detailed versions of these maps are not provided because it is recommended that the corresponding USGS web tool (<http://earthquake.usgs.gov/designmaps/> or <http://content.ssmiitute.org/>) be used to determine the mapped value for a specified location.

REFERENCES

- Building Seismic Safety Council, 2009, NEHRP Recommended Seismic Provisions for New Buildings and Other Structures, FEMA P-750/2009 Edition, Federal Emergency Management Agency, Washington, DC.
- Huang, Yin-Nan, Whittaker, A.S., and Luco, Nicolas, 2008, Maximum spectral demands in the near-fault region, *Earthquake Spectra*, Volume 24, Issue 1, pp. 319-341.
- Klein, F., Frankel, A.D., Mueller, C.S., Wesson, R.L., and Okubo, P., 2001, Seismic hazard in Hawaii: high rate of large earthquakes and probabilistic ground-motion maps, *Bulletin of the Seismological Society of America*, Volume 91, pp. 479-498.
- Luco, Nicolas, Ellingwood, B.R., Hamburger, R.O., Hooper, J.D., Kimball, J.K., and Kircher, C.A., 2007, Risk-Targeted versus Current Seismic Design Maps for the Contiguous United States, *Structural Engineers Association of California 2007 Convention Proceedings*, pp. 163-175.

FIGURE 1613.3.1(3)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR HAWAII OF 0.2- AND 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

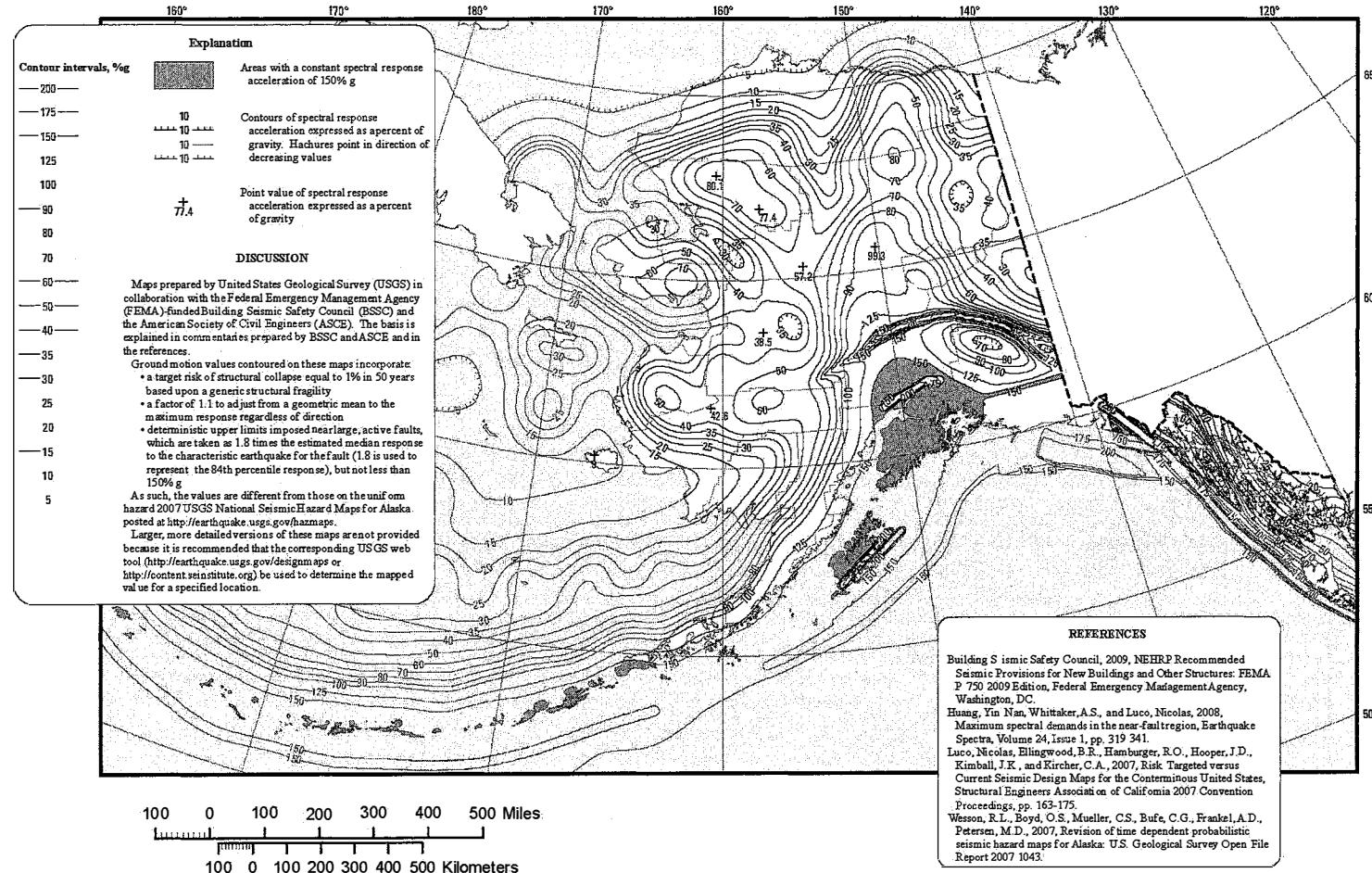


FIGURE 1613.3.1(4)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_r) GROUND MOTION RESPONSE ACCELERATIONS
FOR ALASKA OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION
(5% OF CRITICAL DAMPING), SITE CLASS B

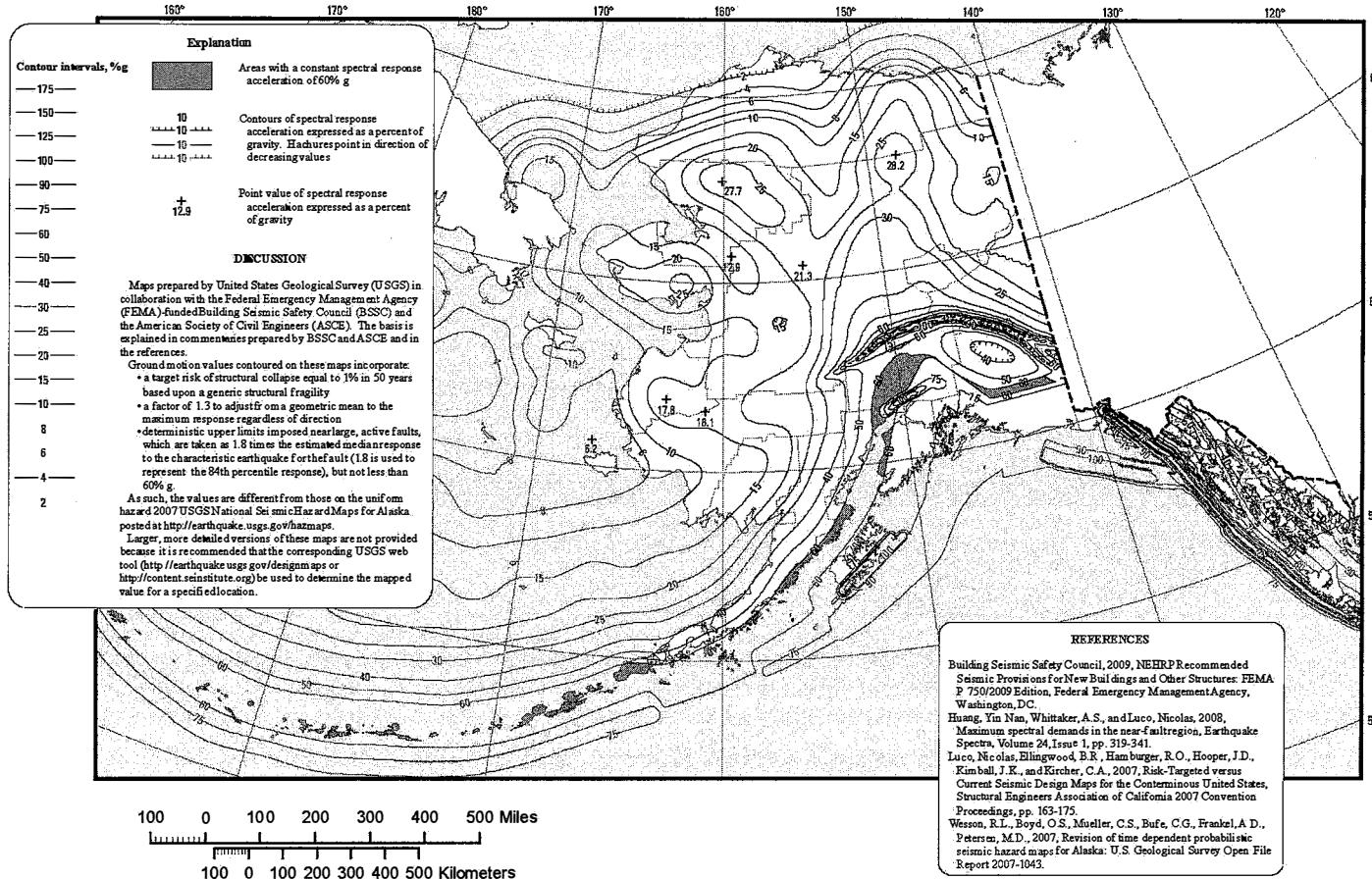
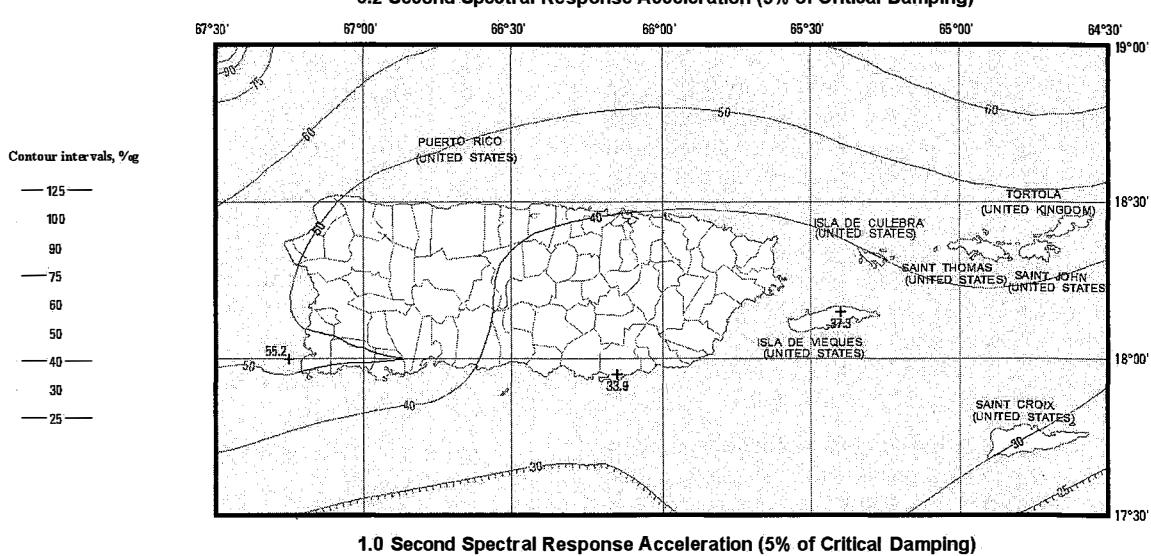
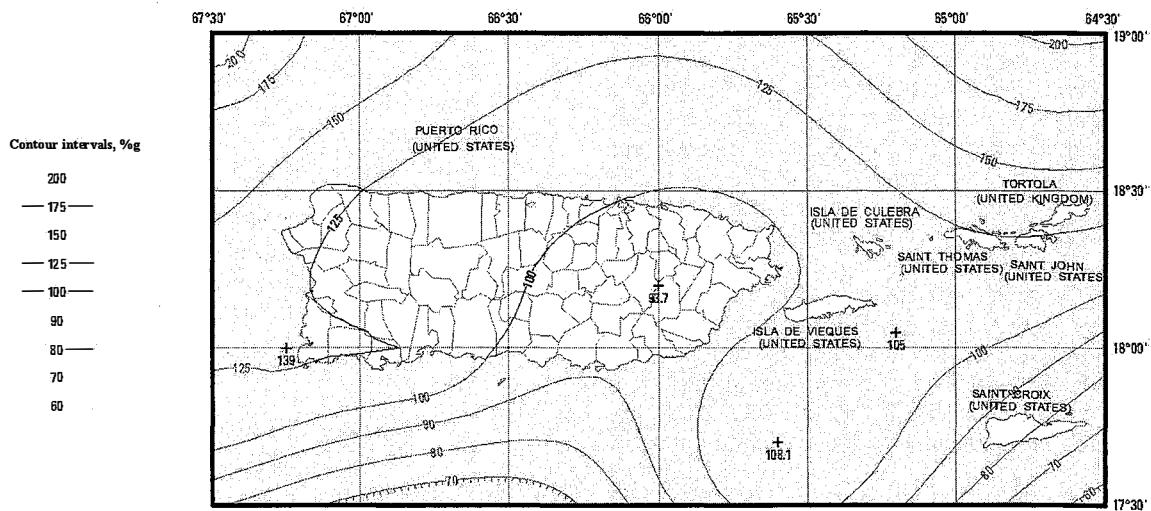


FIGURE 1613.3.1(5)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_r) GROUND MOTION RESPONSE ACCELERATIONS
FOR ALASKA OF 1.0-SECOND SPECTRAL RESPONSE ACCELERATION
(5% OF CRITICAL DAMPING), SITE CLASS B



Explanation

- 10
- 10 —
- ++ 10 ++

Contours of spectral response acceleration expressed as a percent of gravity. Hachures point in direction of decreasing values.

+

93.7

Point value of spectral response acceleration expressed as a percent of gravity

DISCUSSION

Maps prepared by United States Geological Survey (USGS) in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council (BSSC) and the American Society of Civil Engineers (ASCE). The basis is explained in commentaries prepared by BSSC and ASCE and in the references.

Ground motion values contoured on these maps incorporate:

- a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility
- a factor of 1.1 and 1.3 for 0.2 and 1.0 sec, respectively, to adjust from a geometric mean to the maximum response regardless of direction
- deterministic upper limits imposed near large, active faults, which are taken as 1.8 times the estimated median response to the characteristic earthquake for the fault (1.8 is used to represent the 94th percentile response), but not less than 150% and 60% g for 0.2 and 1.0 sec, respectively.

As such, the values are different from those on the uniform-hazard 2003 USGS National Seismic Hazard Maps for Puerto Rico and the U.S. Virgin Islands posted at <http://earthquake.usgs.gov/hazmaps>.

Larger, more detailed versions of these maps are not provided because it is recommended that the corresponding USGS web tool (<http://earthquake.usgs.gov/designmaps> or <http://content.seismiitute.org>) be used to determine the mapped value for a specified location.

50 0 50 Miles
50 0 50 Kilometers

REFERENCES

- Building Seismic Safety Council, 2009, NEHRP Recommended Seismic Provisions for New Buildings and Other Structures: FEMA P-750/2009 Edition, Federal Emergency Management Agency, Washington, DC.
- Huang, Yin-Nan, Whitaker, A.S., and Luco, Nicolas, 2008, Maximum spectral demands in the near-fault region, *Earthquake Spectra*, Volume 24, Issue 1, pp. 319-341.
- Luco, Nicolas, Ellingwood, B.R., Hamburger, R.O., Hooper, J.D., Kimball, J.K., and Kircher, C.A., 2007, Risk-Targeted versus Current Seismic Design Maps for the Contiguous United States, *Structural Engineers Association of California 2007 Convention Proceedings*, pp. 163-175.
- Muller, C.S., Frankel, A.D., Petersen, M.D., and Leyendecker, E.V., 2003, Documentation for the 2003 USGS Seismic Hazard Maps for Puerto Rico and the U.S. Virgin Islands: U.S. Geological Survey Open-File Report 03-379.

FIGURE 1613.3.1(6)

RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR PUERTO RICO AND THE UNITED STATES VIRGIN ISLANDS OF 0.2- AND 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

1613.3.5 Determination of seismic design category. Structures classified as Risk Category I, II or III that are located where the mapped spectral response acceleration parameter at 1-second period, S_1 , is greater than or equal to 0.75 shall be assigned to Seismic Design Category E. Structures classified as Risk Category IV that are located where the mapped spectral response acceleration parameter at 1-second period, S_1 , is greater than or equal to 0.75 shall be assigned to Seismic Design Category F. All other structures shall be assigned to a seismic design category based on their risk category and the design spectral response acceleration parameters, S_{DS} and S_{D1} , determined in accordance with Section 1613.3.4 or the site-specific procedures of ASCE 7. Each building and structure shall be assigned to the more severe seismic design category in accordance with Table 1613.3.5(1) or 1613.3.5(2), irrespective of the fundamental period of vibration of the structure, T .

Exception: [OSHPD 2] Structures not assigned to Seismic Design Category E or F above shall be assigned to Seismic Design Category D.

1613.3.5.1 Alternative seismic design category determination. Where S_1 is less than 0.75, the seismic design category is permitted to be determined from Table 1613.3.5(1) alone when all of the following apply:

1. In each of the two orthogonal directions, the approximate fundamental period of the structure, T_a , in each of the two orthogonal directions determined in accordance with Section 12.8.2.1 of ASCE 7, is less than 0.8 T_s determined in accordance with Section 11.4.5 of ASCE 7.
2. In each of the two orthogonal directions, the fundamental period of the structure used to calculate the story drift is less than T_s .
3. Equation 12.8-2 of ASCE 7 is used to determine the seismic response coefficient, C_s .
4. The diaphragms are rigid as defined in Section 12.3.1 of ASCE 7 or, for diaphragms that are flexible, the distances between vertical elements of the seismic force-resisting system do not exceed 40 feet (12 192 mm).

Exception: [OSHPD 2] Seismic design category shall be determined in accordance with exception to Section 1613.3.5.

1613.3.5.2 Simplified design procedure. Where the alternate simplified design procedure of ASCE 7 is used, the seismic design category shall be determined in accordance with ASCE 7.

Exception: [OSHPD 2] Seismic design category shall be determined in accordance with exception to Section 1613.3.5.

1613.4 Alternatives to ASCE 7. The provisions of Section 1613.4 shall be permitted as alternatives to the relevant provisions of ASCE 7.

1613.4.1 Additional seismic force-resisting systems for seismically isolated structures. Add the following exception to the end of Section 17.5.4.2 of ASCE 7:

Exception: For isolated structures designed in accordance with this standard, the Structural System Limitations and the Building Height Limitations in Table 12.2-1 for ordinary steel concentrically braced frames (OCBFs) as defined in Chapter 11 and ordinary moment frames (OMFs) as defined in Chapter 11 are permitted to be taken as 160 feet (48 768 mm) for structures assigned to *Seismic Design Category D, E or F*, provided that the following conditions are satisfied:

1. The value of R_i as defined in Chapter 17 is taken as 1.
2. For OMFs and OCBFs, design is in accordance with AISC 341.

1613.5 [BSC, HCD 1 & HCD 2] Modifications to ASCE 7. The text of ASCE 7 shall be modified as indicated in Sections 1613.5.1 through 1613.5.2.

1613.5.1 [BSC, HCD 1 & HCD 2] Modify ASCE 7 DEFINITIONS as follows:

1.2 DEFINITIONS.

BALLASTED PHOTOVOLTAIC SYSTEM: A roof mounted system composed of solar photovoltaic panels and supporting members that are unattached or partially attached to the roof and must rely on its weight, aerodynamics and friction to counter the effect of wind and seismic forces.

1613.5.2 [BSC, HCD 1 & HCD 2] Modify ASCE 7 Section 13.4 as follows:

Section 13.4 NONSTRUCTURAL COMPONENT ANCHORAGE.

Components and their supports shall be attached (or anchored) to the structure in accordance with the requirements of this section and the attachment shall satisfy the requirements for the parent material as set forth elsewhere in this standard. Component 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 provided. Local elements of the structure including connections shall be designed and constructed for the component forces where they control the design of the elements or their connections. The component forces shall be those determined in Section 13.3.1, except that modifications to F_p and R , 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 this section.

Exception: Ballasted photovoltaic systems when design is based on Section 13.4.7 and approved by the enforcing agency.

13.4.7. Solar PV panels or modules installed on a roof as a ballasted system need not be rigidly attached to the roof or supporting structure. Ballasted systems shall be designed and installed only on roofs with slopes 1 inch per foot or less. The ballasted system shall be designed to resist sliding and uplift resulting from lateral and vertical forces, using a coefficient of friction determined by acceptable engineering practices. In sites where the Seismic Design Category is C or above, the system shall be designed to accommodate seismic displacement determined by approved analysis or shake-table testing, using input motions consistent with ASCE 7 lateral and vertical seismic forces for non-structural components on roofs.

SECTION 1614 ATMOSPHERIC ICE LOADS

1614.1 General. Ice-sensitive structures shall be designed for atmospheric ice loads in accordance with Chapter 10 of ASCE 7.

SECTION 1615 STRUCTURAL INTEGRITY

1615.1 General. High-rise buildings that are assigned to Risk Category III or IV shall comply with the requirements of this section. Frame structures shall comply with the requirements of Section 1615.3. Bearing wall structures shall comply with the requirements of Section 1615.4.

1615.2 Definitions. The following words and terms are defined in Chapter 2:

BEARING WALL STRUCTURE.

FRAME STRUCTURE.

1615.3 Frame structures. Frame structures shall comply with the requirements of this section.

1615.3.1 Concrete frame structures. Frame structures constructed primarily of reinforced or prestressed concrete, either cast-in-place or precast, or a combination of these, shall conform to the requirements of ACI 318 Sections 7.13, 13.3.8.5, 13.3.8.6, 16.5, 18.12.6, 18.12.7 and 18.12.8 as applicable. Where ACI 318 requires that non-prestressed reinforcing or prestressing steel pass through the region bounded by the longitudinal column reinforcement, that reinforcing or prestressing steel shall have a minimum nominal tensile strength equal to two-thirds of the required one-way vertical strength of the connection of the floor or roof system to the column in each direction of beam or slab reinforcement passing through the column.

Exception: Where concrete slabs with continuous reinforcement having an area not less than 0.0015 times the concrete area in each of two orthogonal directions are present and are either monolithic with or equivalently bonded to beams, girders or columns, the longitudinal

reinforcing or prestressing steel passing through the column reinforcement shall have a nominal tensile strength of one-third of the required one-way vertical strength of the connection of the floor or roof system to the column in each direction of beam or slab reinforcement passing through the column.

1615.3.2 Structural steel, open web steel joist or joist girder, or composite steel and concrete frame structures. Frame structures constructed with a structural steel frame or a frame composed of open web steel joists, joist girders with or without other structural steel elements or a frame composed of composite steel or composite steel joists and reinforced concrete elements shall conform to the requirements of this section.

1615.3.2.1 Columns. Each column splice shall have the minimum design strength in tension to transfer the design dead and live load tributary to the column between the splice and the splice or base immediately below.

1615.3.2.2 Beams. End connections of all beams and girders shall have a minimum nominal axial tensile strength equal to the required vertical shear strength for allowable stress design (ASD) or two-thirds of the required shear strength for load and resistance factor design (LRFD) but not less than 10 kips (45 kN). For the purpose of this section, the shear force and the axial tensile force need not be considered to act simultaneously.

Exception: Where beams, girders, open web joist and joist girders support a concrete slab or concrete slab on metal deck that is attached to the beam or girder with not less than $\frac{3}{8}$ -inch-diameter (9.5 mm) headed shear studs, at a spacing of not more than 12 inches (305 mm) on center, averaged over the length of the member, or other attachment having equivalent shear strength, and the slab contains continuous distributed reinforcement in each of two orthogonal directions with an area not less than 0.0015 times the concrete area, the nominal axial tension strength of the end connection shall be permitted to be taken as half the required vertical shear strength for ASD or one-third of the required shear strength for LRFD, but not less than 10 kips (45 kN).

1615.4 Bearing wall structures. Bearing wall structures shall have vertical ties in all load-bearing walls and longitudinal ties, transverse ties and perimeter ties at each floor level in accordance with this section and as shown in Figure 1615.4.

1615.4.1 Concrete wall structures. Precast bearing wall structures constructed solely of reinforced or prestressed concrete, or combinations of these shall conform to the requirements of Sections 7.13, 13.3.8.5 and 16.5 of ACI 318.

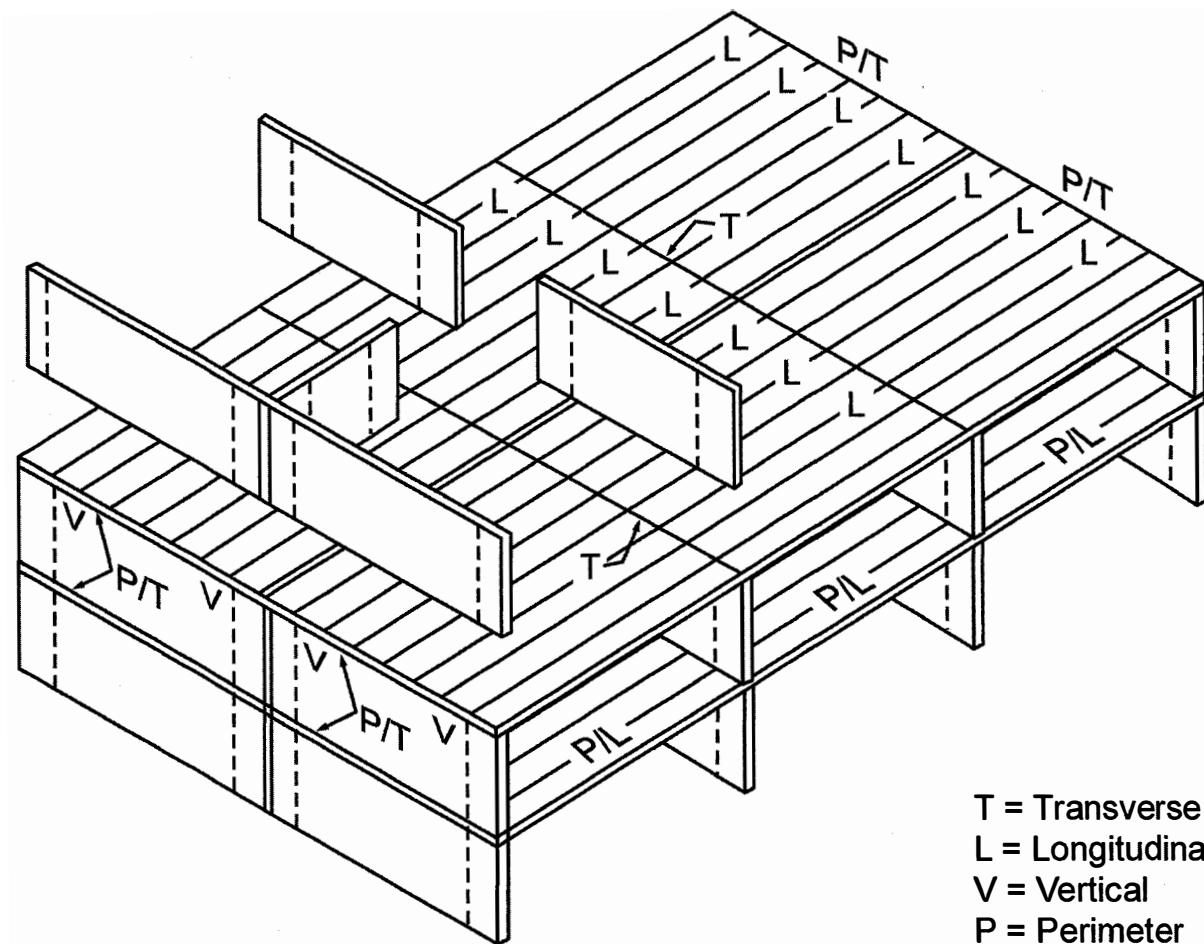


FIGURE 1615.4
LONGITUDINAL, PERIMETER, TRANSVERSE AND VERTICAL TIES

1615.4.2 Other bearing wall structures. Ties in bearing wall structures other than those covered in Section 1615.4.1 shall conform to this section.

1615.4.2.1 Longitudinal ties. Longitudinal ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Longitudinal ties shall extend across interior load-bearing walls and shall connect to exterior load-bearing walls and shall be spaced at not greater than 10 feet (3038 mm) on center. Ties shall have a minimum nominal tensile strength, T_T , given by Equation 16-41. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

$$T_T = w LS \leq \alpha_T S \quad (\text{Equation 16-41})$$

where:

L = The span of the horizontal element in the direction of the tie, between bearing walls, feet (m).

w = The weight per unit area of the floor or roof in the span being tied to or across the wall, psf (N/m^2).

S = The spacing between ties, feet (m).

α_T = A coefficient with a value of 1,500 pounds per foot (2.25 kN/m) for masonry bearing wall structures and a value of 375 pounds per foot (0.6 kN/m) for structures with bearing walls of cold-formed steel light-frame construction.

1615.4.2.2 Transverse ties. Transverse ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Transverse ties shall be placed no farther apart than the spacing of load-bearing walls. Transverse ties shall have minimum nominal tensile strength T_T , given by Equation 16-46. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

1615.4.2.3 Perimeter ties. Perimeter ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Ties around the perimeter of each floor and roof shall be located within 4 feet (1219 mm) of the edge and shall provide a nominal strength in tension not less than T_p , given by Equation 16-42. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

$$T_p = 200w \leq \beta_T \quad (\text{Equation 16-42})$$

$$\text{For SI: } T_p = 90.7w \leq \beta_T$$

where:

w = As defined in Section 1615.4.2.1.

β_T = A coefficient with a value of 16,000 pounds (7200 kN) for structures with masonry bearing walls and a value of 4,000 pounds (1300 kN) for structures with bearing walls of cold-formed steel light-frame construction.

1615.4.2.4 Vertical ties. Vertical ties shall consist of continuous or spliced reinforcing, continuous or spliced members, wall sheathing or other engineered systems. Vertical tension ties shall be provided in bearing walls and shall be continuous over the height of the building. The minimum nominal tensile strength for vertical ties within a bearing wall shall be equal to the weight of the wall within that story plus the weight of the diaphragm tributary to the wall in the story below. No fewer than two ties shall be provided for each wall. The strength of each tie need not exceed 3,000 pounds per foot (450 kN/m) of wall tributary to the tie for walls of masonry construction or 750 pounds per foot (140 kN/m) of wall tributary to the tie for walls of cold-formed steel light-frame construction.

SECTION 1616 ADDITIONAL REQUIREMENTS [DSA-SS/CC]

1616.1 Construction documents.

1616.1.1 Additional requirements for construction documents. Additional requirements for construction documents are included in Sections 4-210 and 4-317 of the California Administrative Code (Part 1, Title 24, C.C.R.).

1616.1.2 Connections. Connections that resist design seismic forces shall be designed and detailed on the design drawings.

1616.1.3 Construction procedures. Where unusual erection or construction procedures are considered essential by the project structural engineer or architect in order to accomplish the intent of the design or influence the design, such procedure shall be indicated on the plans or in the specifications.

1616.2 General design requirements.

1616.2.1 Lateral load deflections.

1616.2.1.1 Horizontal diaphragms. The maximum span-width ratio for any roof or floor diaphragm shall not exceed those given in Table 4.2.4 of AF & PA \leq SDPWS for wood sheathed diaphragms. For other diaphragms, test data and design calculations acceptable to the enforcement agency shall be submitted and approved for span-width ratios.

1616.2.1.2 Veneers. The deflection shall not exceed $l/600$ for veneered walls, anchored veneers and adhered veneers over 1 inch (25 mm) thick, including the mortar backing.

1616.2.1.3 Risk Category of buildings and other structures. Risk Category IV includes structures as defined in the California Administrative Code, Section 4-207 and all structures required for their continuous operation or access/egress.

1616.2.2 Structural walls. For anchorage of concrete or masonry walls to roof and floor diaphragms, the out-of-

plane strength design force shall not be less than 280 lb/linear ft (4.09 kN/m) of wall.

1616.3 Load combinations.

1616.3.1 Stability. When checking stability under the provisions of Section 1605.1.1 using allowable stress design, the factor of safety for soil bearing values shall not be less than the overstrength factor of the structures supported.

1616.4 Roof dead loads. The design dead load shall provide for the weight of at least one additional roof covering in addition to other applicable loadings if the new roof covering is permitted to be applied over the original roofing without its removal, in accordance with Section 1510.

1616.5 Live loads.

1616.5.1 Modifications to Table 1607.1.

1616.5.1.1 Item 4. Assembly areas. The following minimum loads for stage accessories apply:

1. Gridirons and fly galleries: 75 pounds per square foot uniform live load.
2. Loft block wells: 250 pounds per lineal foot vertical load and lateral load.
3. Head block wells and sheave beams: 250 pounds per lineal foot vertical load and lateral load. Head block wells and sheave beams shall be designed for all tributary loft block well loads. Sheave blocks shall be designed with a safety factor of five.
4. Scenery beams where there is no gridiron: 300 pounds per lineal foot vertical load and lateral load.
5. Ceiling framing over stages shall be designed for a uniform live load of 20 pounds per square foot. For members supporting a tributary area of 200 square feet or more, this additional load may be reduced to 15 pounds per square foot (0.72 kN/m²).

1616.5.1.2 Item 24. Reviewing stands, grandstands and bleachers. The minimum uniform live load for a press box floor or accessible roof with railing is 100 psf.

1616.5.1.3 Item 35. Yards and terraces, pedestrians. Item 35 applies to pedestrian bridges and walkways that are not subjected to uncontrolled vehicle access.

1616.5.1.4 Item 36. Storage racks and wall-hung cabinets. The minimum vertical design live load shall be as follows:

Paper media:

12-inch-deep (305 mm) shelf - 33 pounds per lineal foot (482 N/m)

15-inch-deep (381 mm) shelf - 41 pounds per lineal foot (598 N/m), or 33 pounds per cubic foot (5183 N/m³) per total volume of the rack or cabinet, whichever is less.

Film media:

18-inch-deep (457 mm) shelf - 100 pounds per lineal foot (1459 N/m), or

50 pounds per cubic foot (7853 N/m³) per total volume of the rack or cabinet, whichever is less.

Other media:

20 pounds per cubic foot (311 N/m³) or 20 pounds per square foot (958 Pa), whichever is less, but not less than actual loads.

1616.5.2 Uncovered open-frame roof structures. Uncovered open-frame roof structures shall be designed for a vertical live load of not less than 10 pounds per square foot (0.48 kN/m²) of the total area encompassed by the framework.

1616.6 Determination of snow loads. The ground snow load or the design snow load for roofs shall conform with the adopted ordinance of the city, county, or city and county in which the project site is located, and shall be approved by DSA.

1616.7 Wind loads.

1616.7.1 Story drift for wind loads. The calculated story drift due to wind pressures with ultimate design wind speed, V_{ult} , shall not exceed 0.008 times the story height for buildings less than 65 feet (19,812 mm) in height or 0.007 times the story height for buildings 65 feet (19,812 mm) or greater in height.

Exception: This story drift limit need not be applied for single-story open structures.

1616.8 Establishment of flood hazard areas. Flood hazard maps shall include, at a minimum, areas of special flood hazard as identified by the Federal Emergency Management Agency's Flood Insurance Study (FIS) adopted by the local authority having jurisdiction where the project is located, as amended or revised with the accompanying Flood Insurance Rate Map (FIRM) and Flood Boundary and Floodway Map (FBFM) and related supporting data along with any revisions thereto.

1616.9 Earthquake loads.

1616.9.1 Seismic design category. The seismic design category for a structure shall be determined in accordance with Section 1613.

1616.9.2 Definitions. In addition to the definitions in Section 1613.2, the following words and terms shall, for the purposes of this section, have the meanings shown herein.

ACTIVE EARTHQUAKE FAULT. A fault that has been the source of earthquakes or is recognized as a potential source of earthquakes, including those that have exhibited surface displacement within Holocene time (about 11,000 years) as determined by California Geological Survey (CGS) under the Alquist-Priolo Earthquake Fault Zoning Act, those included as type A or type B faults for the U.S. Geological Survey (USGS) National Seismic Hazard Maps, and faults considered to have been active in Holocene time by an authoritative source, federal, state or local governmental agency.

BASE. The level at which the horizontal seismic ground motions are considered to be imparted to the structure or the level at which the structure as a dynamic vibrator is supported. This level does not necessarily coincide with the ground level.

DISTANCE FROM AN ACTIVE EARTHQUAKE FAULT. Distance measured from the nearest point of the building to the closest edge of an Alquist-Priolo Earthquake fault zone for an active fault, if such a map exists, or to the closest mapped splay of the fault.

IRREGULAR STRUCTURE. A structure designed as having one or more plan or vertical irregularities per ASCE 7 Section 12.3.

STRUCTURAL ELEMENTS. Floor or roof diaphragms, decking, joists, slabs, beams, or girders, columns, bearing walls, retaining walls, masonry or concrete nonbearing walls exceeding one story in height, foundations, shear walls or other lateral-force-resisting members, and any other elements necessary to the vertical and lateral strength or stability of either the building as a whole or any of its parts, including connection between such elements.

1616.9.3 Mapped acceleration parameters. Seismic Design Category shall be determined in accordance with Section 1613.3.5.

1616.9.4 Determination of seismic design category. Structures not assigned to Seismic Design Category E or F, in accordance with Section 1613.3, shall be assigned to Seismic Design Category D.

1616.9.4.1 Alternative seismic design category determination. The alternative Seismic Design Category determination procedure of Section 1613.3.5.1 is not permitted by DSA-SS/CC.

1616.9.4.2 Simplified design procedure. The simplified design procedure of Section 1613.3.5.2 is not permitted by DSA-SS/CC.

1616.9.5 Automatic sprinkler systems. The allowable values for design of anchors, hangers, and bracing elements shall be determined in accordance with material chapters of this code in lieu of those in NFPA 13.

1616.10 Modifications to ASCE 7. The text of ASCE 7 shall be modified as indicated in Sections 1616.10.1 through 1616.10.24.

1616.10.1 ASCE 7, Section 1.3. Modify ASCE 7 Section 1.3 by adding Section 1.3.6 as follows:

1.3.6 Structural design criteria. Where design is based on ASCE 7 Chapters 16, 17, 18, or 31, the ground motion, wind tunnel design recommendations, analysis, and design methods, material assumptions, testing requirements, and acceptance criteria proposed by the engineer shall be submitted to the enforcement agency in the form of structural design criteria for approval.

Peer review requirements in Section 3422 of this code shall apply to design reviews required by ASCE 7 Chapters 17 and 18.

1616.10.2 ASCE 7, Section 11.4.7. Modify ASCE 7 Section 11.4.7 by adding the following:

For buildings assigned to Seismic Design Category E and F, or when required by the building official, a ground motion hazard analysis shall be performed in accordance with ASCE 7 Chapter 21, as modified by Section 1803A.6 of this code.

1616.10.3 ASCE 7, Table 12.2-1. Modify ASCE 7 Table 12.2-1 as follows:

A. BEARING WALL SYSTEMS

17. Light-framed walls with shear panels of all other materials - Not permitted by DSA-SS/CC.

B. BUILDING FRAME SYSTEMS

24. Light-framed walls with shear panels of all other materials - Not permitted by DSA-SS/CC.

C. MOMENT RESISTING FRAME SYSTEMS

12. Cold-formed steel — special bolted moment frame - Not permitted by DSA-SS/CC.

Exception:

- 1) Systems listed in this section can be used as an alternative system when pre-approved by the enforcement agency.
- 2) Rooftop or other supported structures not exceeding two stories in height and 10 percent of the total structure weight can use the systems in this section when designed as components per ASCE 7 Chapter 13.
- 3) Systems listed in this section can be used for seismically isolated buildings when permitted by Section 1613.4.1.

1616.10.4 ASCE 7, Section 12.2.3.1. Replace ASCE 7 Section 12.2.3.1, Items 1 and 2 by the following:

The value of the response modification coefficient, R, used for design at any story shall not exceed the lowest value of R that is used in the same direction at any story above that story. Likewise, the deflection amplification factor, C_d , and the system over strength factor, Ω_0 , used for the design at any story shall not be less than the largest value of these factors that are used in the same direction at any story above that story.

1616.10.5 ASCE 7, Section 12.2.3.2. Modify ASCE 7 Section 12.2.3.2 by adding the following additional requirements for a two stage equivalent lateral force procedure or modal response spectrum procedure:

- f. Where design of elements of the upper portion is governed by special seismic load combinations, the special loads shall be considered in the design of the lower portions.

1616.10.6 ASCE 7, Section 12.2.5.6.1. The exception in Item a is not permitted by DSA-SS/CC.

1616.10.7 ASCE 7, Section 12.2.5.7.1. The exception in Item a is not permitted by DSA-SS/CC.

1616.10.8 ASCE 7, Section 12.2.5.7.2. The exception in Item a is not permitted by DSA-SS/CC.

1616.10.9 ASCE 7, Section 12.3.3.1. Modify ASCE 7 Section 12.3.3.1 as follows:

12.3.3.1 Prohibited horizontal and vertical irregularities for Seismic Design Categories D through F. Structures assigned to Seismic Design Category E or F having horizontal structural irregularity Type 1b of Table 12.3-1 or vertical structural irregularities Type 1b, 5a or 5b of Table 12.3-2 shall not be permitted. Structures assigned to Seismic Design Category D having vertical irregularity Type 1b or 5b of Table 12.3-2 shall not be permitted.

1616.10.10 ASCE 7, Section 12.7.2. Modify ASCE 7 Section 12.7.2 by adding Item 6 to read as follows:

6. Where buildings provide lateral support for walls retaining earth, and the exterior grades on opposite sides of the building differ by more than 6 feet (1829 mm), the load combination of the seismic increment of earth pressure due to earthquake acting on the higher side, as determined by a Geotechnical engineer qualified in soils engineering, plus the difference in earth pressures shall be added to the lateral forces provided in this section.

1616.10.11 ASCE 7, Section 12.8.1.3. Replace ASCE 7 Section 12.8.1.3 by the following:

12.8.1.3 Maximum S_s value in determination of C_s . For regular structures five stories or less above the base, as defined in Section 11.2 and with a period, T , of 0.5 s or less, C_s is permitted to be calculated using the larger of either $S_s = 1.5$ or 80 percent of the value of S_s determined per Section 11.4.1 or 11.4.7.

1616.10.12 ASCE 7, Section 12.9.4. Replace ASCE 7 Section 12.9.4 as follows:

12.9.4 Scaling design values of combined response. Modal base shears used to determine forces and drifts shall not be less than the base shear calculated using the equivalent lateral force procedure of Section 12.8.

1616.10.13 ASCE 7, Section 12.10.2.1. Replace ASCE 7 Exception 1 of Section 12.10.2.1 by the following:

Exception: The forces calculated above need not exceed those calculated using the load combinations of Section 12.4.3.2 with seismic forces determined by Equation 12.10-3 and transfer forces, where applicable.

1616.10.14 ASCE 7, Section 12.13.1. Modify ASCE 7 Section 12.13.1 by adding Section 12.13.1.1 as follows:

12.13.1.1 Foundations and superstructure-to-foundation connections. The foundation shall be capable of transmitting the design base shear and the overturning forces from the structure into the supporting soil. Stability against overturning and sliding shall be in accordance with Section 1605.1.1.

In addition, the foundation and the connection of the superstructure elements to the foundation shall have the strength to resist, in addition to gravity loads, the lesser of the following seismic loads:

1. The strength of the superstructure elements
2. The maximum forces that would occur in the fully yielded structural system
3. Forces from the Load Combinations with overstrength factor in accordance with ASCE 7 Section 12.4.3.2

Exceptions:

1. Where referenced standards specify the use of higher design loads.
2. When it can be demonstrated that inelastic deformation of the foundation and superstructure-to-foundation connection will not result in a weak story or cause collapse of the structure.
3. Where basic structural system consists of light-framed walls with shear panels, unless the reference standard specifies the use of higher design loads.

Where the computation of the seismic overturning moment is by the equivalent lateral-force method or the modal analysis method, reduction in overturning moment permitted by Section 12.13.4 of ASCE 7 may be used.

Where moment resistance is assumed at the base of the superstructure elements, the rotation and flexural deformation of the foundation as well as deformation of the superstructure-to-foundation connection shall be considered in the drift and deformation compatibility analyses.

1616.10.15 ASCE 7, Section 13.1.4. Replace ASCE 7 Section 13.1.4 by the following:

13.1.4 Exemptions. The following nonstructural components are exempt from the requirements of this section:

1. Furniture (except storage cabinets as noted in Table 13.5-1).
2. Temporary or moveable (mobile) equipment.

Exceptions:

- 1) Equipment shall be anchored if it is permanently attached to the building utility services such as electricity, gas, or water. For the purposes of this requirement, "permanently attached" shall include all electrical connections except plugs for duplex receptacles.
- 2) The enforcement agency shall be permitted to require temporary attachments for movable equipment which is usually stationed in one place and heavier than 400 pounds, when they are not in use for a period longer than 8 hours at a time.

3. Mechanical and electrical components in Seismic Design Categories D, E or F where all of the following apply:
 - a. The component is positively attached to the structure;
 - b. Flexible connections are provided at seismic separation joints and between the component and associated ductwork, piping and conduit; and either:
 - i. The component weighs 400 lb (1780 N) or less and has a center of mass located 4 ft. (1.22 m) or less above the adjacent floor or roof level;

Exception: Special Seismic Certification requirements of this code in accordance with Section 1705A.12.3 shall be applicable.

or

- ii. The component weighs 20 lb (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.

Exception: The enforcement agency shall be permitted to require attachments for equipment with hazardous contents to be shown on construction documents irrespective of weight.

1616.10.16 ASCE 7, Section 13.5.6. Replace ASCE 7, Section 13.5.6 by the following:

13.5.6 Suspended ceilings. Suspended ceilings shall be in accordance with this section.

13.5.6.1 Seismic forces. The weight of the ceiling, W_p shall include the ceiling grid; ceiling tiles or 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/m²).

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

13.5.6.2 Industry standard construction for acoustical tile or lay-in panel ceilings. Unless designed in accordance with ASTM E 580 Section 5.2.8, or seismically qualified in accordance with Sections 13.2.5 or 13.2.6, acoustical tile or lay-in panel ceilings shall be designed and constructed in accordance with this section.

13.5.6.2.1 Seismic Design Categories D through F. Acoustical tile or lay-in panel ceilings in Seismic Design Categories D, E and F shall be designed and installed in accordance with ASTM C 635, ASTM C 636, and ASTM E 580, Section 5 - Seismic Design Categories D, E and F as modified by this section.

13.5.6.2.2 Modification to ASTM E 580. Modify ASTM E 580 by the following:

1. **Exitways.** Lay-in ceiling assemblies in exitways of hospitals and essential services buildings shall be installed with a main runner or cross runner surrounding all sides of each piece of tile, board or panel and each light fixture or grille. A cross runner that supports another cross runner shall be considered as a main runner for the purpose of structural classification. Splices or intersections of such runners shall be attached with through connectors such as pop rivets, screws, pins, plates with end tabs or other approved connectors.
2. **Corridors and lobbies.** Expansion joints shall be provided in the ceiling at intersections of corridors and at junctions of corridors and lobbies or other similar areas.
3. **Lay-in panels.** Metal panels and panels weighing more than $\frac{1}{2}$ pounds per square foot (24 N/m²) other than acoustical tiles shall be positively attached to the ceiling suspension runners.
4. **Lateral force bracing.** Lateral force bracing is required for all ceiling areas except that they shall be permitted to be omitted in rooms with floor areas up to 144 square feet when perimeter support in accordance with ASTM E 580 Sections 5.2.2 and 5.2.3 are provided and perimeter walls are designed to carry the ceiling lateral forces. Restraining wires shall be secured with four tight twists in $1\frac{1}{2}$ inches, or an approved alternate connection.
5. **Ceiling fixtures.** Fixtures installed in acoustical tile or lay-in panel ceilings shall be mounted in a manner that will not compromise ceiling performance.

All recessed or drop-in light fixtures and grilles shall be supported directly from the fixture housing to the structure above with a minimum of two 12-gage wires located at diagonally opposite corners. Leveling and positioning of fixtures may be provided by the ceiling grid. Fixture support wires may be slightly loose to allow the fixture to seat in the grid system. Fixtures shall not be supported from main runners or cross runners if the weight of the fixtures causes the total dead load to exceed the deflection capability of the ceiling suspension system.

Fixtures shall not be installed so that the main runners or cross runners will be eccentrically loaded.

Surface-mounted fixtures shall be attached to the main runner with at least two positive clamping devices made of material with a minimum of 14 gage. Rotational spring catches do not com-

ply. A 12-gage suspension wire shall be attached to each clamping device and to the structure above.

6. **Partitions.** Where the suspended ceiling system is required to provide lateral support for the permanent or relocatable partitions, the connection of the partition to the ceiling system, the ceiling system members and their connections, and the lateral force bracing shall be designed to support the reaction force of the partition from prescribed loads applied perpendicular to the face of the partition. Partition connectors, the suspended ceiling system and the lateral-force bracing shall all be engineered to suit the individual partition application and shall be shown or defined in the drawings or specifications.

1616.10.17 ASCE 7, Section 13.6.5. Modify ASCE 7, Section 13.6.5.6, Exceptions 1 and 2, as follows:

Exceptions:

1. Design for the seismic forces of Section 13.3 shall not be required for raceways where either:
 - a. Trapeze assemblies are used to support raceways and the total weight of the raceway supported by trapeze assemblies is less than 10 lb/ft (146 N/m), or
 - b. The raceway is supported by hangers and each hanger in the raceway run is 12 in. (305 mm) or less in length from the raceway support point to the supporting structure. Where rod hangers are used, they shall be equipped with swivels to prevent inelastic bending in the rod.
2. Design for the seismic forces of Section 13.3 shall not be required for conduit, regardless of the value of I_p , where the conduit is less than 2.5 in. (64 mm) trade size.

1616.10.18 ASCE 7, Section 13.6.7. Replace ASCE 7, Section 13.6.7, Exceptions 1 and 2, by the following:

Exceptions:

The following exceptions pertain to ductwork not designed to carry toxic, highly toxic or flammable gases, or used for smoke control:

1. Design for the seismic forces of Section 13.3 shall not be required for ductwork where either:
 - a. Trapeze assemblies are used to support ductwork and the total weight of the ductwork supported by trapeze assemblies is less than 10 lb/ft (146 N/m); or
 - b. The ductwork is supported by hangers and each hanger in the duct run is 12 in. (305 mm) or less in length from the duct support point to the supporting structure. Where rod hangers are used, they shall be equipped with swivels to prevent inelastic bending in the rod.

2. Design for the seismic forces of Section 13.3 shall not be required where provisions are made to avoid impact with larger ducts or mechanical components or to protect the ducts in the event of such impact; and HVAC ducts have a cross-sectional area of 6 ft² (0.557 m²) or less, or weigh 10 lb/ft (146 N/m) or less.

1616.10.19 ASCE 7, Section 13.6.8. Modify ASCE 7, Section 13.6.8.2 by adding exception as follows:

Exception: Anchor capacities shall be determined in accordance with material chapters of this code in lieu of using those in NFPA 13 and demand shall be based on ASCE 7.

1616.10.20 ASCE 7, Section 13.6.8.3. Replace ASCE 7, Section 13.6.8.3 with the following:

13.6.8.3 Exceptions. Design of piping systems and attachments for the seismic forces of Section 13.3 shall not be required where one of the following conditions apply:

1. Trapeze assemblies are used to support piping whereby no single pipe exceeds the limits set forth in 3a. or b. below and the total weight of the piping supported by the trapeze assemblies is less than 10 lb/ft (146 N/m).
2. The piping is supported by hangers and each hanger in the piping run is 12 in. (305 mm) or less in length from the top of the pipe to the supporting structure. Where pipes are supported on a trapeze, the trapeze shall be supported by hangers having a length of 12 in. (305 mm) or less. Where rod hangers are used, they shall be equipped with swivels, eye nuts or other devices to prevent bending in the rod.
3. Piping having an R_p in Table 13.6-1 of 4.5 or greater is used and provisions are made to avoid impact with other structural or nonstructural components or to protect the piping in the event of such impact and where the following size requirements are satisfied:
 - a. For Seismic Design Categories D, E or F and values of I_p greater than one, the nominal pipe size shall be 1 inch (25 mm) or less.
 - b. For Seismic Design Categories D, E or F where $I_p = 1.0$ the nominal pipe size shall be 3 inches (80 mm) or less.

The exceptions above shall not apply to elevator piping.

1616.10.21 ASCE 7, Section 13.6.10.1. Modify ASCE 7, Section 13.6.10.1 by adding Section 13.6.10.1.1, as follows:

13.6.10.1.1 Elevators guide rail support. The design of guide rail support bracket fastenings and the supporting structural framing shall use the weight of the counterweight or maximum weight of the car plus not more than 40 percent of its rated load. The seismic forces shall be assumed to be distributed one-third to the top

guiding members and two-thirds to the bottom guiding members of cars and counterweights, unless other substantiating data are provided. In addition to the requirements of ASCE 7 Section 13.6.10.1, the minimum seismic forces shall be $0.5g$ acting in any horizontal direction.

1616.10.22 ASCE 7, Section 13.6.10.4. Replace ASCE 7 Section 13.6.10.4, as follows:

13.6.10.4 Retainer plates. Retainer plates are required at the top and bottom of the car and counterweight, except where safety devices acceptable to the enforcement agency are provided which meet all requirements of the retainer plates, including full engagement of the machined portion of the rail. The design of the car, cab stabilizers, counterweight guide rails and counterweight frames for seismic forces shall be based on the following requirements:

1. The seismic force shall be computed per the requirements of ASCE 7 Section 13.6.10.1. The minimum horizontal acceleration shall be $0.5g$ for all buildings.
2. W_p shall equal the weight of the counterweight or the maximum weight of the car plus not less than 40 percent of its rated load.
3. With the car or counterweight located in the most adverse position, the stress in the rail shall not exceed the limitations specified in these regulations, nor shall the deflection of the rail relative to its supports exceed the deflection listed below:

**TABLE 1224.4.11
ACCEPTABLE CEILING AND CARPET LOCATIONS**

| RAIL SIZE (weight per foot of length, pounds) | WIDTH OF MACHINED SURFACE (inches) | ALLOWABLE RAIL DEFLECTION (inches) |
|---|--|--|
| 8 | $1\frac{1}{4}$ | 0.20 |
| 11 | $1\frac{1}{2}$ | 0.30 |
| 12 | $1\frac{3}{4}$ | 0.40 |
| 15 | $1\frac{31}{32}$ | 0.50 |
| $18\frac{1}{2}$ | $1\frac{31}{32}$ | 0.50 |
| $22\frac{1}{2}$ | 2 | 0.50 |
| 30 | $2\frac{1}{4}$ | 0.50 |

For SI: 1 inch = 25 mm, 1 foot = 305 mm, 1 pound = 0.454 kg.

Note: Deflection limitations are given to maintain a consistent factor of safety against disengagement of retainer plates from the guide rails during an earthquake.

4. Where guide rails are continuous over supports and rail joints are within 2 feet (610 mm) of their supporting brackets, a simple span may be assumed.
5. The use of spreader brackets is allowed.
6. Cab stabilizers and counterweight frames shall be designed to withstand computed lateral load with a minimum horizontal acceleration of $0.5g$.

1616.10.23 ASCE 7, Section 16.1.4. Remove ASCE 7 Sections 16.1.4.1 and 16.1.4.2 and modify 16.1.4 by the following:

Maximum scaled base shears used to determine forces and drifts shall not be less than the base shear calculated using the equivalent lateral force procedure of Section 12.8.

1616.10.24 ASCE 7, Section 16.2.4. Modify ASCE 7 Section 16.2.4 by the following:

a) Where site is located within 3.1 miles (5 km) of an active fault at least seven ground motions shall be analyzed and response parameters shall be based on larger of the average of the maximum response with ground motions applied as follows:

1. Each of the ground motions shall have their maximum component at the fundamental period aligned in one direction.
2. Each of the ground motion's maximum component shall be rotated orthogonal to the previous analysis direction.

b) Where site is located more than 3.1 miles (5 km) from an active fault at least 10 ground motions shall be analyzed. The ground motions shall be applied such that one-half shall have their maximum component aligned in one direction and the other half aligned in the orthogonal direction. The average of the maximum response of all the analyses shall be used for design.

1616.10.25 ASCE 7, Section 17.2.1. Modify ASCE 7 Section 17.2.1 by adding the following:

The importance factor, I_p , for parts and portions of a seismically isolated building shall be the same as that required for a fixed-base building of the same risk category.

1616.10.26 ASCE 7 Section 17.2.4.7. Modify ASCE 7 Section 17.2.4.7 by adding the following to the end of the section:

The effects of uplift and/or rocking shall be explicitly accounted for in the analysis and in the testing of the isolator units.

1616.10.27 ASCE 7, Section 17.2.5.2. Modify ASCE 7, Section 17.2.5.2 by adding the following:

The separation requirements for the building above the isolation system and adjacent buildings shall be the sum of the factored displacements for each building. The factors to be used in determining separations shall be:

1. For seismically isolated buildings, the deformation resulting from the analyses using the maximum considered earthquake unmodified by R_f .
2. For fixed based buildings, C_d times the elastic deformations resulting from an equivalent static analysis using the seismic base shear computed via ASCE 7 Section 12.8.



CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 16A – STRUCTURAL DESIGN

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | X | | X | | | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | X | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| <i>1607A.8.2</i> | | | | | | X | | | | | | | | | | | | | | |



CHAPTER 16A

STRUCTURAL DESIGN

SECTION 1601A GENERAL

1601A.1 Scope. The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code.

1601A.1.1 Application. *The scope of application of Chapter 16A is as follows:*

1. *Applications listed in Section 1.9.2.1, regulated by the Division of the State Architect-Structural Safety (DSA-SS). These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.*
2. *Applications listed in Sections 1.10.1 and 1.10.4, regulated by the Office of Statewide Health Planning and Development (OSHPD). These applications include hospitals, skilled nursing facilities, intermediate care facilities, and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 16 and any applicable amendments therein.

1601A.1.2 Amendments in this chapter. DSA-SS and OSHPD adopt this chapter and all amendments.

Exception: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect-Structural Safety: [DSA-SS] – For applications listed in Section 1.9.2.1.*
2. *Office of Statewide Health Planning and Development: [OSHPD 1] – For applications listed in Section 1.10.1. [OSHPD 4] – For applications listed in Section 1.10.4.*

1601A.2 Enforcement agency approval. In addition to the requirements of the California Administrative Code and the California Building Code, any aspect of project design, construction, quality assurance or quality control programs for which this code requires approval by the design professional are also subject to approval by the enforcement agency.

SECTION 1602A DEFINITIONS AND NOTATIONS

1602A.1 Definitions. The following terms are defined in Chapter 2 except those defined below, which shall, for the purposes of this section, have the meanings shown herein.

ALLOWABLE STRESS DESIGN.

DEAD LOADS.

DESIGN STRENGTH.

DIAPHRAGM.

Diaphragm, blocked.

Diaphragm boundary.

Diaphragm chord.

Diaphragm flexible.

Diaphragm, rigid.

DURATION OF LOAD.

ESSENTIAL FACILITIES.

FABRIC PARTITION.

FACTORED LOAD.

HELIPAD.

HOSPITAL BUILDING. Any building defined in Section 129725, Health and Safety Code.

ICE-SENSITIVE STRUCTURE.

IMPACT LOAD.

LIMIT STATE.

LIVE LOAD.

LIVE LOAD (ROOF).

LOAD AND RESISTANCE FACTOR DESIGN (LRFD).

LOAD EFFECTS.

LOAD FACTOR.

LOADS.

NOMINAL LOADS.

OTHER STRUCTURES.

PANEL (PART OF A STRUCTURE).

RESISTANCE FACTOR.

RISK CATEGORY.

STRENGTH, NOMINAL.

STRENGTH, REQUIRED.

STRENGTH DESIGN.

SUSCEPTIBLE BAY.

VEHICLE BARRIER.

NOTATIONS.

D = Dead load.

D_i = Weight of ice in accordance with Chapter 10 of ASCE 7.

STRUCTURAL DESIGN

E = Combined effect of horizontal and vertical earthquake induced forces as defined in Section 12.4.2 of ASCE 7.

F = Load due to fluids with well-defined pressures and maximum heights.

F_a = Flood load in accordance with Chapter 5 of ASCE 7.

H = Load due to lateral earth pressures, ground water pressure or pressure of bulk materials.

L = Roof live load greater than 20 psf (0.96 kN/m²) and floor live load.

L_r = Roof live load of 20 psf (0.96 kN/m²) or less.

R = Rain load.

S = Snow load.

T = Self-straining load.

V_{asd} = Nominal design wind speed (3-second gust), miles per hour (mph) (km/hr) where applicable.

V_{ult} = Ultimate design wind speeds (3-second gust), miles per hour (mph) (km/hr) determined from Figures 1609A, 1609B, or 1609C or ASCE 7.

W_i = Wind-on-ice in accordance with Chapter 10 of ASCE 7.

W = Load due to wind pressure.

SECTION 1603A CONSTRUCTION DOCUMENTS

1603A.1 General. Construction documents shall show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603A.1.1 through 1603A.1.10 shall be indicated on the construction documents.

Exception: Construction documents for buildings constructed in accordance with the conventional light-frame construction provisions of Section 2308 shall indicate the following structural design information:

1. Floor and roof live loads.
2. Ground snow load, P_g .
3. Ultimate design wind speed, V_{ult} , (3-second gust), miles per hour (mph) (km/hr) and nominal design wind speed, V_{asd} , as determined in accordance with Section 1609.3.1 and wind exposure.
4. Seismic design category and site class.
5. Flood design data, if located in flood hazard areas established in Section 1612A.3.
6. Design load-bearing values of soils.

[DSA-SS] Additional requirements are included in Section 4-210 and 4-317 of the California Administrative Code (Part 1, Title 24, C.C.R.).

[OSHPD 1] Additional requirements are included in Section 7-115 and 7-125 of the California Administrative Code (Part 1, Title 24, C.C.R.).

1603A.1.1 Floor live load. The uniformly distributed, concentrated and impact floor live load used in the design shall be indicated for floor areas. Use of live load reduction in accordance with Section 1607A.10 shall be indicated for each type of live load used in the design.

1603A.1.2 Roof live load. The roof live load used in the design shall be indicated for roof areas (Section 1607A.12).

1603A.1.3 Roof snow load data. The ground snow load, P_g , shall be indicated. In areas where the ground snow load, P_g , exceeds 10 pounds per square foot (psf) (0.479 kN/m²), the following additional information shall also be provided, regardless of whether snow loads govern the design of the roof:

1. Flat-roof snow load, P_f
2. Snow exposure factor, C_e
3. Snow load importance factor, I .
4. Thermal factor, C_r

1603A.1.4 Wind design data. The following information related to wind loads shall be shown, regardless of whether wind loads govern the design of the lateral force-resisting system of the structure:

1. Ultimate design wind speed, V_{ult} , (3-second gust), miles per hour (km/hr) and nominal design wind speed, V_{asd} , as determined in accordance with Section 1609.3.1.
2. Risk category.
4. The applicable internal pressure coefficient.
5. Components and cladding. The design wind pressures in terms of psf (kN/m²) to be used for the design of exterior component and cladding materials not specifically designed by the registered design professional.

1603A.1.5 Earthquake design data. The following information related to seismic loads shall be shown, regardless of whether seismic loads govern the design of the lateral force-resisting system of the structure:

1. Risk category.
2. Seismic importance factor, I_e .
3. Mapped spectral response acceleration parameters, S_s and S_{1} .
4. Site class.
5. Design spectral response acceleration parameters, S_{DS} and S_{D1} .
6. Seismic design category.
7. Basic seismic force-resisting system(s).
8. Design base shear(s).
9. Seismic response coefficient(s), C_s .
10. Response modification coefficient(s), R .
11. Analysis procedure used.
12. Applicable horizontal structural irregularities.

13. Applicable vertical structural irregularities.
14. Location of base as defined in Section 1613A.2.

1603A.1.5.1 Connections. Connections that resist design seismic forces shall be designed and detailed on the design drawings.

1603A.1.6 Geotechnical information. The design load-bearing values of soils shall be shown on the construction documents.

1603A.1.7 Flood design data. For buildings located in whole or in part in flood hazard areas as established in Section 1612A.3, the documentation pertaining to design, if required in Section 1612A.5, shall be included and the following information, referenced to the datum on the community's Flood Insurance Rate Map (FIRM), shall be shown, regardless of whether flood loads govern the design of the building:

1. In flood hazard areas not subject to high-velocity wave action, the elevation of the proposed lowest floor, including the basement.
2. In flood hazard areas not subject to high-velocity wave action, the elevation to which any nonresidential building will be dry floodproofed.
3. In flood hazard areas subject to high-velocity wave action, the proposed elevation of the bottom of the lowest horizontal structural member of the lowest floor, including the basement.

1603A.1.8 Special loads. Special loads that are applicable to the design of the building, structure or portions thereof shall be indicated along with the specified section of this code that addresses the special loading condition.

1603A.1.9 Systems and components requiring special inspections for seismic resistance. Construction documents or specifications shall be prepared for those systems and components requiring special inspection for seismic resistance as specified in Section 1707.1 by the registered design professional responsible for their design and shall be submitted for approval in accordance with Section 107.1. Reference to seismic standards in lieu of detailed drawings is acceptable.

1603A.1.10 Construction procedures. Where unusual erection or construction procedures are considered essential by the Registered Design Professional (RDP) in order to accomplish the intent of the design or influence the design, such procedure shall be indicated on the construction documents.

1603A.2 Site data reports. Geotechnical and geohazard reports for review by the enforcement agency shall be accompanied by a description of the project prepared by the registered design professional (RDP) in responsible charge, which shall include the following:

1. Type of service such as general acute care facility, skilled nursing facility, intermediate care facility, acute

psychiatric facility, central utility plants, K-12 school, community college, essential services, etc.

2. Construction materials used for the project such as steel, concrete, masonry, wood, etc.
3. Type of construction such as new, addition, alteration, repair, etc.
4. For existing buildings, extent of construction such as incidental, minor, major, and/or voluntary seismic improvements as defined in Section 3418 [DSA-SS] Sections 202 and 3402A.2 [OSHPD 1 & 4].
5. Seismic force resisting system used for each structure in the project.
6. Foundation system that will be used for each structure in the project such as spread footing, drilled piers, etc.
7. Analysis procedure used and basis of design such as ASCE 7 Equivalent Lateral Force Procedure, ASCE 41 Nonlinear Dynamic Procedure, etc.
8. Building characteristics such as number of stories above and below grade, foot print area at grade, grade slope on site, etc.
9. Special features such as requirement for shoring, underpinning, retaining walls, etc.

1603A.3 Structural calculations. The application for the approval of construction documents that involves structural elements or components shall be accompanied by complete and accurate structural design computations, which shall comply with requirements prescribed by the enforcement agency:

1. The computations shall be preceded by a detailed index.
2. The computations including each major subsection shall be prefaced by a statement clearly and concisely outlining the basis for the structural design and indicating the manner in which the structure will resist the vertical loads and lateral forces.
3. The computations shall be sufficiently complete to the extent that calculations for the individual structural members and connections can be readily interpreted.

SECTION 1604A GENERAL DESIGN REQUIREMENTS

1604A.1 General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

1604A.2 Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this code without exceeding the appropriate strength limit states for the materials of construction. Alternatively, buildings and other

structures, and parts thereof, shall be designed and constructed to support safely the nominal loads in load combinations defined in this code without exceeding the appropriate specified allowable stresses for the materials of construction.

Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the building official.

1604A.3 Serviceability. Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift. See Section 12.12.1 of ASCE 7 for drift limits applicable to earthquake loading.

1604A.3.1 Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604A.3.2 through 1604A.3.6 or that permitted by Table 1604A.3.

1604A.3.2 Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

1604A.3.3 Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI S100, ASCE 8, SJI CJ-1.0, SJI JG-1.1, SJI K-1.1 or SJI LH/DLH-1.1, as applicable.

1604A.3.4 Masonry. The deflection of masonry structural members shall not exceed that permitted by TMS 402/ACI 530/ASCE 5.

1604A.3.5 Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

1604A.3.6 Limits. The deflection limits of Section 1604A.3.1 shall be used unless more restrictive deflection limits are required by a referenced standard for the element or finish material.

1604A.3.7 Horizontal diaphragms. The maximum span-width ratio for any roof or floor diaphragm shall not exceed those given in Table 4.2.4 of AF & PA SDPWS for wood or maximum span-depth ratio given in Table 1604A.4 for steel and composite steel-slab decking, unless test data and design calculations acceptable to the enforcement agency are submitted and approved for the use of other span-width or span-depth ratios. Concrete diaphragms shall not exceed the span depth ratios for the equivalent composite steel-slab diaphragm in Table 1604A.4.

1604A.3.8 Deflections. Deflection criteria for materials not specified shall be developed by the project architect or structural engineer in a manner consistent with the provisions of this section and approved by the enforcement agency.

1604A.4 Analysis. Load effects on structural members and their connections shall be determined by methods of struc-

TABLE 1604A.3
DEFLECTION LIMITS^{a, b, c, h, i}

| CONSTRUCTION | L | S or W ^f | D + L ^{d, g} |
|--|-------------------------|----------------------------------|-------------------------|
| Roof members: Supporting plaster or stucco ceiling Supporting nonplaster ceiling Not supporting ceiling | I/360 I/240 I/180 | I/360 I/240 I/180 | I/240 I/180 I/120 |
| Floor members | I/360 | — | I/240 |
| Exterior walls and interior partitions: With plaster or stucco finishes With other brittle finishes With flexible finishes <i>Veneered walls, anchored veneers and adhered veneers over 1 inch (25 mm) thick, including the mortar backing</i> | — — — | I/360 I/240 I/120 I/600 | — — — — |
| Farm buildings | — | — | I/180 |
| Greenhouses | — | — | I/120 |

For SI: 1 foot = 304.8 mm.

- a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed I/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed I/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed I/90. For roofs, this exception only applies when the metal sheets have no roof covering.
- b. Interior partitions not exceeding 6 feet in height and flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.14.
- c. See Section 2403 for glass supports.
- d. For wood structural members having a moisture content of less than 16 percent at time of installation and used under dry conditions, the deflection resulting from $L + 0.5D$ is permitted to be substituted for the deflection resulting from $L + D$.
- e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Section 1611A for rain and ponding requirements and Section 1503.4 for roof drainage requirements.
- f. The wind load is permitted to be taken as 0.42 times the "component and cladding" loads for the purpose of determining deflection limits herein.
- g. For steel structural members, the dead load shall be taken as zero.
- h. For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed I/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed I/175 for each glass lite or I/60 for the entire length of the member, whichever is more stringent. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed I/120.
- i. For cantilever members, l shall be taken as twice the length of the cantilever.

tural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during their service life.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

The total lateral force shall be distributed to the various vertical elements of the lateral-force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements assumed not to be a part of the lateral-force-resisting system are permitted to be incorporated into buildings provided their effect on the action of the system is considered and provided for in the design. Except where diaphragms are flexible, or are permitted to be analyzed as flexible, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral-force-resisting system.

Every structure shall be designed to resist the overturning effects caused by the lateral forces specified in this chapter.

See Section 1609A for wind loads, Section 1610A for lateral soil loads and Section 1613A for earthquake loads.

1604A.5 Risk category. Each building and structure shall be assigned a risk category in accordance with Table 1604A.5. Where a referenced standard specifies an occupancy category, the risk category shall not be taken as lower than the occupancy category specified therein.

1604.5A.1 Multiple occupancies. Where a building or structure is occupied by two or more occupancies not included in the same risk category, it shall be assigned the classification of the highest risk category corresponding to the various occupancies. Where buildings or structures have two or more portions that are structurally separated, each portion shall be separately classified. Where a separated portion of a building or structure provides required access to, required egress from or shares life safety components with another portion having a higher risk category, both portions shall be assigned to the higher risk category.

1604A.6 In-situ load tests. The building official is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with Section 1709A.

1604A.7 Preconstruction load tests. Materials and methods of construction that are not capable of being designed by approved engineering analysis or that do not comply with the

**TABLE 1604A.4
MAXIMUM HORIZONTAL DIAPHRAGM SPAN AND SPAN-DEPTH RATIOS^{1,3,4}**

| FLEXIBILITY FACTOR(F^2) | MAXIMUM DIAPHRAGM SPAN FOR MASONRY OR CONCRETE WALLS (feet) | DIAPHRAGM SPAN-DEPTH LIMITATION | | | |
|-----------------------------|---|--|----------------|--|----------------|
| | | Rotation (torsion) Not Considered in Diaphragm | | Rotation (torsion) Considered in Diaphragm | |
| | | Masonry or Concrete Walls | Flexible Walls | Masonry or Concrete Walls | Flexible Walls |
| More than 150 | Not to be used | Not to be used | 2:1 | Not to be used | 1½:1 |
| 70-150 | 200 | 2:1 or as required for deflection | 3:1 | Not to be used | 2:1 |
| 10-70 | 400 | 2½:1 or as required for deflection | 4:1 | As required for deflection | 2½:1 |
| 1-10 | No limitation | 3:1 or as required for deflection | 5:1 | As required for deflection | 3:1 |
| Less than 1 | No limitation | As required for deflection | No limitation | As required for deflection | 3½:1 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 plf = 14.594 N/m, 1 psi = 6894 Pa

1. Diaphragms shall satisfy span depth limitations based on flexibility.

2. Flexibility factor (F) is the average deflection in micro inches (10^6) or μm of the diaphragm web per foot (m) of span stressed with a shear of 1 pound per foot (N/m).

3. The total deflection Δ of the diaphragm may be computed from the equation: $\Delta = \Delta_f + \Delta_w$.

Where:

Δ_f = Flexural deflection of the diaphragm determined in the same manner as the deflection of beams. The flexural stiffness of the web of diaphragms consisting of bare steel decking shall be neglected.

Δ_w = Web deflection of the diaphragm may be determined solving the following equation:

$$F = \frac{\Delta_w \times 10^6}{q_{ave} L}$$

Where:

L = Distance in feet (m) between the vertical resisting element (such as a shear wall) and the point to which the deflection is to be determined.

q_{ave} = Average shear in the diaphragm in pounds per foot (N/m) over length L .

4 When applying these limitations to cantilevered diaphragms, the allowable span depth ratio will be half of that shown.

TABLE 1604A.5
RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

| RISK CATEGORY | NATURE OF OCCUPANCY |
|---------------|---|
| I | Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: <ul style="list-style-type: none"> • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities. |
| II | Buildings and other structures except those listed in Risk Categories I, III and IV |
| III | Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: <ul style="list-style-type: none"> • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000^a. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: <ul style="list-style-type: none"> Exceed maximum allowable quantities per control area as given in Table 307A.1(1) or 307.1(2) or per outdoor control area in accordance with the <i>California Fire Code</i>; and Are sufficient to pose a threat to the public if released.^b |
| IV | Buildings and other structures designated as essential facilities, including but not limited to: <ul style="list-style-type: none"> • <i>[OSHPD 1 & 4] Hospital Buildings as defined in the California Administrative Code, Section 7-111 and all structures required for their continuous operation or access/egress.</i> • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response <i>[DSA-SS] as defined in the California Administrative Code (Title 24, Part 1, CCR) Section 4-207 and all structures required for their continuous operation or access/egress.</i> • Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: <ul style="list-style-type: none"> Exceed maximum allowable quantities per control area as given in Table 307A.1(2) or per outdoor control area in accordance with the <i>California Fire Code</i>; and Are sufficient to pose a threat to the public if released.^b • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression. |

- a. For purposes of occupant load calculation, occupancies required by Table 1004A.1.2 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.
- b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II, provided it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

applicable referenced standards, or alternative test procedures in accordance with Section 1707, shall be load tested in accordance with Section 1710A.

1604A.8 Anchorage. Buildings and other structures, and portions thereof, shall be provided with anchorage in accordance with Sections 1604A.8.1 through 1604A.8.3, as applicable.

1604A.8.1 General. Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall

be provided to resist the uplift and sliding forces that result from the application of the prescribed loads.

1604A.8.2 Structural walls. Walls that provide vertical load-bearing resistance or lateral shear resistance for a portion of the structure shall be anchored to the roof and to all floors and members that provide lateral support for the wall or that are supported by the wall. The connections shall be capable of resisting the horizontal forces specified in Section 1.4.4 of ASCE 7 for walls of structures assigned

to Seismic Design Category A and to Section 12.11 of ASCE 7 for walls of structures assigned to all other seismic design categories. *For anchorage of concrete or masonry walls to roof and floor diaphragms, the out-of-plane strength design force shall not be less than 280 lb/linear ft (4.09 kN/m) of wall.* Required anchors in masonry walls of hollow units or cavity walls shall be embedded in a reinforced grouted structural element of the wall. See Sections 1609A for wind design requirements and 1613A for earthquake design requirements.

1604A.8.3 Decks. Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads as applicable. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. Connections of decks with cantilevered framing members to exterior walls or other framing members shall be designed for both of the following:

1. The reactions resulting from the dead load and live load specified in Table 1607A.1, or the snow load specified in Section 1608A, in accordance with Section 1605A, acting on all portions of the deck.
2. The reactions resulting from the dead load and live load specified in Table 1607A.1, or the snow load specified in Section 1608A, in accordance with Section 1605A, acting on the cantilevered portion of the deck, and no live load or snow load on the remaining portion of the deck.

1604A.9 Counteracting structural actions. Structural members, systems, components and cladding shall be designed to resist forces due to earthquake and wind, with consideration of overturning, sliding and uplift. Continuous load paths shall be provided for transmitting these forces to the foundation. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

1604A.10 Wind and seismic detailing. Lateral-force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7, excluding Chapter 14 and Appendix 11A, even when wind load effects are greater than seismic load effects.

SECTION 1605A LOAD COMBINATIONS

1605A.1 General. Buildings and other structures and portions thereof shall be designed to resist:

1. The load combinations specified in Section 1605A.2, 1605A.3.1 or 1605A.3.2,
2. The load combinations specified in Chapters 18 through 23, and
3. The seismic load effects including overstrength factor in accordance with Section 12.4.3 of ASCE 7 where required by Section 12.2.5.2, 12.3.3.3 or 12.10.2.1 of ASCE 7. With the simplified procedure of ASCE 7

Section 12.14, the seismic load effects including overstrength factor in accordance with Section 12.14.3.2 of ASCE 7 shall be used.

Applicable loads shall be considered, including both earthquake and wind, in accordance with the specified load combinations. Each load combination shall also be investigated with one or more of the variable loads set to zero.

Where the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7 apply, they shall be used as follows:

1. The basic combinations for strength design with overstrength factor in lieu of Equations 16-5 and 16-7 in Section 1605A.2.
2. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16-12, 16-14 and 16-16 in Section 1605A.3.1.
3. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16-21 and 16-22 in Section 1605A.3.2.

1605A.1.1 Stability. Regardless of which load combinations are used to design for strength, where overall structure stability (such as stability against overturning, sliding, or buoyancy) is being verified, use of the load combinations specified in Section 1605A.2 or 1605A.3 shall be permitted. Where the load combinations specified in Section 1605A.2 are used, strength reduction factors applicable to soil resistance shall be provided by a registered design professional. The stability of retaining walls shall be verified in accordance with Section 1807A.2.3. *When using allowable stress design, factor of safety for soil bearing values shall not be less than the overstrength factor of the structures supported.*

1605A.2 Load combinations using strength design or load and resistance factor design. Where strength design or load and resistance factor design is used, buildings and other structures, and portions thereof, shall be designed to resist the most critical effects resulting from the following combinations of factored loads:

$$1.4(D + F) \quad (\text{Equation 16A-1})$$

$$1.2(D + F) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16A-2})$$

$$1.2(D + F) + 1.6(L_r \text{ or } S \text{ or } R) + 1.6H + (f_1L \text{ or } 0.5W) \quad (\text{Equation 16A-3})$$

$$1.2(D + F) + 1.0W + f_1L + 1.6H + 0.5(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16A-4})$$

$$1.2(D + F) + 1.0E + f_1L + 1.6H + f_2S \quad (\text{Equation 16A-5})$$

$$0.9D + 1.0W + 1.6H \quad (\text{Equation 16A-6})$$

$$0.9(D + F) + 1.0E + 1.6H \quad (\text{Equation 16A-7})$$

where:

$f_1 = 1$ for places of public assembly live loads in excess of 100 pounds per square foot (4.79 kN/m^2), and parking garages; and 0.5 for other live loads.

$f_2 = 0.7$ for roof configurations (such as saw tooth) that do not shed snow off the structure, and 0.2 for other roof configurations.

Exceptions:

- Where other factored load combinations are specifically required by other provisions of this code, such combinations shall take precedence.
- Where the effect of H resists the primary variable load effect, a load factor of 0.9 shall be included with H where H is permanent and H shall be set to zero for all other conditions.

1605A.2.1 Other loads. Where flood loads, F_a , are to be considered in the design, the load combinations of Section 2.3.3 of ASCE 7 shall be used. Where self-straining loads, T , are considered in design, their structural effects in combination with other loads shall be determined in accordance with Section 2.3.5 of ASCE 7. Where an ice-sensitive structure is subjected to loads due to atmospheric icing, the load combinations of Section 2.3.4 of ASCE 7 shall be considered.

1605A.3 Load combinations using allowable stress design.

1605A.3.1 Basic load combinations. Where allowable stress design (working stress design), as permitted by this code, is used, structures and portions thereof shall resist the most critical effects resulting from the following combinations of loads:

$$D + F \quad (\text{Equation 16A-8})$$

$$D + H + F + L \quad (\text{Equation 16A-9})$$

$$D + H + F + (L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16A-10})$$

$$D + H + F + 0.75(L) + 0.75(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16A-11})$$

$$D + H + F + (0.6W \text{ or } 0.7E) \quad (\text{Equation 16A-12})$$

$$D + H + F + 0.75(0.6W) + 0.75L + 0.75(L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16A-13})$$

$$D + H + F + 0.75(0.7E) + 0.75L + 0.75S \quad (\text{Equation 16A-14})$$

$$0.6D + 0.6W + H \quad (\text{Equation 16A-15})$$

$$0.6(D + F) + 0.7E + H \quad (\text{Equation 16A-16})$$

Exceptions:

- Crane hook loads need not be combined with roof live load or with more than three-fourths of the snow load or one-half of the wind load.
- Flat roof snow loads of 30 psf (1.44 kN/m²) or less and roof live loads of 30 psf or less need not be combined with seismic loads. Where flat roof snow loads exceed 30 psf (1.44 kN/m²), 20 percent shall be combined with seismic loads.
- Where the effect of H resists the primary variable load effect, a load factor of 0.6 shall be included with H where H is permanent and H shall be set to zero for all other conditions.

4. In Equation 16-15, the wind load, W , is permitted to be reduced in accordance with Exception 2 of Section 2.4.1 of ASCE 7.

5. In Equation 16-16, 0.6 D is permitted to be increased to 0.9 D for the design of special reinforced masonry shear walls complying with Chapter 21.

1605A.3.1.1 Stress increases. Increases in allowable stresses specified in the appropriate material chapter or the referenced standards shall not be used with the load combinations of Section 1605A.3.1, except that increases shall be permitted in accordance with Chapter 23.

1605A.3.1.2 Other loads. Where flood loads, F_a , are to be considered in design, the load combinations of Section 2.4.2 of ASCE 7 shall be used. Where self-straining loads, T , are considered in design, their structural effects in combination with other loads shall be determined in accordance with Section 2.4.4 of ASCE 7. Where an ice-sensitive structure is subjected to loads due to atmospheric icing, the load combinations of Section 2.4.3 of ASCE 7 shall be considered.

1605A.3.2 Alternative basic load combinations. In lieu of the basic load combinations specified in Section 1605.3.1, structures and portions thereof shall be permitted to be designed for the most critical effects resulting from the following combinations. When using these alternative basic load combinations that include wind or seismic loads, allowable stresses are permitted to be increased or load combinations reduced where permitted by the material chapter of this code or the referenced standards. For load combinations that include the counteracting effects of dead and wind loads, only two-thirds of the minimum dead load likely to be in place during a design wind event shall be used. When using allowable stresses which have been increased or load combinations which have been reduced as permitted by the material chapter of this code or the referenced standards, where wind loads are calculated in accordance with Chapters 26 through 31 of ASCE 7, the coefficient (ω) in the following equations shall be taken as 1.3. For other wind loads, (ω) shall be taken as 1. When allowable stresses have not been increased or load combinations have not been reduced as permitted by the material chapter of this code or the referenced standards, (ω) shall be taken as 1. When using these alternative load combinations to evaluate sliding, overturning and soil bearing at the soil-structure interface, the reduction of foundation overturning from Section 12.13.4 in ASCE 7 shall not be used. When using these alternative basic load combinations for proportioning foundations for loadings, which include seismic loads, the vertical seismic load effect, E_v , in Equation 12.4-4 of ASCE 7 is permitted to be taken equal to zero.

$$D + L + (L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16A-17})$$

$$D + L + 0.6 \omega W \quad (\text{Equation 16A-18})$$

$$D + L + 0.6 \omega W + S/2 \quad (\text{Equation 16A-19})$$

$$D + L + S + 0.6 \omega W/2 \quad (\text{Equation 16A-20})$$

$$D + L + S + E/1.4$$

(Equation 16A-21)

$$0.9D + E/1.4$$

(Equation 16A-22)

Exceptions:

1. Crane hook loads need not be combined with roof live loads or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 30 psf (1.44 kN/m^2) or less and roof live loads of 30 psf or less need not be combined with seismic loads. Where flat roof snow loads exceed 30 psf (1.44 kN/m^2), 20 percent shall be combined with seismic loads.

1605A.3.2.1 Other loads. Where F , H or T are to be considered in the design, each applicable load shall be added to the combinations specified in Section 1605A.3.2. Where self-straining loads, T , are considered in design, their structural effects in combination with other loads shall be determined in accordance with Section 2.4.4 of ASCE 7..

SECTION 1606A DEAD LOADS

1606A.1 General. Dead loads are those loads defined in Section 1602A.1. Dead loads shall be considered permanent loads.

1606A.2 Design dead load. For purposes of design, the actual weights of materials of construction and fixed service equipment shall be used. In the absence of definite information, values used shall be subject to the approval of the building official.

1606A.3 Roof dead loads. *The design dead load shall provide for the weight of at least one additional roof covering in addition to other applicable loadings if the new roof covering is permitted to be applied over the original roofing without its removal, in accordance with Section 1510.*

SECTION 1607A LIVE LOADS

1607A.1 General. Live loads are those loads defined in Section 1602A.1.

1607A.2 Loads not specified. For occupancies or uses not designated in Table 1607A.1, the live load shall be determined in accordance with a method approved by the building official.

1607A.3 Uniform live loads. The live loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy but shall in no case be less than the minimum uniformly distributed live loads given in Table 1607A.1.

1607A.4 Concentrated live loads. Floors and other similar surfaces shall be designed to support the uniformly distributed live loads prescribed in Section 1607A.3 or the concentrated live loads, in pounds (kiloNewtons), given in Table 1607A.1, whichever produces the greater load effects. Unless otherwise specified, the indicated concentration shall be

assumed to be uniformly distributed over an area of $2\frac{1}{2}$ feet by $2\frac{1}{2}$ feet (762 mm by 762 mm) and shall be located so as to produce the maximum load effects in the structural members.

1607A.5 Partition loads. In office buildings and in other buildings where partition locations are subject to change, provisions for partition weight shall be made, whether or not partitions are shown on the construction documents, unless the specified live load exceeds 80 psf (3.83 kN/m^2). The partition load shall not be less than a uniformly distributed live load of 15 psf (0.74 kN/m^2).

1607A.6 Helipads. Helipads shall be designed for the following live loads:

1. A uniform live load, L , as specified below. This load shall not be reduced.
 - 1.1. 40 psf (1.92 kN/m^2) where the design basis helicopter has a maximum take-off weight of 3,000 pounds (13.35 kN) or less.
 - 1.2. 60 psf (2.87 kN/m^2) where the design basis helicopter has a maximum take-off weight greater than 3,000 pounds (13.35 kN).
2. A single concentrated live load, L , of 3,000 pounds (13.35 kN) applied over an area of 4.5 inches by 4.5 inches (114 mm by 114 mm) and located so as to produce the maximum load effects on the structural elements under consideration. The concentrated load is not required to act concurrently with other uniform or concentrated live loads.
3. Two single concentrated live loads, L , 8 feet (2438 mm) apart applied on the landing pad (representing the helicopter's two main landing gear, whether skid type or wheeled type), each having a magnitude of 0.75 times the maximum take-off weight of the helicopter, and located so as to produce the maximum load effects on the structural elements under consideration. The concentrated loads shall be applied over an area of 8 inches by 8 inches (203 mm by 203 mm) and are not required to act concurrently with other uniform or concentrated live loads.

Landing areas designed for a design basis helicopter with maximum take-off weight of 3,000 pounds (13.35 kN) shall be identified with a 3,000 pound (13.34 kN) weight limitation. The landing area weight limitation shall be indicated by the numeral "3" (kips) located in the bottom right corner of the landing area as viewed from the primary approach path. The indication for the landing area weight limitation shall be a minimum 5 feet (1524 mm) in height.

1607A.7 Heavy vehicle loads. Floors and other surfaces that are intended to support vehicle loads greater than a 10,000 pound (4536 kg) gross vehicle weight rating shall comply with Sections 1607A.7.1 through 1607A.7.5.

1607A.7.1 Loads. Where any structure does not restrict access for vehicles that exceed a 10,000-pound (4536 kg) gross vehicle weight rating, those portions of the structure subject to such loads shall be designed using the vehicular live loads, including consideration of impact and fatigue,

in accordance with the codes and specifications required by the jurisdiction having authority for the design and construction of the roadways and bridges in the same location of the structure.

1607A.7.2 Fire truck and emergency vehicles. Where a structure or portions of a structure are accessed and loaded by fire department access vehicles and other similar emergency vehicles, the structure shall be designed for the greater of the following loads:

1. The actual operational loads, including outrigger reactions and contact areas of the vehicles as stipulated and approved by the building official; or
2. The live loading specified in Section 1607A.7.1.

1607A.7.3 Heavy vehicle garages. Garages designed to accommodate vehicles that exceed a 10,000 pound (4536 kg) gross vehicle weight rating, shall be designed using the live loading specified by Section 1607A.7.1. For garages the design for impact and fatigue is not required.

Exception: The vehicular live loads and load placement are allowed to be determined using the actual vehicle weights for the vehicles allowed onto the garage floors, provided such loads and placement are based on rational engineering principles and are approved by the building official, but shall not be less than 50 psf (2.9 kN/m²). This live load shall not be reduced.

1607A.7.4 Forklifts and movable equipment. Where a structure is intended to have forklifts or other movable equipment present, the structure shall be designed for the total vehicle or equipment load and the individual wheel loads for the anticipated vehicles as specified by the owner of the facility. These loads shall be posted per Section 1607A.7.5.

1607A.7.4.1 Impact and fatigue. Impact loads and fatigue loading shall be considered in the design of the supporting structure. For the purposes of design, the vehicle and wheel loads shall be increased by 30 percent to account for impact.

1607A.7.5 Posting. The maximum weight of the vehicles allowed into or on a garage or other structure shall be posted by the owner in accordance with Section 106A.1.

1607A.8 Loads on handrails, guards, grab bars, seats and vehicle barriers. Handrails, guards, grab bars, accessible seats, accessible benches and vehicle barriers shall be designed and constructed to the structural loading conditions set forth in this section.

1607A.8.1 Handrails and guards. Handrails and guards shall be designed to resist a linear load of 50 pounds per linear foot (plf) (0.73 kN/m) in accordance with Section

4.5.1 of ASCE 7. Glass handrail assemblies and guards shall also comply with Section 2407A.

Exceptions:

1. For one- and two-family dwellings, only the single concentrated load required by Section 1607A.8.1.1 shall be applied.
2. In Group I-3, F, H and S occupancies, for areas that are not accessible to the general public and that have an occupant load less than 50, the minimum load shall be 20 pounds per foot (0.29 kN/m).

1607A.8.1.1 Concentrated load. Handrails and guards shall also be designed to resist a concentrated load of 200 pounds (0.89 kN) in accordance with Section 4.5.1 of ASCE 7.

1607A.8.1.2 Intermediate rails. Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to resist a concentrated load of 50 pounds (0.22 kN) in accordance with Section 4.5.1 of ASCE 7.

1607A.8.2 Grab bars, shower seats and dressing room bench seats. Grab bars, shower seats and dressing room bench seat systems shall be designed to resist a single concentrated load of 250 pounds (1.11 kN) applied in any direction at any point on the grab bar or seat so as to produce the maximum load effects. [DSA-AC] See Chapter 11A, Section 1127A.4, and Chapter 11B, Sections 11B-609.8, 11B-610.4 and 11B-903.6 for grab bars, shower seats and dressing room bench seats, as applicable.

1607A.8.3 Vehicle barriers. Vehicle barriers for passenger vehicles shall be designed to resist a concentrated load of 6,000 pounds (26.70 kN) in accordance with Section 4.5.3 of ASCE 7. Garages accommodating trucks and buses shall be designed in accordance with an approved method that contains provisions for traffic railings.

1607A.9 Impact loads. The live loads specified in Sections 1607A.3 through 1607A.8 shall be assumed to include adequate allowance for ordinary impact conditions. Provisions shall be made in the structural design for uses and loads that involve unusual vibration and impact forces.

1607A.9.1 Elevators. Members, elements and components subject to dynamic loads from elevators shall be designed for impact loads and deflection limits prescribed by ASME A17.1.

1607A.9.2 Machinery. For the purpose of design, the weight of machinery and moving loads shall be increased as follows to allow for impact: (1) light machinery, shaft- or motor-driven, 20 percent; and (2) reciprocating machinery or power-driven units, 50 percent. Percentages shall be increased where specified by the manufacturer.

TABLE 1607A.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND
MINIMUM CONCENTRATED LIVE LOADS^g

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (lbs.) |
|--|--|------------------------|
| 1. Apartments (see residential) | | |
| 2. Access floor systems | | |
| Office use | 50 | 2,000 |
| Computer use | 100 | 2,000 |
| 3. Armories and drill rooms | 150 ^m | |
| 4. Assembly areas ^{a,q} | | |
| Fixed seats (fastened to floor) | 60 ^m | |
| Follow spot, projections and control rooms | 50 | |
| Lobbies | 100 ^m | |
| Movable seats | 100 ^m | |
| Stage floors | 150 ^m | |
| Platforms (assembly) | 100 ^m | |
| Other assembly areas | 100 ^m | |
| 5. Balconies and decks ^h | Same as occupancy served | |
| 6. Catwalks | 40 | 300 |
| 7. Cornices | 60 | |
| 8. Corridors | | |
| First floor | 100 | |
| Other floors | Same as occupancy served except as indicated | |
| 9. Dining rooms and restaurants | 100 ^m | |
| 10. Dwellings (see residential) | | |
| 11. Elevator machine room grating (on area of 2 inches by 2 inches) | | 300 |
| 12. Finish light floor plate construction (on area of 1 inch by 1 inch) | | 200 |
| 13. Fire escapes | | |
| On single family dwellings only | 100 | |
| | 40 | |
| 14. Garages (passenger vehicles only) | 40 ^m | Note a |
| Trucks and buses | | See Section 1607.7 |
| 15. Handrails, guards and grab bars | | See Section 1607.8 |
| 16. Helipads | | See Section 1607.6 |
| 17. Hospitals [OSHPD 1 & 4] | | |
| Corridors above first floor | 100 | 1,000 |
| Operating rooms, laboratories | 60 | 1,000 |
| Patient rooms | 40 | 1,000 |
| <i>Mechanical and electrical equipment areas including open areas around equipment</i> | 50 | |
| <i>Storage</i> | | |
| <i>Light</i> | 125 | |
| <i>Heavy</i> | 250 | |
| <i>Dining Area (not used for assembly)</i> | 100 | 1,000 |
| <i>Kitchen and serving areas</i> | 50 | 1,000 |
| 18. Hotels (see residential) | | |
| 19. Libraries ⁿ | | |
| Corridors above first floor | 80 | 1,000 |
| Reading rooms | 60 | 1,000 |
| Stack rooms | 150 ^{b,m} | 1,000 |
| 20. Manufacturing | | |
| Heavy | 250 ^m | 3,000 |
| Light | 125 ^m | 2,000 |
| 21. Marquees | 75 | |

(continued)

TABLE 1607A.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND
MINIMUM CONCENTRATED LIVE LOADS^g

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (lbs.) |
|--|--------------------|------------------------|
| 22. Office buildings ⁿ | | |
| Corridors above first floor | 80 | 2,000 |
| File and computer rooms shall be designed for heavier loads based on anticipated occupancy | — | |
| Lobbies and first floor corridors | 100 | 2,000 |
| Offices | 50 | 2,000 |
| 23. Penal institutions | | |
| Cell blocks | 40 | |
| Corridors | 100 | |
| 24. Recreational uses: | | |
| Bowling alleys, poolrooms and similar uses | 75 ^m | |
| Dance halls and ballrooms | 100 ^m | |
| Gymnasiums | 100 ^m | |
| Reviewing stands, grandstands and bleachers ^q | 100 ^{c,m} | |
| Stadiums and arenas with fixed seats (fastened to floor) | 60 ^{c,m} | |
| 25. Residential | | |
| One and two family dwellings | 10 | |
| Uninhabitable attics without storage ⁱ | 20 | |
| Uninhabitable attics with storage ^{i,j,k} | 30 | |
| Habitable attics and sleeping areas ^k | 40 | |
| All other areas | | |
| Hotels and multifamily dwellings | | |
| Private rooms and corridors serving them | 40 | |
| Public rooms ^m and corridors serving them | 100 | |
| 26. Roofs | | |
| All roof surfaces subject to maintenance workers | | 300 |
| Awnings and canopies: | | |
| Fabric construction supported by a skeleton structure | 5 | |
| All other construction | 20 | |
| Ordinary flat, pitched, and curved roofs (that are not occupiable) | 20 | |
| Where primary roof members are exposed to a work floor, at single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs: | | |
| Over manufacturing, storage ware houses, and repair garages | | |
| All other primary roof members | | |
| Occupiable roofs: | | |
| Roof gardens | 100 | |
| Assembly areas | 100 ^m | |
| All other similar areas | Note 1 | Note 1 |
| 27. Schools ⁿ | | |
| Classrooms | 40 ^p | 1,000 |
| Corridors above first floor | 80 | 1,000 |
| First floor corridors | 100 | 1,000 |
| 28. Scuttles, skylight ribs and accessible ceilings | | 200 |
| 29. Sidewalks, vehicular drive ways and yards, subject to trucking | 250 ^{d,m} | 8,000 ^e |

(continued)

TABLE 1607A.1—continued
**MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o ,
AND MINIMUM CONCENTRATED LIVE LOADS^g**

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (lbs.) |
|--|--------------------------------------|--------------------------------------|
| 30. Stairs and exits One and two family dwellings All other | 40 100 | 300 ^f 300 ^f |
| 31. Storage warehouses (shall be designed for heavier loads if required for anticipated storage) Heavy Light | 250 ^m 125 ^m | |
| 32. Stores Retail First floor Upper floors Wholesale, all floors | 100 75 125 ^m | 1,000 1,000 1,000 |
| 33. Vehicle barriers | | See Section 1607.8.3 |
| 34. Walkways and elevated platforms (other than exitways) | 60 | — |
| 35. Yards and terraces, pedestrians ^t | 100 ^m | |
| 36. Storage racks and wall hung cabinets. | Total loads ⁿ | |

- For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm²,
1 square foot = 0.0929 m²,
1 pound per square foot = 0.0479 kN/m², 1 pound = 0.004448 kN,
1 pound per cubic foot = 16 kg/m³.
- a. Floors in garages or portions of buildings used for the storage of motor vehicles shall be designed for the uniformly distributed live loads of Table 1607.1 or the following concentrated loads: (1) for garages restricted to passenger vehicles accommodating not more than nine passengers, 3,000 pounds acting on an area of 4.5 inches by 4.5 inches; (2) for mechanical parking structures without slab or deck that are used for storing passenger vehicles only, 2,250 pounds per wheel.
 - b. The loading applies to stack room floors that support nonmobile, double-faced library bookstacks, subject to the following limitations:
 - 1. The nominal bookstack unit height shall not exceed 90 inches;
 - 2. The nominal shelf depth shall not exceed 12 inches for each face; and
 - 3. Parallel rows of double-faced book stacks shall be separated by aisles not less than 36 inches wide.
 - c. Design in accordance with ICC 300.
 - d. Other uniform loads in accordance with an approved method containing provisions for truck loadings shall also be considered where appropriate.
 - e. The concentrated wheel load shall be applied on an area of 4.5 inches by 4.5 inches.
 - f. The minimum concentrated load on stair treads shall be applied on an area of 2 inches by 2 inches. This load need not be assumed to act concurrently with the uniform load.
 - g. Where snow loads occur that are in excess of the design conditions, the structure shall be designed to support the loads due to the increased loads caused by drift buildup or a greater snow design determined by the building official (see Section 1608A). For special-purpose roofs, see Section 1607A.11.2.2.
 - h. See Section 1604A.8.3 for decks attached to exterior walls.
 - i. Uninhabitable attics without storage are those where the maximum clear height between the joists and rafters is less than 42 inches, or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. This live load need not be assumed to act concurrently with any other live load requirements.
 - j. Uninhabitable attics with storage are those where the maximum clear height between the joists and rafters is 42 inches or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. The live load need only be applied to those portions of the joists or truss bottom chords where both of the following conditions are met:
 - i. The attic area is accessible from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the attic is a minimum of 30 inches; and
 - ii. The slopes of the joists or truss bottom chords are no greater than two units vertical in 12 units horizontal.
The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 lb./ft².
 - k. Attic spaces served by stairways other than the pull-down type shall be designed to support the minimum live load specified for habitable attics and sleeping rooms.
 - l. Areas of occupiable roofs, other than roof gardens and assembly areas, shall be designed for appropriate loads as approved by the building official. Unoccupied landscaped areas of roofs shall be designed in accordance with Section 1607A.12.3.
 - m. Live load reduction is not permitted unless specific exceptions of Section 1607A.10 apply.

Table Notes TABLE 1607A.1—continued

n. The minimum vertical design live load shall be as follows:

Paper media:

12-inch-deep shelf 33 pounds per lineal foot
15-inch-deep shelf 41 pounds per lineal foot, or
33 pounds per cubic foot per total volume of the rack or cabinet, whichever is less.

Film media:

18-inch-deep shelf 100 pounds per lineal foot, or
50 pounds per cubic foot per total volume of the rack or cabinet, whichever is less.

Other media:

20 pounds per cubic foot or 20 pounds per square foot, whichever is less, but not less than actual loads.

o. [DSA-SS] The following minimum loads for stage accessories apply:

1. Gridirons and fly galleries: 75 pounds per square foot uniform live load.
 2. Loft block wells: 250 pounds per lineal foot vertical load and lateral load.
 3. Head block wells and sheave beams: 250 pounds per lineal foot vertical load and lateral load. Head block wells and sheave beams shall be designed for all tributary loft block well loads. Sheave blocks shall be designed with a safety factor of five.
 4. Scenery beams where there is no gridiron: 300 pounds per lineal foot vertical load and lateral load.
 5. Ceiling framing over stages shall be designed for a uniform live load of 20 pounds per square foot. For members supporting a tributary area of 200 square feet or more, this additional load may be reduced to 15 pounds per square foot.
- p. [DSA-SS] The minimum uniform live load for classroom occupancies is 50 psf. Live load reduction is not permitted for classrooms classified as Group A occupancies unless specific exception of Section 1607A.10 apply.
- q. [DSA-SS] The minimum uniform live load for a press box floor or accessible roof with railing is 100 psf.
- r. [DSA-SS] Item 35 applies to pedestrian bridges and walkways that are not subjected to uncontrolled vehicle access.

1607A.10 Reduction in uniform live loads. Except for uniform live loads at roofs, all other minimum uniformly distributed live loads, L_o , in Table 1607A.1 are permitted to be reduced in accordance with Section 1607A.10.1 or 1607A.10.2. Uniform live loads at roofs are permitted to be reduced in accordance with Section 1607A.12.2.

1607A.10.1 Basic uniform live load reduction. Subject to the limitations of Sections 1607A.10.1.1 through 1607A.10.1.3 and Table 1607A.1, members for which a value of $K_{LL}A_T$ is 400 square feet (37.16 m²) or more are permitted to be designed for a reduced uniformly distributed live load, L , in accordance with the following equation:

(Equation 16A-22)

$$L = L_o \left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}} \right)$$

For SI: $L = L_o \left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}} \right)$
where:

L = Reduced design live load per square foot (m²) of area supported by the member.

L_o = Unreduced design live load per square foot (m²) of area supported by the member (see Table 1607A.1).

K_{LL} = Live load element factor (see Table 1607A.10.1).

A_T = Tributary area, in square feet (square meters).

L shall not be less than $0.50L_o$ for members supporting one floor and L shall not be less than $0.40L_o$ for members supporting two or more floors.

**TABLE 1607A.10.1
LIVE LOAD ELEMENT FACTOR, K_{LL}**

| ELEMENT | K_{LL} |
|--|----------|
| Interior columns | 4 |
| Exterior columns without cantilever slabs | 4 |
| Edge columns with cantilever slabs | 3 |
| Corner columns with cantilever slabs | 2 |
| Edge beams without cantilever slabs | 2 |
| Interior beams | 2 |
| All other members not identified above including: Edge beams with cantilever slabs Cantilever beams One way slabs Two way slabs Members without provisions for continuous shear transfer normal to their span | 1 |

1607A.10.1.1 One-way slabs. The tributary area, A_T , for use in Equation 16A-23 for one-way slabs shall not exceed an area defined by the slab span times a width normal to the span of 1.5 times the slab span.

1607A.10.1.2 Heavy live loads. Live loads that exceed 100 psf (4.79 kN/m^2) shall not be reduced.

Exception:

1. The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607A.10.1.
2. For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

1607A.10.1.3 Passenger vehicle garages. The live loads shall not be reduced in passenger vehicle garages.

Exception: The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607A.10.1.

1607A.10.2 Alternative uniform live load reduction. As an alternative to Section 1607A.10.1 and subject to the limitations of Table 1607A.1, uniformly distributed live loads are permitted to be reduced in accordance with the following provisions. Such reductions shall apply to slab systems, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted where the live load exceeds 100 psf (4.79 kN/m^2) except that the design live load for members supporting two or more floors is permitted to be reduced by a maximum of 20 percent.

Exception: For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

2. A reduction shall not be permitted in passenger vehicle parking garages except that the live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent.

3. For live loads not exceeding 100 psf (4.79 kN/m^2), the design live load for any structural member supporting 150 square feet (13.94 m^2) or more is permitted to be reduced in accordance with Equation 16A-24.

4. For one-way slabs, the area, A , for use in Equation 16A-24 shall not exceed the product of the slab span and a width normal to the span of 0.5 times the slab span.

$$R = 0.08(A - 150) \quad (\text{Equation 16A-24})$$

$$\text{For SI: } R = 0.861(A - 13.94)$$

Such reduction shall not exceed the smallest of:

1. 40 percent for horizontal members;
2. 60 percent for vertical members; or
3. R as determined by the following equation.

$$R = 23.1(1 + D/L_o) \quad (\text{Equation 16A-25})$$

where:

A = Area of floor supported by the member, square feet (m^2).

D = Dead load per square foot (m^2) of area supported.

L_o = Unreduced live load per square foot (m^2) of area supported.

R = Reduction in percent.

1607A.11 Distribution of floor loads. Where uniform floor live loads are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full dead loads on all spans in combination with the floor live loads on spans selected to produce the greatest load effect at each location under consideration. It shall be permitted to reduce floor live loads in accordance with Section 1607A.10.

1607A.12 Roof loads. The structural supports of roofs and marquees shall be designed to resist wind and, where applicable, snow and earthquake loads, in addition to the dead load of construction and the appropriate live loads as prescribed in this section, or as set forth in Table 1607A.1. The live loads acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

1607A.12.1 Distribution of roof loads. Where uniform roof live loads are reduced to less than 20 psf (0.96 kN/m^2) in accordance with Section 1607A.12.2.1 and are applied to the design of structural members arranged so as to create continuity, the reduced roof live load shall be applied to adjacent spans or to alternate spans, whichever produces the most unfavorable load effect. See Section 1607A.12.2 for reductions in minimum roof live loads and Section 7.5 of ASCE 7 for partial snow loading.

1607A.12.2 General. The minimum uniformly distributed live loads of roofs and marquees, L_o , in Table 1607A.1 are

permitted to be reduced in accordance with Section 1607A.12.2.1.

1607A.12.2.1 Ordinary roofs, awnings and canopies.

Ordinary flat, pitched and curved roofs, and awnings and canopies other than of fabric construction supported by a skeleton structure, are permitted to be designed for a reduced uniformly distributed roof live load, L_r , as specified in the following equations or other controlling combinations of loads as specified in Section 1605A, whichever produces the greater load effect.

In structures such as greenhouses, where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof load than specified in the following equations shall not be used unless approved by the building official. Such structures shall be designed for a minimum roof live load of 12 psf (0.58 kN/m²).

$$L_r = L_o R_1 R_2 \quad (\text{Equation 16A-26})$$

where: $12 \leq L_r \leq 20$

For SI: $L_r = L_o R_1 R_2$

where: $0.58 \leq L_r \leq 0.96$

L_o = Unreduced roof live load per square foot (m²) of horizontal projection supported by the member (see Table 1607A.1).

L_r = Reduced roof live load per square foot (m²) of horizontal projection supported by the member.

The reduction factors R_1 and R_2 shall be determined as follows:

$$R_1 = 1 \text{ for } A_t \leq 200 \text{ square feet} \\ (18.58 \text{ m}^2) \quad (\text{Equation 16A-27})$$

$$R_1 = 1.2 - 0.001A_t \text{ for } 200 \text{ square feet} < A_t < 600 \text{ square feet} \quad (\text{Equation 16A-28})$$

For SI: $1.2 - 0.011A_t$ for 18.58 square meters $< A_t < 55.74$ square meters

$$R_1 = 0.6 \text{ for } A_t \geq 600 \text{ square feet} \\ (55.74 \text{ m}^2) \quad (\text{Equation 16A-29})$$

where:

A_t = Tributary area (span length multiplied by effective width) in square feet (m²) supported by the member, and

$$R_2 = 1 \text{ for } F \leq 4 \quad (\text{Equation 16A-30})$$

$$R_2 = 1.2 - 0.05F \text{ for } 4 < F < 12 \quad (\text{Equation 16A-31})$$

$$R_2 = 0.6 \text{ for } F \geq 12 \quad (\text{Equation 16A-32})$$

where:

F = For a sloped roof, the number of inches of rise per foot (for SI: $F = 0.12 \times$ slope, with slope expressed as a percentage), or for an arch or dome, the rise-to-span ratio multiplied by 32.

1607A.12.3 Occupiable roofs. Areas of roofs that are occupiable, such as roof gardens, or for assembly or other similar purposes, and marquees are permitted to have their

uniformly distributed live loads reduced in accordance with Section 1607.10.

1607A.12.3.1 Landscaped roofs. The uniform design

live load in unoccupied landscaped areas on roofs shall be 20 psf (0.958 kN/m²). The weight of all landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil.

1607A.12.4 Awnings and canopies. Awnings and canopies shall be designed for uniform live loads as required in Table 1607A.1 as well as for snow loads and wind loads as specified in Sections 1608A and 1609A.

1607A.12.5 Uncovered open-frame roof structures. Uncovered open-frame roof structures shall be designed for a vertical live load of not less than 10 pounds per square foot (0.48 kN/m²) of the total area encompassed by the framework.

1607A.13 Crane loads. The crane live load shall be the rated capacity of the crane. Design loads for the runway beams, including connections and support brackets, of moving bridge cranes and monorail cranes shall include the maximum wheel loads of the crane and the vertical impact, lateral and longitudinal forces induced by the moving crane.

1607A.13.1 Maximum wheel load. The maximum wheel loads shall be the wheel loads produced by the weight of the bridge, as applicable, plus the sum of the rated capacity and the weight of the trolley with the trolley positioned on its runway at the location where the resulting load effect is maximum.

1607A.13.2 Vertical impact force. The maximum wheel loads of the crane shall be increased by the percentages shown below to determine the induced vertical impact or vibration force:

| | |
|---|------------|
| Monorail cranes (powered)..... | 25 percent |
| Cab-operated or remotely operated bridge cranes (powered)..... | 25 percent |
| Pendant-operated bridge cranes (powered) | 10 percent |
| Bridge cranes or monorail cranes with hand-gearred bridge, trolley and hoist..... | 0 percent |

1607A.13.3 Lateral force. The lateral force on crane runway beams with electrically powered trolleys shall be calculated as 20 percent of the sum of the rated capacity of the crane and the weight of the hoist and trolley. The lateral force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction perpendicular to the beam, and shall be distributed with due regard to the lateral stiffness of the runway beam and supporting structure.

1607A.13.4 Longitudinal force. The longitudinal force on crane runway beams, except for bridge cranes with hand-gearred bridges, shall be calculated as 10 percent of the maximum wheel loads of the crane. The longitudinal force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction parallel to the beam.

1607A.14 Interior walls and partitions. Interior walls and partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the loads to which they are subjected but not less than a horizontal load of 5 psf (0.240 kN/m²). *The 5 psf (0.24 kN/m²) working load need not be applied simultaneously with wind or seismic loads. The deflection of such walls under a load of 5 psf (0.24 kN/m²) shall not exceed the limits in Table 1604A.3.*

Exception: Fabric partitions complying with Section 1607A.14.1 shall not be required to resist the minimum horizontal load of 5 psf (0.24 kN/m²).

1607A.14.1 Fabric partitions. Fabric partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the following load conditions:

1. A horizontal distributed load of 5 psf (0.24 kN/m²) applied to the partition framing. The total area used to determine the distributed load shall be the area of the fabric face between the framing members to which the fabric is attached. The total distributed load shall be uniformly applied to such framing members in proportion to the length of each member.
2. A concentrated load of 40 pounds (0.176 kN) applied to an 8-inch diameter (203 mm) area [50.3 square inches (32 452 mm²)] of the fabric face at a height of 54 inches (1372 mm) above the floor.

SECTION 1608A SNOW LOADS

1608A.1 General. Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but the design roof load shall not be less than that determined by Section 1607A.

1608A.2 Ground snow loads. The ground snow loads to be used in determining the design snow loads for roofs shall be determined in accordance with ASCE 7 or Figure 1608A.2 for the contiguous United States. Site-specific case studies shall be made in areas designated "CS" in Figure 1608A.2. Ground snow loads for sites at elevations above the limits indicated in Figure 1608A.2 and for all sites within the CS areas shall be approved. Ground snow load determination for such sites shall be based on an extreme value statistical analysis of data available in the vicinity of the site using a value with a 2-percent annual probability of being exceeded (50-year mean recurrence interval).

1608A.3 Ponding instability. Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Section 7.11 of ASCE 7.

1608A.4 Determination of snow loads. *[DSA-SS] The ground snow load or the design snow load for roofs shall conform with the adopted ordinance of the city, county, or city and county in which the project site is located, and shall be approved by DSA.*

SECTION 1609A WIND LOADS

1609A.1 Applications. Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

1609A.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternate all-heights method in Section 1609A.6. The type of opening protection required, the ultimate design wind speed, V_{ult} , and the exposure category for a site is permitted to be determined in accordance with Section 1609A or ASCE 7. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. Subject to the limitations of Section 1609A.1.1.1, the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. Subject to the limitations of Section 1609A.1.1.1, residential structures using the provisions of the AF&PA WFCM.
3. Subject to the limitations of Section 1609A.1.1.1, residential structures using the provisions of AISI S230.
4. Designs using NAAMM FP 1001.
5. Designs using TIA-222 for antenna-supporting structures and antennas, provided the horizontal extent of Topographic Category 2 escarpments in Section 2.6.6.2 of TIA-222 shall be 16 times the height of the escarpment.
6. Wind tunnel tests in accordance with Chapter 31 of ASCE 7.

The wind speeds in Figures 1609A, 1609B and 1609C are ultimate design wind speeds, V_{ult} , and shall be converted in accordance with Section 1609.3.1 to nominal design wind speeds, V_{asd} , when the provisions of the standards referenced in Exceptions 1 through 5 are used.

1609A.1.1.1 Applicability. The provisions of ICC 600 are applicable only to buildings located within Exposure B or C as defined in Section 1609A.4. The provisions of ICC 600, AF&PA WFCM and AISI S230 shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting the following conditions:

1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C;
2. The maximum average slope of the hill exceeds 10 percent; and
3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is greater.

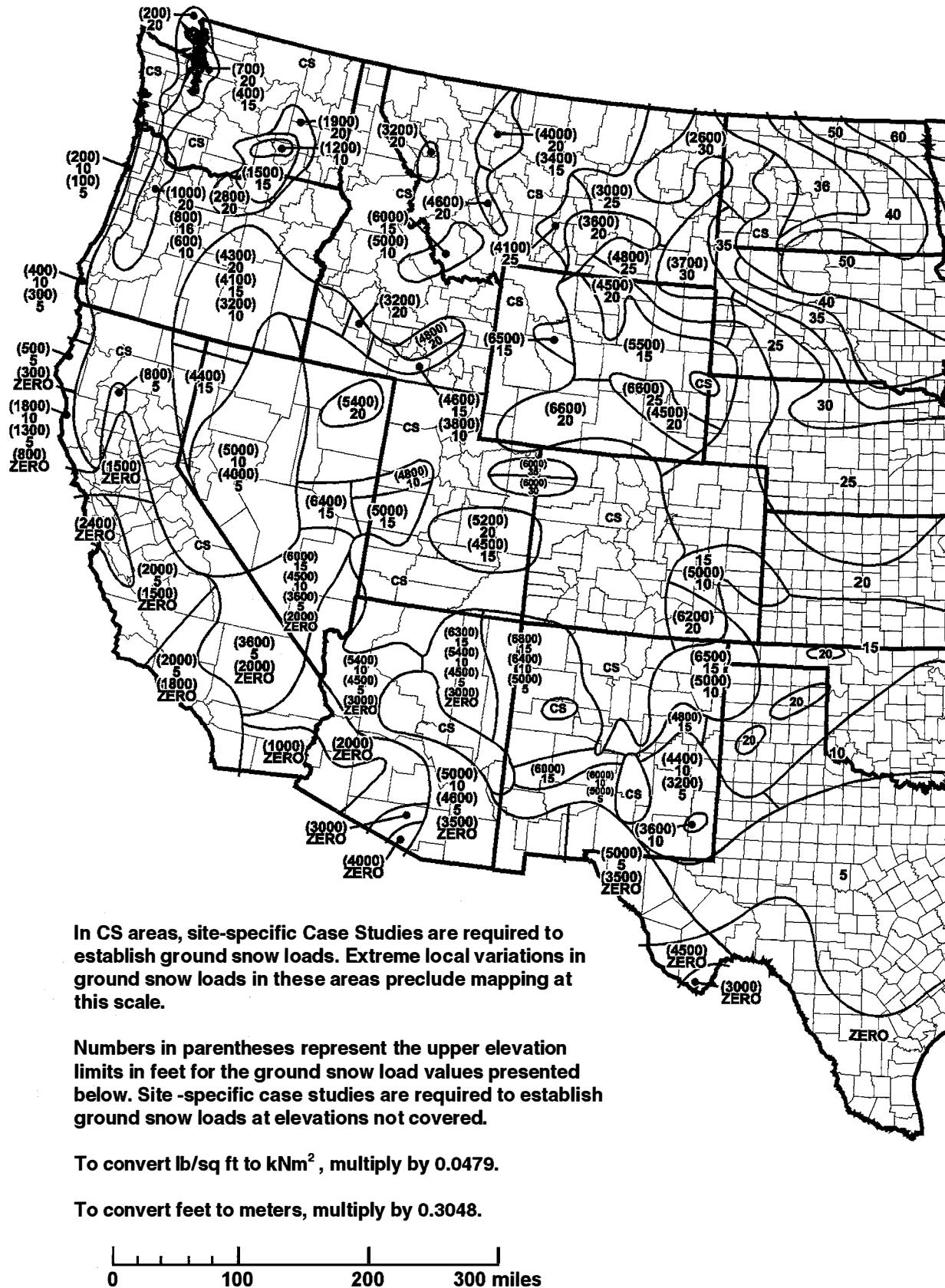


FIGURE 1608.A.2
GROUND SNOW LOADS, p_g , FOR THE UNITED STATES (psf)



FIGURE 1608.A.2—continued
GROUND SNOW LOADS, p_g , FOR THE UNITED STATES (psf)

1609A.1.2 Protection of openings. In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant standard or ASTM E 1996 and ASTM E 1886 referenced herein as follows:

1. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the large missile test of ASTM E 1996.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the small missile test of ASTM E 1996.

Exceptions:

1. Wood structural panels with a minimum thickness of $\frac{7}{16}$ inch (11.1 mm) and maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in one- and two-story buildings classified as Group R-3 or R-4 occupancy. Panels shall be precut so that they shall be attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method and shall be secured with the attachment hardware provided. Attachments shall be designed to resist the components and cladding loads determined in accordance with the provisions of ASCE 7, with corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table 1609A.1.2 with corrosion-resistant attachment hardware provided and anchors permanently installed on the building is permitted for buildings with a mean roof height of 45 feet (13 716 mm) or less where V_{asd} determined in accordance with Section 1609A.3.1 does not exceed 140 mph (63 m/s).
2. Glazing in Risk Category I buildings as defined in Section 1604A.5, including greenhouses that are occupied for growing plants on a production or research basis, without public access shall be permitted to be unprotected.
3. Glazing in Risk Category II, III or IV buildings located over 60 feet (18 288 mm) above the ground and over 30 feet (9144 mm) above aggregate surface roofs located within 1,500 feet (458 m) of the building shall be permitted to be unprotected.

1609A.1.2.1 Louvers. Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet requirements of an approved impact-resisting standard or the large missile test of AMCA 54.

**TABLE 1609A.1.2
WIND-BORNE DEBRIS PROTECTION FASTENING SCHEDULE
FOR WOOD STRUCTURAL PANELS^{a, b, c, d}**

| FASTENER TYPE | FASTENER SPACING (inches) | | |
|--|---------------------------|-------------------------------------|-------------------------------------|
| | Panel Span \leq 4 feet | 4 feet $<$ Panel Span \leq 6 feet | 6 feet $<$ Panel Span \leq 8 feet |
| No. 8 wood-screw-based anchor with 2-inch embedment length | 16 | 10 | 8 |
| No. 10 wood-screw-based anchor with 2-inch embedment length | 16 | 12 | 9 |
| $\frac{1}{4}$ -inch diameter lag-screw-based anchor with 2-inch embedment length | 16 | 16 | 16 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N,
1 mile per hour = 0.447 m/s.

- a. This table is based on 140 mph wind speeds and a 45 foot mean roof height.
- b. Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located a minimum of 1 inch from the edge of the panel.
- c. Anchors shall penetrate through the exterior wall covering with an embedment length of 2 inches minimum into the building frame. Fasteners shall be located a minimum of $2\frac{1}{2}$ inches from the edge of concrete block or concrete.
- d. Where panels are attached to masonry or masonry/stucco, they shall be attached using vibration resistant anchors having a minimum ultimate withdrawal capacity of 1,500 pounds.

1609A.1.2.2. Application of ASTM E 1996. The text of Section 6.2.2 of ASTM E 1996 shall be substituted as follows:

6.2.2 Unless otherwise specified, select the wind zone based on the strength design wind speed, V_{ult} , as follows:

6.2.2.1 *Wind Zone 1*—130 mph \leq ultimate design wind speed, $V_{ult} < 140$ mph.

6.2.2.2 *Wind Zone 2*—140 mph \leq ultimate design wind speed, $V_{ult} < 150$ mph at greater than one mile (1.6 km) from the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.3 *Wind Zone 3*—150 mph (58 m/s) \leq ultimate design wind speed, $V_{ult} \leq 160$ mph (63 m/s), or 140 mph (54 m/s) \leq ultimate design wind speed, $V_{ult} \leq 160$ mph (63 m/s) and within one mile (1.6 km) of the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.4 *Wind Zone 4*—ultimate design wind speed, $V_{ult} > 160$ mph (63 m/s).

1609A.1.2.3 Garage doors. Garage door glazed opening protection for wind-borne debris shall meet the requirements of an approved impact-resisting standard or ANSI/DASMA 115.

1609A.1.3 Story drift for wind loads. The calculated story drift due to wind pressures with ultimate design wind speed, V_{ult} , shall not exceed 0.008 times the story height for buildings less than 65 feet (19 812 mm) in height or 0.007 times the story height for buildings 65 feet (19 812 mm) or greater in height.

Exception: This story drift limit need not be applied for single-story open structures.

1609A.2 Definitions. For the purposes of Section 1609A and as used elsewhere in this code, the following terms are defined in Chapter 2.

HURRICANE-PRONE REGIONS.

WIND-BORNE DEBRIS REGION.

WIND SPEED, V_{ult} .

WIND SPEED, V_{asd} .

1609A.3 Basic wind speed. The ultimate design wind speed, V_{ult} , in mph, for the determination of the wind loads shall be determined by Figures 1609A, 1609B and 1609C. The ultimate design wind speed, V_{ult} , for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609A. The ultimate design wind speed, V_{ult} , for use in the design of Risk Category III and IV buildings and structures shall be obtained from Figure 1609B. The ultimate design wind speed, V_{ult} , for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609C. The ultimate design wind speed, V_{ult} , for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The ultimate design wind speeds, V_{ult} , determined by the local jurisdiction shall be in accordance with Section 26.5.1 of ASCE 7.

In nonhurricane-prone regions, when the ultimate design wind speed, V_{ult} , is estimated from regional climatic data, the ultimate design wind speed, V_{ult} , shall be determined in accordance with Section 26.5.3 of ASCE 7.

1609A.3.1 Wind speed conversion. When required, the ultimate design wind speeds of Figures 1609A, 1609B and 1609C shall be converted to nominal design wind speeds, V_{asd} , using Table 1609A.3.1 or Equation 16-33.

$$V_{asd} = V_{ult}\sqrt{0.6}$$

(Equation 16A-33)

where:

V_{asd} = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609.1.1.

V_{ult} = ultimate design wind speeds determined from Figures 1609A, 1609B or 1609C.

1609A.4 Exposure category. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features.

1609A.4.1 Wind directions and sectors. For each selected wind direction at which the wind loads are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609A.4.2 and 1609A.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1609A.4.2 Surface roughness categories. A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1609A.4.3 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1609A.4.3.

Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, and grasslands.

Surface Roughness D. Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice.

TABLE 1609A.3.1
WIND SPEED CONVERSIONS^{a, b, c}

| V_{ult} | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| V_{asd} | 78 | 85 | 93 | 101 | 108 | 116 | 124 | 132 | 139 | 147 | 155 |

For SI: 1 mile per hour = 0.44 m/s.

a. Linear interpolation is permitted.

b. V_{asd} = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609A.1.1.

c. V_{ult} = ultimate design wind speeds determined from Figures 1609A, 1609B, or 1609C.

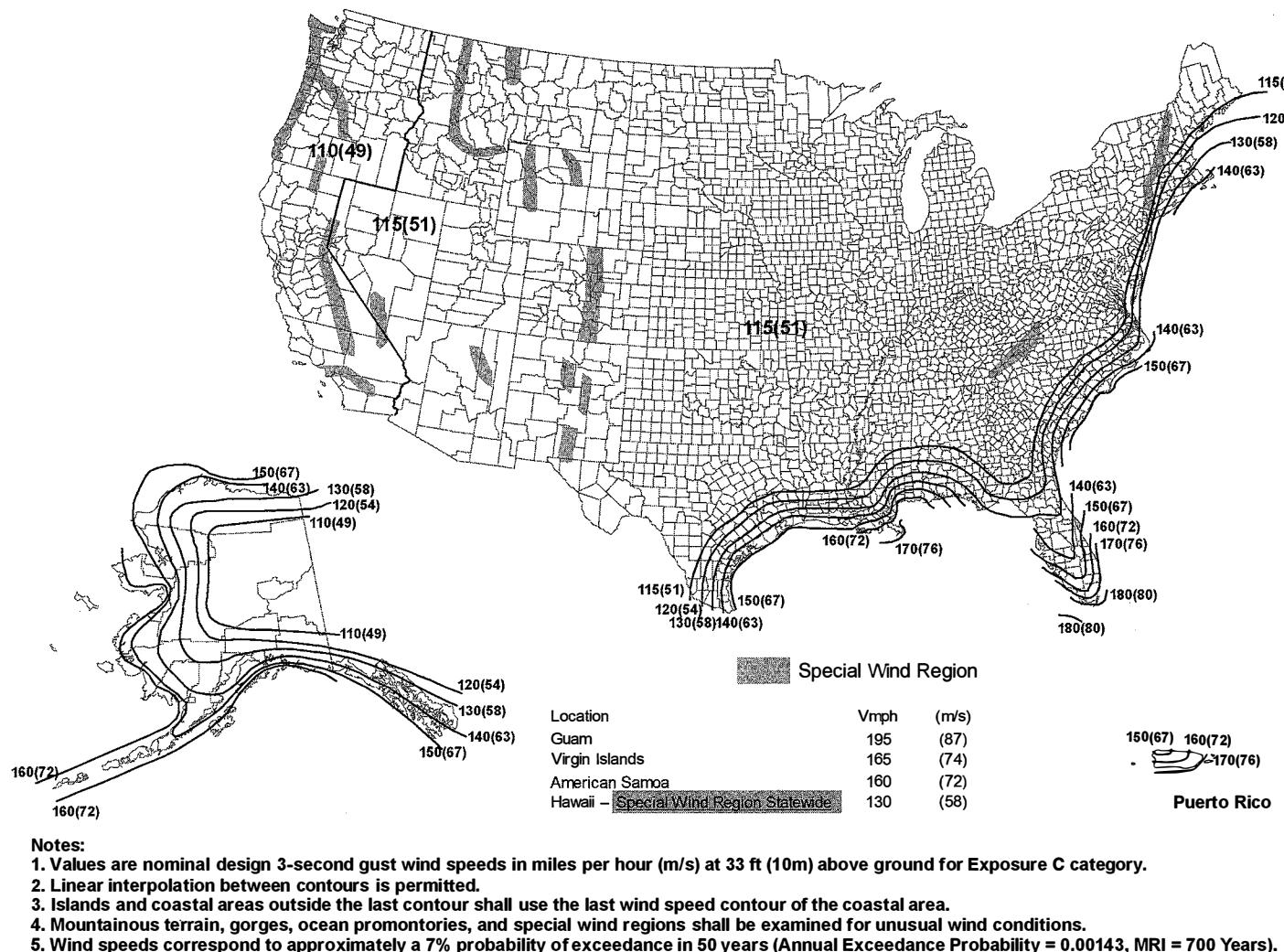
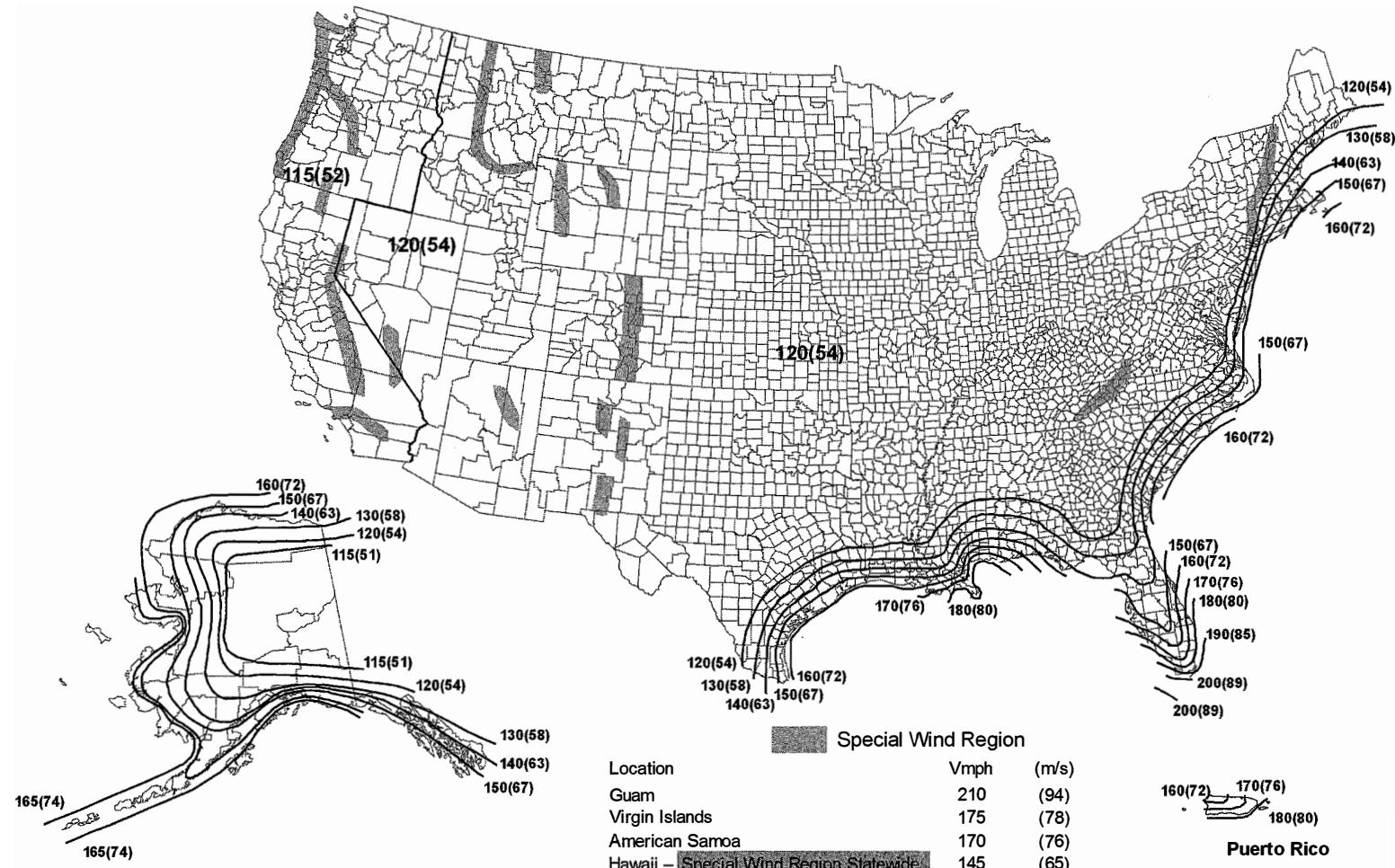
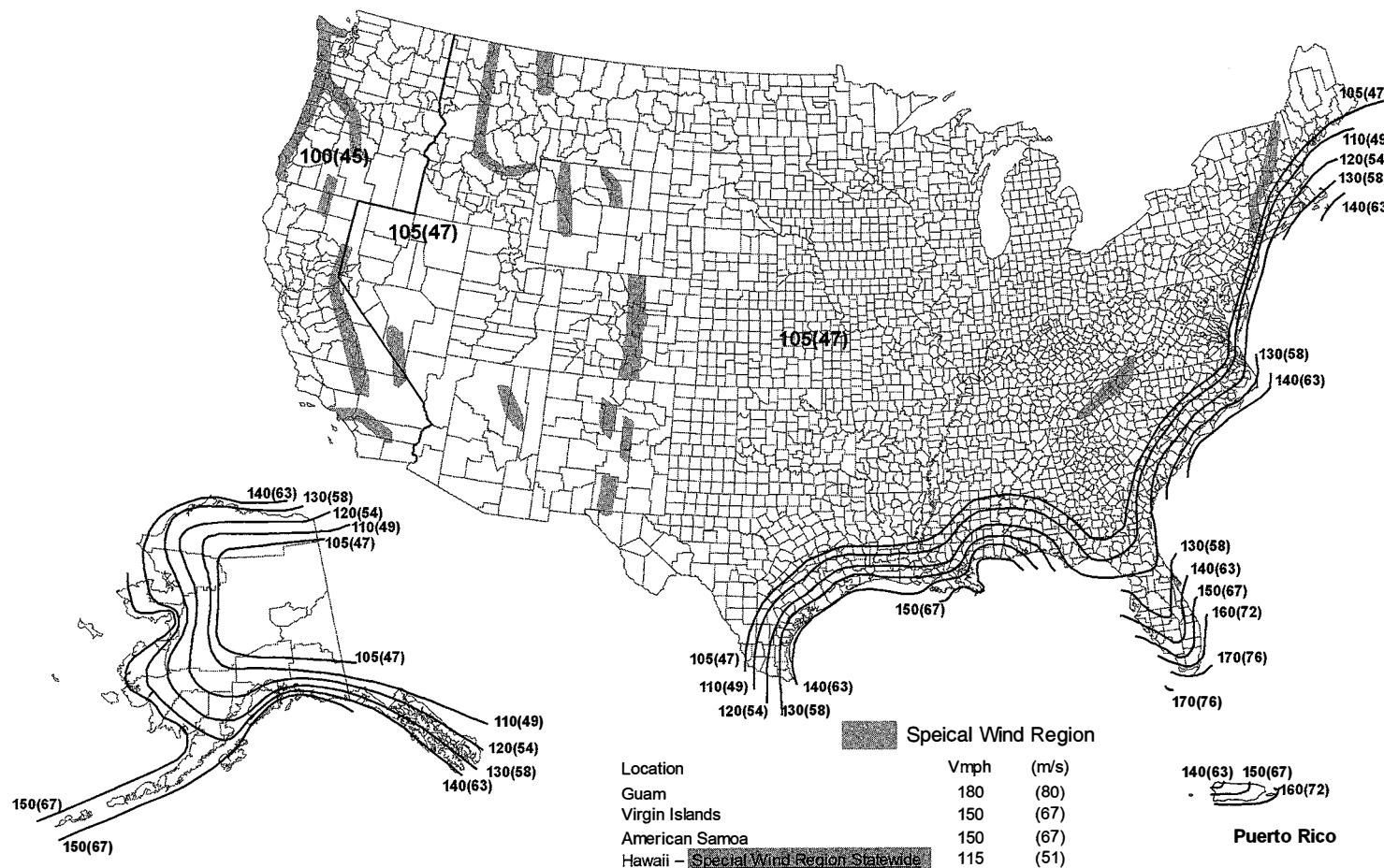


FIGURE 1609A
ULTIMATE DESIGN WIND SPEEDS, V_{ULD} , FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES

**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 Years).

FIGURE 1609B**ULTIMATE DESIGN WIND SPEEDS, V_{ULT} , FOR RISK CATEGORY III AND IV BUILDINGS AND OTHER STRUCTURES**

**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).

FIGURE 1609C
ULTIMATE DESIGN WIND SPEEDS, V_{ULP} , FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES

1609A.4.3 Exposure categories. An exposure category shall be determined in accordance with the following:

Exposure B. For buildings with a mean roof height of less than or equal to 30 feet (9144 mm), Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 1,500 feet (457 m). For buildings with a mean roof height greater than 30 feet (9144 mm), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.

Exposure C. Exposure C shall apply for all cases where Exposures B or D do not apply.

Exposure D. Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of at least 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 feet (183 m) or 20 times the building height, whichever is greater, from an exposure D condition as defined in the previous sentence.

1609A.5 Roof systems. Roof systems shall be designed and constructed in accordance with Sections 1609A.5.1 through 1609A.5.3, as applicable.

1609A.5.1 Roof deck. The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609A.5.2 Roof coverings. Roof coverings shall comply with Section 1609A.5.1.

Exception: Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609A.5.1 are permitted to be designed in accordance with Section 1609A.5.3.

Asphalt shingles installed over a roof deck complying with Section 1609A.5.1 shall comply with the wind-resistance requirements of Section 1507.2.7.1.

1609A.5.3 Rigid tile. Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:

$$M_a = q_h C_L b L L_a [1.0 - GC_p] \quad (\text{Equation 16A-34})$$

For SI: $M_a =$

where:

b = Exposed width, feet (mm) of the roof tile.

C_L = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1711A.2.

GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.

L = Length, feet (mm) of the roof tile.

L_a = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76 L from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

M_a = Aerodynamic uplift moment, foot-pounds (N-mm) acting to raise the tail of the tile.

q_h = Wind velocity pressure, psf (kN/m^2) determined from Section 27.3.2 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be either loose laid on battens, mechanically fastened, mortar set or adhesive set.
2. The roof tiles shall be installed on solid sheathing which has been designed as components and cladding.
3. An underlayment shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).
7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).
8. Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.

1609A.6 Alternate all-heights method. The alternate wind design provisions in this section are simplifications of the ASCE 7 Directional Procedure.

1609A.6.1 Scope. As an alternative to ASCE 7 Chapters 27 and 30, the following provisions are permitted to be used to determine the wind effects on regularly shaped buildings, or other structures that are regularly shaped, which meet all of the following conditions:

1. The building or other structure is less than or equal to 75 feet (22 860 mm) in height with a height-to-least-width ratio of 4 or less, or the building or other structure has a fundamental frequency greater than or equal to 1 hertz.

2. The building or other structure is not sensitive to dynamic effects.
3. The building or other structure is not located on a site for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.
4. The building shall meet the requirements of a simple diaphragm building as defined in ASCE 7 Section 26.2, where wind loads are only transmitted to the main windforce-resisting system (MWFRS) at the diaphragms.
5. For open buildings, multispan gable roofs, stepped roofs, sawtooth roofs, domed roofs, roofs with slopes greater than 45 degrees (0.79 rad), solid free-standing walls and solid signs, and rooftop equipment, apply ASCE 7 provisions.

1609A.6.1.1 Modifications. The following modifications shall be made to certain subsections in ASCE 7: in Section 1609A.6.2, symbols and notations that are specific to this section are used in conjunction with the symbols and notations in ASCE 7 Section 26.3.

1609A.6.2 Symbols and notations. Coefficients and variables used in the alternative all-heights method equations are as follows:

C_{net} = Net-pressure coefficient based on K_d [(G) (C_p) – (GC_{pi})], in accordance with Table 1609A.6.2.

G = Gust effect factor for rigid structures in accordance with ASCE 7 Section 26.9.1.

I = *Importance Factor in accordance with ASCE 7 Section 6.5.5*

K_d = Wind directionality factor in accordance with ASCE 7 Table 26-6.

P_{net} = Design wind pressure to be used in determination of wind loads on buildings or other structures or their components and cladding, in psf (kN/m²).

1609A.6.3 Design equations. When using the alternative all-heights method, the MWFRS, and components and cladding of every structure shall be designed to resist the effects of wind pressures on the building envelope in accordance with Equation 16A-34.

$$P_{net} = 0.00256V^2K_zC_{net}K_{zt} \quad (\text{Equation 16-35})$$

Design wind forces for the MWFRS shall not be less than 16 psf (0.77 kN/m²) multiplied by the area of the structure projected on a plane normal to the assumed wind direction (see ASCE 7 Section 27.4.7 for criteria). Design net wind pressure for components and cladding shall not be less than 16 psf (0.77 kN/m²) acting in either direction normal to the surface.

1609A.6.4 Design procedure. The MWFRS and the components and cladding of every building or other structure

shall be designed for the pressures calculated using Equation 16A-35.

1609A.6.4.1 Main wind-force-resisting systems. The MWFRS shall be investigated for the torsional effects identified in ASCE 7 Figure 27.4.6.

1609A.6.4.2 Determination of K_z and K_{zt} . Velocity pressure exposure coefficient, K_z , shall be determined in accordance with ASCE 7 Section 27.3.1 and the topographic factor, K_{zt} , shall be determined in accordance with ASCE 7 Section 26-8.

1. For the windward side of a structure, K_{zt} and K_z shall be based on height z .
2. For leeward and sidewalls, and for windward and leeward roofs, K_{zt} and K_z shall be based on mean roof height h .

1609A.6.4.3 Determination of net pressure coefficients, C_{net} . For the design of the MWFRS and for components and cladding, the sum of the internal and external net pressure shall be based on the net pressure coefficient, C_{net} .

1. The pressure coefficient, C_{net} , for walls and roofs shall be determined from Table 1609A.6.2.
2. Where C_{net} has more than one value, the more severe wind load condition shall be used for design.

1609A.6.4.4 Application of wind pressures. When using the alternative all-heights method, wind pressures shall be applied simultaneously on, and in a direction normal to, all building envelope wall and roof surfaces.

1609A.6.4.4.1 Components and cladding. Wind pressure for each component or cladding element is applied as follows using C_{net} values based on the effective wind area, A , contained within the zones in areas of discontinuity of width and/or length "a," "2a" or "4a" at: corners of roofs and walls; edge strips for ridges, rakes and eaves; or field areas on walls or roofs as indicated in figures in tables in ASCE 7 as referenced in Table 1609A.6.2 in accordance with the following:

1. Calculated pressures at local discontinuities acting over specific edge strips or corner boundary areas.
2. Include "field" (Zone 1, 2 or 4, as applicable) pressures applied to areas beyond the boundaries of the areas of discontinuity.
3. Where applicable, the calculated pressures at discontinuities (Zones 2 or 3) shall be combined with design pressures that apply specifically on rakes or eave overhangs.

TABLE 1609.A.6.2
NET PRESSURE COEFFICIENTS, $C_{net}^{a,b}$

| STRUCTURE OR PART THEREOF | DESCRIPTION | C_{net} FACTOR | | | | |
|---|---------------------------------------|-----------------------------|------------------------------|---------------------|---------------------|---------------------|
| | | Enclosed | | Partially enclosed | | |
| | | + Internal pressure | - Internal pressure | + Internal pressure | - Internal pressure | |
| 1. Main windforce-resisting frames and systems | Walls: | Windward wall | 0.43 | 0.73 | 0.11 | 1.05 |
| | | Leeward wall | -0.51 | -0.21 | -0.83 | 0.11 |
| | | Sidewall | -0.66 | -0.35 | -0.97 | -0.04 |
| | | Parapet wall | Windward | 1.28 | 1.28 | |
| | | | Leeward | -0.85 | -0.85 | |
| | Roofs: | Enclosed | | Partially enclosed | | |
| | | Wind perpendicular to ridge | + Internal pressure | - Internal pressure | + Internal pressure | - Internal pressure |
| | | Leeward roof or flat roof | -0.66 | -0.35 | -0.97 | -0.04 |
| | Windward roof slopes: | | | | | |
| | Slope < 2:12 (10°) | Condition 1 | -1.09 | -0.79 | -1.41 | -0.47 |
| | | Condition 2 | -0.28 | 0.02 | -0.60 | 0.34 |
| | Slope = 4:12 (18°) | Condition 1 | -0.73 | -0.42 | -1.04 | -0.11 |
| | | Condition 2 | -0.05 | 0.25 | -0.37 | 0.57 |
| | Slope = 5:12 (23°) | Condition 1 | -0.58 | -0.28 | -0.90 | 0.04 |
| | | Condition 2 | 0.03 | 0.34 | -0.29 | 0.65 |
| | Slope = 6:12 (27°) | Condition 1 | -0.47 | -0.16 | -0.78 | 0.15 |
| | | Condition 2 | 0.06 | 0.37 | -0.25 | 0.68 |
| | Slope = 7:12 (30°) | Condition 1 | -0.37 | -0.06 | -0.68 | 0.25 |
| | | Condition 2 | 0.07 | 0.37 | -0.25 | 0.69 |
| | Slope = 9:12 (37°) | Condition 1 | -0.27 | 0.04 | -0.58 | 0.35 |
| | | Condition 2 | 0.14 | 0.44 | -0.18 | 0.76 |
| | Slope = 12:12 (45°) | | 0.14 | 0.44 | -0.18 | 0.76 |
| | Wind parallel to ridge and flat roofs | | -1.09 | -0.79 | -1.41 | -0.47 |
| Nonbuilding Structures: Chimneys, Tanks and Similar Structures: | | | | | | |
| | | | h/D | | | |
| | | | 1 | 7 | 25 | |
| Square (Wind normal to face) | | | 0.99 | 1.07 | 1.53 | |
| Square (Wind on diagonal) | | | 0.77 | 0.84 | 1.15 | |
| Hexagonal or Octagonal | | | 0.81 | 0.97 | 1.13 | |
| Round | | | 0.65 | 0.81 | 0.97 | |
| Open signs and lattice frameworks | | | Ratio of solid to gross area | | | |
| | | | < 0.1 | 0.1 to 0.29 | 0.3 to 0.7 | |
| Flat | | | 1.45 | 1.30 | 1.16 | |
| Round | | | 0.87 | 0.94 | 1.08 | |

(continued)

TABLE 1609A.6.2—continued
NET PRESSURE COEFFICIENTS, $C_{net}^{a,b}$

| STRUCTURE OR PART THEREOF | DESCRIPTION | | C_{net} FACTOR | |
|--|---|-------------------------|------------------|--------------------|
| | | | Enclosed | Partially enclosed |
| | Roof elements and slopes | | | |
| | Gable of hipped configurations (Zone 1) | | | |
| | Flat $< \text{Slope} < 6:12$ (27°) See ASCE 7 Figure 30.4-2B Zone 1 | | | |
| 2. Components and cladding not in areas of discontinuity—roofs and overhangs | Positive | 10 square feet or less | 0.58 | 0.89 |
| | | 100 square feet or more | 0.41 | 0.72 |
| | Negative | 10 square feet or less | -1.00 | -1.32 |
| | | 100 square feet or more | -0.92 | -1.23 |
| | Overhang: Flat $< \text{Slope} < 6:12$ (27°) See ASCE 7 Figure 30.4-2A Zone 1 | | | |
| Negative | 10 square feet or less | -1.45 | | |
| | 100 square feet or more | -1.36 | | |
| | 500 square feet or more | -0.94 | | |
| | 6:12 (27°) $< \text{Slope} < 12:12$ (45°) See ASCE 7 Figure 30.4-2C Zone 1 | | | |
| Positive | 10 square feet or less | 0.92 | 1.23 | |
| | 100 square feet or more | 0.83 | 1.15 | |
| Negative | 10 square feet or less | -1.00 | -1.32 | |
| | 100 square feet or more | -0.83 | -1.15 | |
| | Monosloped configurations (Zone 1) | | Enclosed | Partially enclosed |
| | Flat $< \text{Slope} < 7:12$ (30°) See ASCE 7 Figure 30.4-5B Zone 1 | | | |
| Positive | 10 square feet or less | 0.49 | 0.81 | |
| | 100 square feet or more | 0.41 | 0.72 | |
| Negative | 10 square feet or less | -1.26 | -1.57 | |
| | 100 square feet or more | -1.09 | -1.40 | |
| | Tall flat-topped roofs $h > 60$ feet | | Enclosed | Partially enclosed |
| | Flat $< \text{Slope} < 2:12$ (10°) (Zone 1) See ASCE 7 Figure 30.8-1 Zone 1 | | | |
| Negative | 10 square feet or less | -1.34 | -1.66 | |
| | 500 square feet or more | -0.92 | -1.23 | |
| 3. Components and cladding in areas of discontinuities—roofs and overhangs (continued) | Gable or hipped configurations at ridges, eaves and rakes (Zone 2) | | | |
| | Flat $< \text{Slope} < 6:12$ (27°) See ASCE 7 Figure 30.4-2B Zone 2 | | | |
| | Positive | 10 square feet or less | 0.58 | 0.89 |
| | | 100 square feet or more | 0.41 | 0.72 |
| | Negative | 10 square feet or less | -1.68 | -2.00 |
| | | 100 square feet or more | -1.17 | -1.49 |
| | Overhang for Slope Flat $< \text{Slope} < 6:12$ (27°) See ASCE 7 Figure 30.4-2B Zone 2 | | | |
| | Negative | 10 square feet or less | -1.87 | |
| | | 100 square feet or more | -1.87 | |
| | 6:12 (27°) $< \text{Slope} < 12:12$ (45°) Figure 30.4-2C | | Enclosed | Partially enclosed |
| | Positive | 10 square feet or less | 0.92 | 1.23 |
| | | 100 square feet or more | 0.83 | 1.15 |
| | Negative | 10 square feet or less | -1.17 | -1.49 |
| | | 100 square feet or more | -1.00 | -1.32 |
| | Overhang for 6:12 (27°) $< \text{Slope} < 12:12$ (45°) See ASCE 7 Figure 30.4-2C Zone 2 | | | |
| | Negative | 10 square feet or less | -1.70 | |
| | | 500 square feet or more | -1.53 | |

(continued)

**TABLE 1609A.6.2—continued
NET PRESSURE COEFFICIENTS, $C_{net}^{a,b}$**

| STRUCTURE OR PART THEREOF | DESCRIPTION | | C_{net} FACTOR | | | |
|---|---------------------------------|-------|------------------|---------------------------|--|--|
| | Roof elements and slopes | | Enclosed | Partially enclosed | | |
| Monosloped configurations at ridges, eaves and rakes (Zone 2) | | | | | | |
| Flat < Slope < 7:12 (30°) See ASCE 7 Figure 30.4-5B Zone 2 | | | | | | |
| Positive | 10 square feet or less | 0.49 | 0.81 | | | |
| | 100 square feet or more | 0.41 | 0.72 | | | |
| Negative | 10 square feet or less | -1.51 | -1.83 | | | |
| | 100 square feet or more | -1.43 | -1.74 | | | |
| Tall flat topped roofs $h > 60$ feet | | | Enclosed | Partially enclosed | | |
| Flat < Slope < 2:12 (10°) (Zone 2) See ASCE 7 Figure 30.8-1 Zone 2 | | | | | | |
| Negative | 10 square feet or less | -2.11 | -2.42 | | | |
| | 500 square feet or more | -1.51 | -1.83 | | | |
| Gable or hipped configurations at corners (Zone 3) See ASCE 7 Figure 30.4-2B Zone 3 | | | | | | |
| Flat < Slope < 6:12 (27°) | | | Enclosed | Partially enclosed | | |
| Positive | 10 square feet or less | 0.58 | 0.89 | | | |
| | 100 square feet or more | 0.41 | 0.72 | | | |
| Negative | 10 square feet or less | -2.53 | -2.85 | | | |
| | 100 square feet or more | -1.85 | -2.17 | | | |
| Overhang for Slope Flat < Slope < 6:12 (27°) See ASCE 7 Figure 30.4-2B Zone 3 | | | | | | |
| Negative | 10 square feet or less | -3.15 | | | | |
| | 100 square feet or more | -2.13 | | | | |
| 6:12 (27°) < 12:12 (45°) See ASCE 7 Figure 30.4-2C Zone 3 | | | | | | |
| Positive | 10 square feet or less | 0.92 | 1.23 | | | |
| | 100 square feet or more | 0.83 | 1.15 | | | |
| Negative | 10 square feet or less | -1.17 | -1.49 | | | |
| | 100 square feet or more | -1.00 | -1.32 | | | |
| Overhang for 6:12 (27°) < Slope < 12:12 (45°) | | | Enclosed | Partially enclosed | | |
| Negative | 10 square feet or less | -1.70 | | | | |
| | 100 square feet or more | -1.53 | | | | |
| Monosloped Configurations at corners (Zone 3) See ASCE 7 Figure 30.4-5B Zone 3 | | | | | | |
| Flat < Slope < 7:12 (30°) | | | | | | |
| Positive | 10 square feet or less | 0.49 | 0.81 | | | |
| | 100 square feet or more | 0.41 | 0.72 | | | |
| Negative | 10 square feet or less | -2.62 | -2.93 | | | |
| | 100 square feet or more | -1.85 | -2.17 | | | |
| Tall flat topped roofs $h > 60$ feet | | | Enclosed | Partially enclosed | | |
| Flat < Slope < 2:12 (10°) (Zone 3) See ASCE 7 Figure 30.8-1 Zone 3 | | | | | | |
| Negative | 10 square feet or less | -2.87 | -3.19 | | | |
| | 500 square feet or more | -2.11 | -2.42 | | | |
| Wall Elements: $h = 60$ feet (Zone 4) Figure 30.4-1 | | | Enclosed | Partially enclosed | | |
| Positive | 10 square feet or less | 1.00 | 1.32 | | | |
| | 500 square feet or more | 0.75 | 1.06 | | | |
| Negative | 10 square feet or less | -1.09 | -1.40 | | | |
| | 500 square feet or more | -0.83 | -1.15 | | | |
| Wall Elements: $h > 60$ feet (Zone 4) See ASCE 7 Figure 30.8-1 Zone 4 | | | | | | |
| Positive | 20 square feet or less | 0.92 | 1.23 | | | |
| | 500 square feet or more | 0.66 | 0.98 | | | |

(continued)

**TABLE 1609A.6.2—continued
NET PRESSURE COEFFICIENTS, C_{net} ^{a,b}**

| STRUCTURE OR PART THEREOF | DESCRIPTION | C_{net} FACTOR | |
|---|---|---|---------------------------|
| 4. Components and cladding not in areas of discontinuity-walls and parapets (continued) | Negative | 20 square feet or less 500 square feet or more | -0.92 -0.75 |
| | Parapet Walls | | |
| | Positive | 2.87 | 3.19 |
| | Negative | -1.68 | -2.00 |
| 5. Components and cladding in areas of discontinuity—walls and parapets | Wall elements: $h \leq 60$ feet (Zone 5) Figure 30.4-1 | Enclosed | Partially enclosed |
| | Positive | 10 square feet or less 500 square feet or more | 1.00 0.75 |
| | Negative | 10 square feet or less 500 square feet or more | -1.34 -0.83 |
| | Wall elements: $h > 60$ feet (Zone 5) See ASCE 7 Figure 30.8-1 Zone 4 | | |
| | Positive | 20 square feet or less 500 square feet or more | 0.92 0.66 |
| | Negative | 20 square feet or less 500 square feet or more | -1.68 -1.00 |
| | Parapet walls | | |
| | Positive | 3.64 | 3.95 |
| | Negative | -2.45 | -2.76 |

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929m², 1 degree = 0.0175 rad.

a. Linear interpolation between values in the table is permitted.

b. Some C_{net} values have been grouped together. Less conservative results may be obtained by applying ASCE 7 provisions.

SECTION 1610A SOIL LATERAL LOADS

1610A.1 General. Foundation walls and retaining walls shall be designed to resist lateral soil loads. Soil loads specified in Table 1610A.1 shall be used as the minimum design lateral soil loads unless determined otherwise by a geotechnical investigation in accordance with Section 1803A. Foundation walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top shall be permitted to be designed for active pressure. Design lateral pressure from surcharge loads shall be added to the lateral earth pressure load. Design lateral pressure shall be increased if soils at the site are expansive. Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1805A.4.2 and 1805A.4.3.

Exception: Foundation walls extending not more than 8 feet (2438 mm) below grade and laterally supported at the top by flexible diaphragms shall be permitted to be designed for active pressure.

SECTION 1611A RAIN LOADS

1611A.1 Design rain loads. Each portion of a roof shall be designed to sustain the load of rainwater that will accumulate on it if the primary drainage system for that portion is

blocked plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow. The design rainfall shall be based on the 100-year hourly rainfall rate indicated in Figure 1611A.1 or on other rainfall rates determined from approved local weather data.

$$R = 5.2(d_s + d_h) \quad (\text{Equation 16A-36})$$

For SI: $R = 0.0098(d_s + d_h)$

where:

d_h = Additional depth of water on the undeflected roof above the inlet of secondary drainage system at its design flow (i.e., the hydraulic head), in inches (mm).

d_s = Depth of water on the undeflected roof up to the inlet of secondary drainage system when the primary drainage system is blocked (i.e., the static head), in inches (mm).

R = Rain load on the undeflected roof, in psf (kN/m₂). When the phrase “undeflected roof” is used, deflections from loads (including dead loads) shall not be considered when determining the amount of rain on the roof.

1611A.2 Ponding instability. Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Section 8.4 of ASCE 7.

1611A.3 Controlled drainage. Roofs equipped with hardware to control the rate of drainage shall be equipped with a

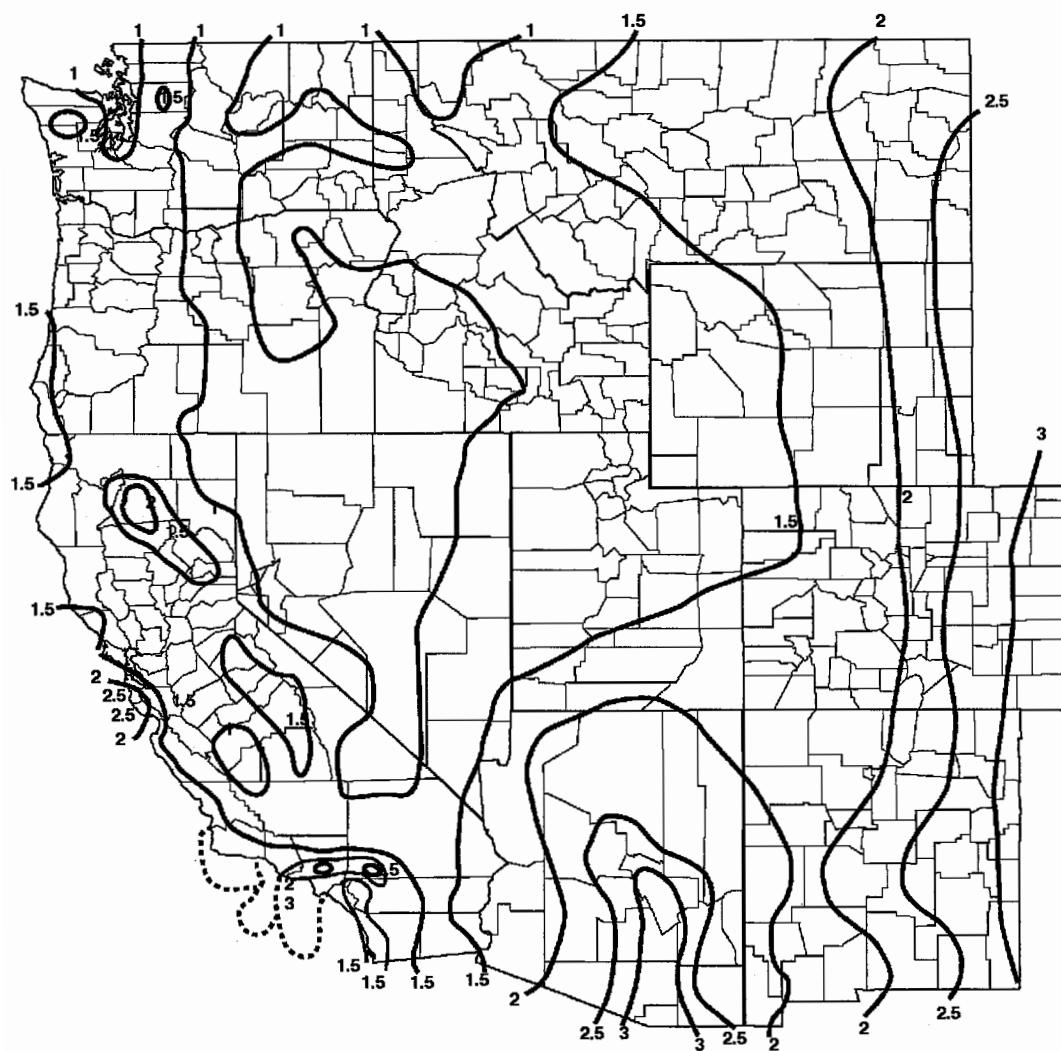
secondary drainage system at a higher elevation that limits accumulation of water on the roof above that elevation. Such roofs shall be designed to sustain the load of rainwater that will accumulate on them to the elevation of the secondary drainage system plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow determined from Section 1611A.1. Such roofs shall also be checked for ponding instability in accordance with Section 1611A.2.

**TABLE 1610A.1
LATERAL SOIL LOAD**

| DESCRIPTION OF BACKFILL MATERIAL ^c | UNIFIED SOIL CLASSIFICATION | DESIGN LATERAL SOIL LOAD ^a (pound per square foot per foot of depth) | |
|---|-----------------------------|--|------------------|
| | | Active pressure | At-rest pressure |
| Well-graded, clean gravels; gravel-sand mixes | GW | 30 | 60 |
| Poorly graded clean gravels; gravel-sand mixes | GP | 30 | 60 |
| Silty gravels, poorly graded gravel-sand mixes | GM | 40 | 60 |
| Clayey gravels, poorly graded gravel-and-clay mixes | GC | 45 | 60 |
| Well-graded, clean sands; gravelly sand mixes | SW | 30 | 60 |
| Poorly graded clean sands; sand-gravel mixes | SP | 30 | 60 |
| Silty sands, poorly graded sand-silt mixes | SM | 45 | 60 |
| Sand-silt clay mix with plastic fines | SM-SC | 45 | 100 |
| Clayey sands, poorly graded sand-clay mixes | SC | 60 | 100 |
| Inorganic silts and clayey silts | ML | 45 | 100 |
| Mixture of inorganic silt and clay | ML-CL | 60 | 100 |
| Inorganic clays of low to medium plasticity | CL | 60 | 100 |
| Organic silts and silt clays, low plasticity | OL | Note b | Note b |
| Inorganic clayey silts, elastic silts | MH | Note b | Note b |
| Inorganic clays of high plasticity | CH | Note b | Note b |
| Organic clays and silty clays | OH | Note b | Note b |

For SI: 1 pound per square foot per foot of depth = 0.157 kPa/m, 1 foot = 304.8 mm.

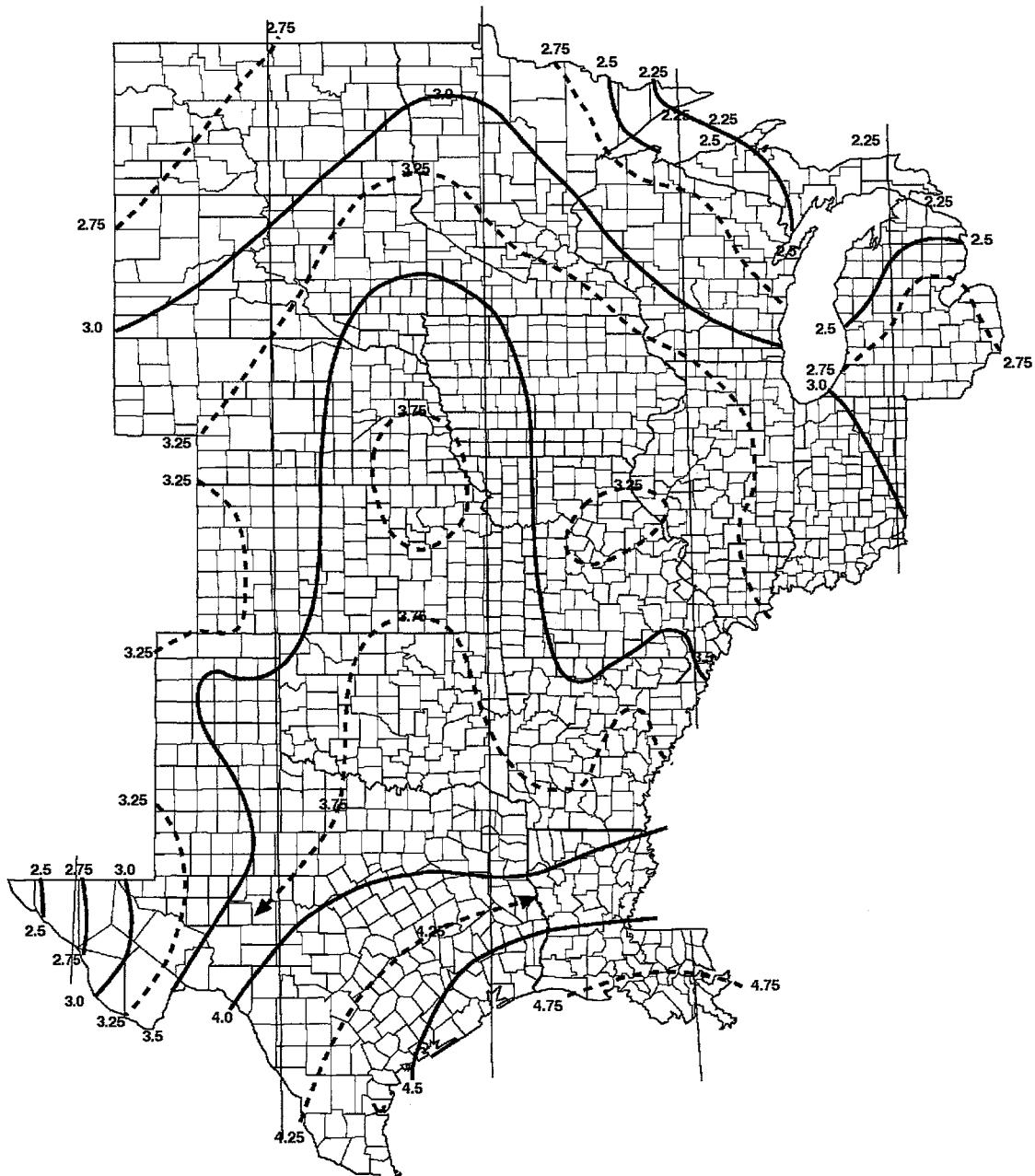
- a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.
- b. Unsuitable as backfill material.
- c. The definition and classification of soil materials shall be in accordance with ASTM D 2487.



[P] FIGURE 1611A.1
100-YEAR, 1-HOUR RAINFALL (INCHES) WESTERN UNITED STATES

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611A.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) CENTRAL UNITED STATES

For SI: 1 inch = 25.4 mm.

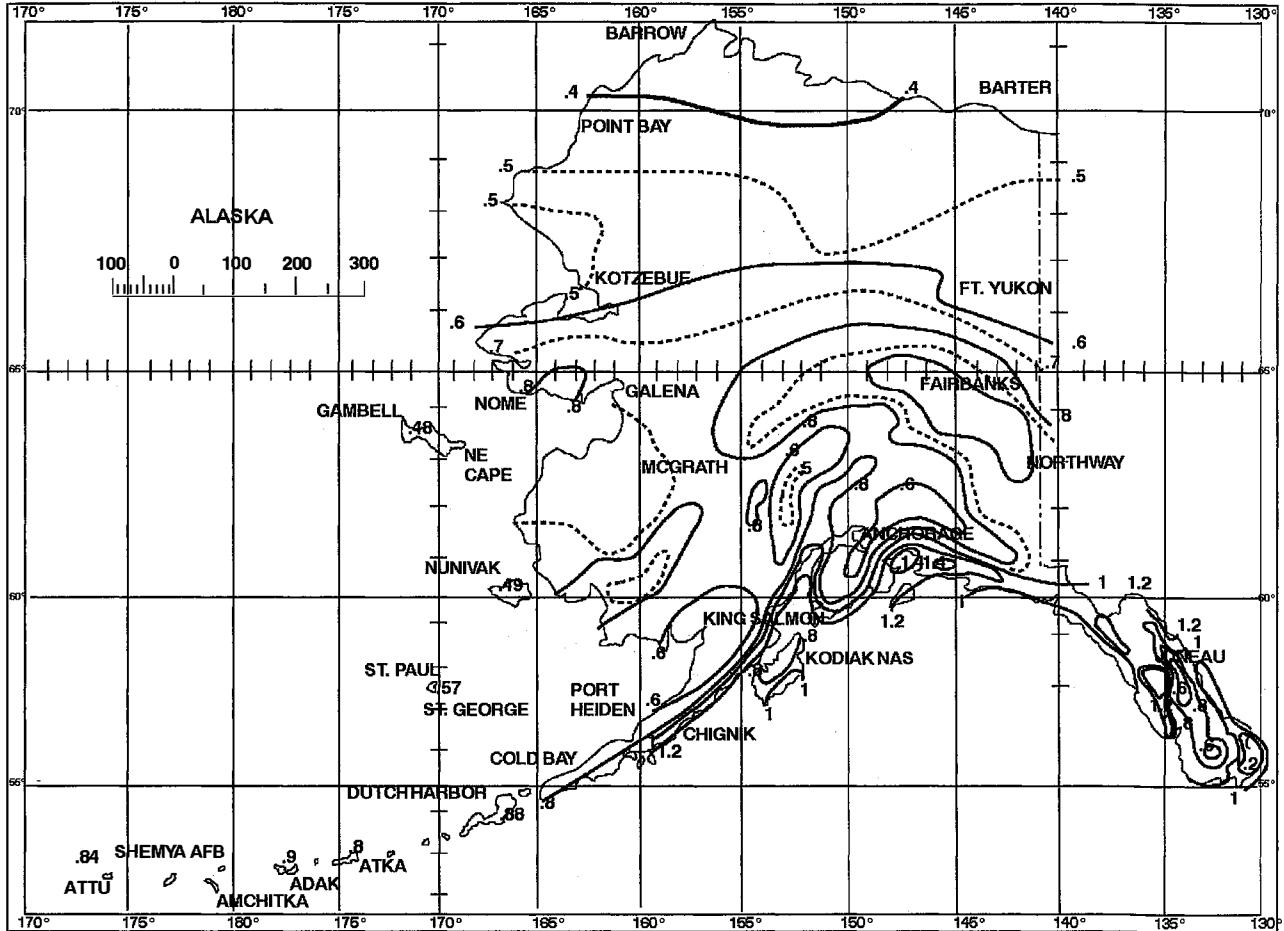
Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611A.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) EASTERN UNITED STATES

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611A.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) ALASKA

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611A.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) HAWAII

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

SECTION 1612A FLOOD LOADS

1612A.1 General. Within flood hazard areas as established in Section 1612A.3, all new construction of buildings, structures and portions of buildings and structures, including substantial improvement and restoration of substantial damage to buildings and structures, shall be designed and constructed to resist the effects of flood hazards and flood loads. For buildings that are located in more than one flood hazard area, the provisions associated with the most restrictive flood hazard area shall apply.

1612A.2 Definitions. The following words and terms are defined in Chapter 2.

BASE FLOOD.

BASE FLOOD ELEVATION.

BASEMENT.

DESIGN FLOOD.

DESIGN FLOOD ELEVATION.

DRY FLOODPROOFING.

EXISTING CONSTRUCTION.

EXISTING STRUCTURE.

FLOOD or FLOODING.

FLOOD DAMAGE-RESISTANT MATERIALS.

FLOOD HAZARD AREA.

FLOOD HAZARD AREA SUBJECT TO HIGH-VELOCITY WAVE ACTION.

FLOOD INSURANCE RATE MAP (FIRM).

FLOOD INSURANCE STUDY.

FLOODWAY.

LOWEST FLOOR.

SPECIAL FLOOD HAZARD AREA.

START OF CONSTRUCTION.

SUBSTANTIAL DAMAGE.

SUBSTANTIAL IMPROVEMENT.

1612A.3 Establishment of flood hazard areas. To establish flood hazard areas, the applicable governing authority shall adopt a flood hazard map and supporting data. The flood hazard map shall include, at a minimum, areas of special flood hazard as identified by the Federal Emergency Management Agency's *Flood Insurance Study (FIS)* adopted by the local authority having jurisdiction where the project is located, as amended or revised with the accompanying Flood Insurance Rate Map (FIRM) and Flood Boundary and Floodway Map (FBFM) and related supporting data along with any revisions thereto. The adopted flood hazard map and supporting data are hereby adopted by reference and declared to be part of this section.

1612A.3.1 Design flood elevations. Where design flood elevations are not included in the flood hazard areas established in Section 1612A.3, or where floodways are not designated, the building official is authorized to require the applicant to:

- Obtain and reasonably utilize any design flood elevation and floodway data available from a federal, state or other source; or

- Determine the design flood elevation and/or floodway in accordance with accepted hydrologic and hydraulic engineering practices used to define special flood hazard areas. Determinations shall be undertaken by a registered design professional who shall document that the technical methods used reflect currently accepted engineering practice.

1612A.3.2 Determination of impacts. In riverine flood hazard areas where design flood elevations are specified but floodways have not been designated, the applicant shall provide a floodway analysis that demonstrates that the proposed work will not increase the design flood elevation more than 1 foot (305 mm) at any point within the jurisdiction of the applicable governing authority.

1612A.4 Design and construction. The design and construction of buildings and structures located in flood hazard areas, including flood hazard areas subject to high-velocity wave action, shall be in accordance with Chapter 5 of ASCE 7 and with ASCE 24.

1612A.5 Flood hazard documentation. The following documentation shall be prepared and sealed by a registered design professional and submitted to the building official:

- For construction in flood hazard areas not subject to high-velocity wave action:
 - The elevation of the lowest floor, including the basement, as required by the lowest floor elevation inspection in Section 110.3.3.
 - For fully enclosed areas below the design flood elevation where provisions to allow for the automatic entry and exit of floodwaters do not meet the minimum requirements in Section 2.6.2.1 of ASCE 24, construction documents shall include a statement that the design will provide for equalization of hydrostatic flood forces in accordance with Section 2.6.2.2 of ASCE 24.
 - For dry floodproofed nonresidential buildings, construction documents shall include a statement that the dry floodproofing is designed in accordance with ASCE 24.
- For construction in flood hazard areas subject to high-velocity wave action:
 - The elevation of the bottom of the lowest horizontal structural member as required by the lowest floor elevation inspection in Section 110.3.3.
 - Construction documents shall include a statement that the building is designed in accordance with ASCE 24, including that the pile or column foundation and building or structure to be attached thereto is designed to be anchored to resist flotation, collapse and lateral movement due to the effects of wind and flood loads acting simultaneously on all building components, and other load requirements of Chapter 16A.

2.3. For breakaway walls designed to have a resistance of more than 20 psf (0.96 kN/m^2) determined using allowable stress design, construction documents shall include a statement that the breakaway wall is designed in accordance with ASCE 24.

SECTION 1613A EARTHQUAKE LOADS

1613A.1 Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7 *with all the modifications incorporated herein*, excluding Chapter 14 and Appendix 11A. The seismic design category for a structure *shall be determined in accordance with Section 1613A.*

Exception: Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7 and for which other regulations provide seismic criteria, such as vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenances and nuclear reactors.

1613A.2 Definitions. The following terms are defined in Chapter 2, *except those defined below which shall, for the purposes of this section, have the meanings shown herein. Definition provided in Section 3402A.1 and ASCE 7 Section 11.2 shall apply when appropriate in addition to terms defined in this section.*

ACTIVE EARTHQUAKE FAULT. A fault that has been the source of earthquakes or is recognized as a potential source of earthquakes, including those that have exhibited surface displacement within Holocene time (about 11,000 years) as determined by California Geological Survey (CGS) under the Alquist-Priolo Earthquake Fault Zoning Act, those included as type A or type B faults for the U.S. Geological Survey (USGS) National Seismic Hazard Maps, and faults considered to have been active in Holocene time by any authoritative source, federal, state or local governmental agency.

BASE. The level at which the horizontal seismic ground motions are considered to be imparted to the structure or the level at which the structure as a dynamic vibrator is supported. This level does not necessarily coincide with the ground level.

DESIGN EARTHQUAKE GROUND MOTION.

DISTANCE FROM AN ACTIVE EARTHQUAKE FAULT. Distance measured from the nearest point of the building to the closest edge of an Alquist-Priolo Earthquake Fault Zone for an active fault, if such a map exists, or to the closest mapped splay of the fault.

GENERAL ACUTE CARE HOSPITAL. See Section 1224.3.

HOSPITAL BUILDINGS. Hospital buildings and all other medical facilities as defined in Section 1250, Health and Safety Code.

IRREGULAR STRUCTURE. A structure designed as having one or more plan or vertical irregularities per ASCE 7 Section 12.3.

MECHANICAL SYSTEMS.

ORTHOGONAL.

RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATION.

SEISMIC DESIGN CATEGORY.

SEISMIC FORCE-RESISTING SYSTEM.

SITE CLASS.

SITE COEFFICIENTS.

STRUCTURAL ELEMENTS. Floor or roof diaphragms, decking, joists, slabs, beams or girders, columns, bearing walls, retaining walls, masonry or concrete nonbearing walls exceeding one story in height, foundations, shear walls or other lateral-force-resisting members and any other elements necessary to the vertical and lateral strength or stability of either the building as a whole or any of its parts, including connection between such elements.

1613A.3 Seismic ground motion values. Seismic ground motion values shall be determined in accordance with this section.

1613A.3.1 Mapped acceleration parameters. The parameters S_s and S_1 shall be determined from the 0.2 and 1-second spectral response accelerations shown on Figures 1613.3.1(1) through 1613.3.1(6).

1613A.3.2 Site class definitions. Based on the site soil properties, the site shall be classified as Site Class A, B, C, D, E or F in accordance with Chapter 20 of ASCE 7. Where the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the building official or geotechnical data determines Site Class E or F soils are present at the site.

1613A.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. The maximum considered earthquake spectral response acceleration for short periods, S_{MS} , and at 1-second period, S_{M1} , adjusted for site class effects shall be determined by Equations 16A-37 and 16A-38, respectively:

$$S_{MS} = F_a S_s \quad (\text{Equation 16A-37})$$

$$S_{M1} = F_v S_1 \quad (\text{Equation 16A-38})$$

where:

F_a = Site coefficient defined in Table 1613A.3.3(1).

F_v = Site coefficient defined in Table 1613A.3.3(2).

S_s = The mapped spectral accelerations for short periods as determined in Section 1613A.3.1.

S_1 = The mapped spectral accelerations for a 1-second period as determined in Section 1613A.3.1.

1613A.3.4 Design spectral response acceleration parameters. Five-percent damped design spectral response acceleration at short periods, S_{DS} , and at 1-sec-

ond period, S_{D1} , shall be determined from Equations 16A-39 and 16A-40, respectively:

$$S_{DS} = \frac{2}{3}S_{MS} \quad (\text{Equation 16A-39})$$

$$S_{D1} = \frac{2}{3}S_{M1} \quad (\text{Equation 16A-40})$$

where:

S_{MS} = The maximum considered earthquake spectral response accelerations for short period as determined in Section 1613A.3.3.

S_{M1} = The maximum considered earthquake spectral response accelerations for 1-second period as determined in Section 1613A.3.3.

1613A.3.5 Determination of seismic design category. Structures classified as Risk Category I, II or III that are located where the mapped spectral response acceleration parameter at 1-second period, S_1 , is greater than or equal to 0.75 shall be assigned to Seismic Design Category E. Structures classified as Risk Category IV that are located where the mapped spectral response acceleration parameter at 1-second period, S_1 , is greater than or equal to 0.75 shall be assigned to Seismic Design Category F. All other structures shall be assigned to Seismic Design Category D.

1613A.3.5.1 Alternative seismic design category determination. Not permitted by DSA-SS OSHPD.

1613A.3.5.2 Simplified design procedure. Not permitted by DSA-SS and OSHPD.

1613A.4 Alternatives to ASCE 7. The provisions of Section 1613A.4 shall be permitted as alternatives to the relevant provisions of ASCE 7.

1613A.4.1 Additional seismic-force-resisting systems for seismically isolated structures. Add the following exception to the end of Section 17.5.4.2 of ASCE 7:

Exception: For isolated structures designed in accordance with this standard, the Structural System Limitations and the Building Height Limitations in Table 12.2-1 for ordinary steel concentrically braced frames (OCBFs) as defined in Chapter 11 and intermediate moment frames (IMFs) as defined in Chapter 11 are permitted to be taken as 160 feet (48 768 mm) for structures assigned to Seismic Design Category D, E or F, provided that the following conditions are satisfied:

1. The value of R_I as defined in Chapter 17 is taken as 1.
2. For OCBFs, design is in accordance with AISC 341.
3. For IMFs, design is in accordance with AISC 341. In addition, requirements of Section E3.6e of AISC 341 shall be satisfied.

TABLE 1613A.3.3(1)
VALUES OF SITE COEFFICIENT F_a ^a

| SITE CLASS | MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIOD | | | | |
|------------|---|--------------|--------------|--------------|-----------------|
| | $S_s \leq 0.25$ | $S_s = 0.50$ | $S_s = 0.75$ | $S_s = 1.00$ | $S_s \geq 1.25$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 |
| D | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 |
| E | 2.5 | 1.7 | 1.2 | 0.9 | 0.9 |
| F | Note b | Note b | Note b | Note b | Note b |

a. Use straight line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s .

b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

TABLE 1613A.3.3(2)
VALUES OF SITE COEFFICIENT F_v ^a

| SITE CLASS | MAPPED SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD | | | | |
|------------|--|-------------|-------------|-------------|----------------|
| | $S_1 \leq 0.1$ | $S_1 = 0.2$ | $S_1 = 0.3$ | $S_1 = 0.4$ | $S_1 \geq 0.5$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 |
| D | 2.4 | 2.0 | 1.8 | 1.6 | 1.5 |
| E | 3.5 | 3.2 | 2.8 | 2.4 | 2.4 |
| F | Note b | Note b | Note b | Note b | Note b |

a. Use straight line interpolation for intermediate values of mapped spectral response acceleration at 1 second period, S_1 .

b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

TABLE 1613A.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATIONS

| VALUE OF S_{DS} | RISK CATEGORY | | |
|------------------------------|---------------|-----|----|
| | I or II | III | IV |
| $S_{DS} < 0.167g$ | A | A | A |
| $0.167g \leq S_{DS} < 0.33g$ | B | B | C |
| $0.33g \leq S_{DS} < 0.50g$ | C | C | D |
| $0.50g \leq S_{DS}$ | D | D | D |

TABLE 1613A.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

| VALUE OF S_{DI} | RISK CATEGORY | | |
|-------------------------------|---------------|-----|----|
| | I or II | III | IV |
| $S_{DI} < 0.067g$ | A | A | A |
| $0.067g \leq S_{DI} < 0.133g$ | B | B | C |
| $0.133g \leq S_{DI} < 0.20g$ | C | C | D |
| $0.20g \leq S_{DI}$ | D | D | D |

SECTION 1614A ATMOSPHERIC ICE LOADS

1614A.1 General. Ice-sensitive structures shall be designed for atmospheric ice loads in accordance with Chapter 10 of ASCE 7.

SECTION 1615A STRUCTURAL INTEGRITY

1615A.1 General. High-rise buildings that are assigned to Risk Category III or IV shall comply with the requirements of this section. Frame structures shall comply with the requirements of Section 1615A.3. Bearing wall structures shall comply with the requirements of Section 1615A.4.

1615A.2 Definitions. The following words and terms are defined in Chapter 2, *except those defined below which shall, for the purposes of this section, have the meanings shown herein.*

BEARING WALL STRUCTURE.

FRAME STRUCTURE.

HIGH-RISE BUILDING. A building with an occupied floor located more than 75 feet (22 860 mm) above the base.

1615A.3 Frame structures. Frame structures shall comply with the requirements of this section.

1615A.3.1 Concrete frame structures. Frame structures constructed primarily of reinforced or prestressed concrete, either cast-in-place or precast, or a combination of these, shall conform to the requirements of ACI 318 Sections 7.13, 13.3.8.5, 13.3.8.6, 16.5, 18.12.6, 18.12.7 and 18.12.8 as applicable. Where ACI 318 requires that non-prestressed reinforcing or prestressing steel pass through

the region bounded by the longitudinal column reinforcement, that reinforcing or prestressing steel shall have a minimum nominal tensile strength equal to two-thirds of the required one-way vertical strength of the connection of the floor or roof system to the column in each direction of beam or slab reinforcement passing through the column.

Exception: Where concrete slabs with continuous reinforcing having an area not less than 0.0015 times the concrete area in each of two orthogonal directions are present and are either monolithic with or equivalently bonded to beams, girders or columns, the longitudinal reinforcing or prestressing steel passing through the column reinforcement shall have a nominal tensile strength of one-third of the required one-way vertical strength of the connection of the floor or roof system to the column in each direction of beam or slab reinforcement passing through the column.

1615A.3.2 Structural steel, open web steel joist or joist girder, or composite steel and concrete frame structures. Frame structures constructed with a structural steel frame or a frame composed of open web steel joists, joist girders with or without other structural steel elements or a frame composed of composite steel or composite steel joists and reinforced concrete elements shall conform to the requirements of this section.

1615A.3.2.1 Columns. Each column splice shall have the minimum design strength in tension to transfer the design dead and live load tributary to the column between the splice and the splice or base immediately below.

1615A.3.2.2 Beams. End connections of all beams and girders shall have a minimum nominal axial tensile

strength equal to the required vertical shear strength for allowable stress design (ASD) or two-thirds of the required shear strength for load and resistance factor design (LRFD) but not less than 10 kips (45 kN). For the purpose of this section, the shear force and the axial tensile force need not be considered to act simultaneously.

Exception: Where beams, girders, open web joist and joist girders support a concrete slab or concrete slab on metal deck that is attached to the beam or girder with not less than $\frac{3}{8}$ -inch-diameter (9.5 mm) headed shear studs, at a spacing of not more than 12 inches (305 mm) on center, averaged over the length of the member, or other attachment having equivalent shear strength, and the slab contains continuous distributed reinforcement in each of two orthogonal directions with an area not less than 0.0015 times the concrete area, the nominal axial tension strength of the end connection shall be permitted to be taken as half the required vertical shear strength for ASD or one-third of the required shear strength for LRFD, but not less than 10 kips (45 kN).

1615A.4 Bearing wall structures. Bearing wall structures shall have vertical ties in all load-bearing walls and longitudinal ties, transverse ties and perimeter ties at each floor level in accordance with this section and as shown in Figure 1615A.4.

1615A.4.1 Concrete wall structures. Precast bearing wall structures constructed solely of reinforced or prestressed concrete, or combinations of these shall conform to the requirements of Sections 7.13, 13.3.8.5 and 16.5 of ACI 318.

1615A.4.2 Other bearing wall structures. Ties in bearing wall structures other than those covered in Section 1615A.4.1 shall conform to this section.

1615A.4.2.1 Longitudinal ties. Longitudinal ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Longitudinal ties shall extend across interior load-bearing walls and shall connect to exterior load-bearing walls and shall be spaced at not greater than 10 feet (3038 mm) on center. Ties shall have a minimum nominal tensile strength, T_T , given by Equation 16A-41. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

$$T_T = wL_S \leq \alpha_T S \quad (\text{Equation 16A-41})$$

where:

L = The span of the horizontal element in the direction of the tie, between bearing walls, feet (m).

w = The weight per unit area of the floor or roof in the span being tied to or across the wall, psf (N/m^2).

S = The spacing between ties, feet (m).

α_T = A coefficient with a value of 1,500 pounds per foot (2.25 kN/m) for masonry bearing wall structures and a value of 375 pounds per foot (0.6 kN/m) for structures with bearing walls of cold-formed steel light-frame construction.

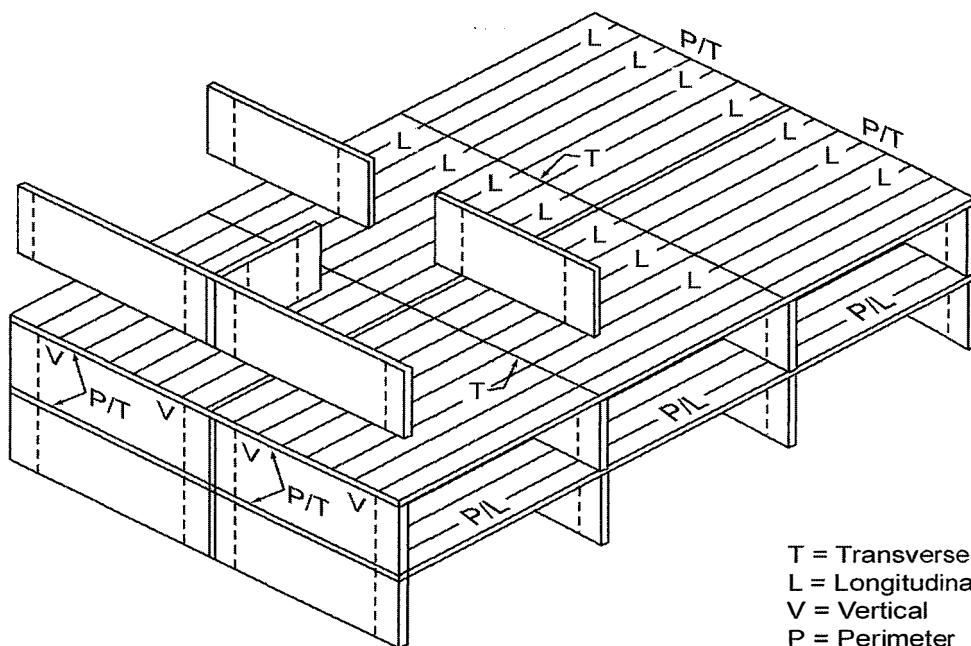


FIGURE 1614A.4
LONGITUDINAL, PERIMETER, TRANSVERSE AND VERTICAL TIES

1615A.4.2.2 Transverse ties. Transverse ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Transverse ties shall be placed no farther apart than the spacing of load-bearing walls. Transverse ties shall have minimum nominal tensile strength T_T , given by Equation 16A-46. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

1615A.4.2.3 Perimeter ties. Perimeter ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Ties around the perimeter of each floor and roof shall be located within 4 feet (1219 mm) of the edge and shall provide a nominal strength in tension not less than T_p , given by Equation 16A-42. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

$$T_p = 200w \leq \beta_T \quad (\text{Equation 16A-42})$$

For SI:

$$T_p = 90.7w \leq \beta_T$$

where:

w = As defined in Section 1614A.4.2.1.

β_T = A coefficient with a value of 16,000 pounds (7200 kN) for structures with masonry bearing walls and a value of 4,000 pounds (1300 kN) for structures with bearing walls of cold-formed steel light-frame construction.

1615A.4.2.4 Vertical ties. Vertical ties shall consist of continuous or spliced reinforcing, continuous or spliced members, wall sheathing or other engineered systems. Vertical tension ties shall be provided in bearing walls and shall be continuous over the height of the building. The minimum nominal tensile strength for vertical ties within a bearing wall shall be equal to the weight of the wall within that story plus the weight of the diaphragm tributary to the wall in the story below. No fewer than two ties shall be provided for each wall. The strength of each tie need not exceed 3,000 pounds per foot (450 kN/m) of wall tributary to the tie for walls of masonry construction or 750 pounds per foot (140 kN/m) of wall tributary to the tie for walls of cold-formed steel light-frame construction.

SECTION 1616A MODIFICATIONS TO ASCE 7

1616A.1 General. The text of ASCE 7 shall be modified as indicated in Sections 1616A.1.1 through 1616A.1.42.

1616A.1.1 ASCE 7, Section 1.3. Modify ASCE 7 Section 1.3 by the adding Section 1.3.6 as follows:

1.3.6 Structural design criteria. Where design is based on ASCE 7, Chapters 16, 17, 18, or 31, the ground

motion, wind tunnel design recommendations, analysis, and design methods, material assumptions, testing requirements, and acceptance criteria proposed by the engineer shall be submitted to the enforcement agency in the form of structural design criteria for approval.

[DSA-SS, OSHPD 1 & 4] Peer review requirements in Section 3414A of this code shall apply to design reviews required by ASCE 7 Chapters 17 and 18.

1616A.1.2 ASCE 7, Section 11.1.3. Replace last paragraph of ASCE 7, Section 11.1.3, by the following:

Buildings shall be designed and detailed in accordance with Chapter 12.

1616A.1.3 ASCE 7, Section 11.4.7. Modify ASCE 7 Section 11.4.7 by adding the following:

For buildings assigned to Seismic Design Category E or F, or when required by the building official, a ground motion hazard analysis shall be performed in accordance with ASCE 7 Chapter 21 as modified by Section 1803A.6 of this code.

1616A.1.4 ASCE 7, Table 12.2-1. Modify ASCE 7 Table 12.2-1 as follows:

A. BEARING WALL SYSTEMS

- 5. *Intermediate Precast Shear Walls—Not permitted by OSHPD.*
- 17. *Light-framed walls with shear panels of all other materials—Not permitted by OSHPD and DSA-SS.*

B. BUILDING FRAME SYSTEMS

- 3. *Ordinary steel concentrically braced frames—Not permitted by OSHPD.*
- 8. *Intermediate Precast Shear Walls—Not permitted by OSHPD.*
- 24. *Light-framed walls with shear panels of all other materials—Not permitted by OSHPD and DSA-SS.*
- 26. *Special steel plate shear wall—Not permitted by OSHPD.*

C. MOMENT-RESISTING FRAME SYSTEMS

- 2. *Special steel truss moment frames—Not permitted by OSHPD.*
- 3. *Intermediate steel moment frames—Not permitted by OSHPD.*
- 4. *Ordinary steel moment frames—Not permitted by OSHPD.*
- 5. *Cold-formed steel—special bolted moment frame - Not permitted by DSA-SS and OSHPD.*

Exceptions:

- 1. *Systems listed in this section can be used as an alternative system when preapproved by the enforcement agency.*
- 2. *Rooftop or other supported structures not exceeding two stories in height and 10 percent of the total structure weight can use the systems in*

this section when designed as components per ASCE 7 Chapter 13.

3. Systems listed in this section can be used for seismically isolated buildings when permitted by Section 1613A.4.1.

1616A.1.5 ASCE 7, Section 12.2.3.1. Replace ASCE 7, Section 12.2.3.1, Items 1 and 2, by the following:

The value of the response modification coefficient, R , used for design at any story shall not exceed the lowest value of R that is used in the same direction at any story above that story. Likewise, the deflection amplification factor, C_d , and the system over strength factor, Ω_0 , used for the design at any story shall not be less than the largest value of these factors that are used in the same direction at any story above that story.

1616A.1.6 ASCE 7, Section 12.2.3.2. Modify ASCE 7, Section 12.2.3.2, by adding the following additional requirements:

- f. Where design of elements of the upper portion is governed by special seismic load combinations, the special loads shall be considered in the design of the lower portion.

1616A.1.7 ASCE 7, Section 12.2.5.6.1 [DSA-SS] The exception after the first paragraph is not permitted by DSA-SS.

1616A.1.8 ASCE 7, Section 12.2.5.7.1 [DSA-SS] The exception after the first paragraph is not permitted by DSA-SS.

1616A.1.9 ASCE 7, Section 12.2.5.7.2 [DSA-SS] The exception after the first paragraph is not permitted by DSA-SS.

1616A.1.10 ASCE 7, Section 12.3.3. Modify first sentence of ASCE 7, Section 12.3.3.1, as follows:

12.3.3.1 Prohibited horizontal and vertical irregularities for Seismic Design Categories D through F. Structures assigned to Seismic Design Category D, E or F having horizontal structural irregularity Type 1b of Table 12.3-1 or vertical structural irregularities Type 1b, 5a or 5b of Table 12.3-2 shall not be permitted.

1616A.1.11 ASCE 7, Section 12.7.2. Modify ASCE 7, Section 12.7.2, by adding Item 6 to read as follows:

6. Where buildings provide lateral support for walls retaining earth, and the exterior grades on opposite sides of the building differ by more than 6 feet (1829 mm), the load combination of the seismic increment of earth pressure due to earthquake acting on the higher side, as determined by a geotechnical engineer qualified in soils engineering plus the difference in earth pressures shall be added to the lateral forces provided in this section.

1616A.1.12 ASCE 7, Section 12.8.1.3. Replace ASCE 7, Section 12.8.1.3, by the following:

12.8.1.3 Maximum S_s value in determination of C_s . For regular structures five stories or less above the base, as defined in Section 11.2, and with a period, T , of 0.5 s or less, C_s is permitted to be calculated using the larger of either $S_s = 1.5$ or 80 percent of the value of S_s determined per Sections 11.4.1 or 11.4.7.

1616A.1.13 ASCE 7, Section 12.9.4. Replace ASCE 7 Section 12.9.4 as follows:

12.9.4 Scaling design values of combined response. Modal base shears used to determine forces and drifts shall not be less than the base shear calculated using the equivalent lateral force procedure of Section 12.8.

1616A.1.14 ASCE 7, Section 12.10.2.1. Replace ASCE 7, Exception 1 of Section 12.10.2.1, by adding the following:

Exception:

1. The forces calculated above need not exceed those calculated using the load combinations of Section 12.4.3.2 with seismic forces determined by Equation 12.10-3 and transfer forces, where applicable.

1616A.1.15 ASCE 7, Section 12.12.3. [OSHPD 1 & 4] Replace ASCE 7 Equation 12.12-1 by the following:

$$\delta_M = C_d \delta_{max} \quad (\text{Equation 12.12-1})$$

1616A.1.16 ASCE 7, Section 12.13.1. Modify ASCE 7 Section 12.13.1 by adding Section 12.13.1.1 as follows:

12.13.1.1 Foundations and superstructure-to-foundation connections. The foundation shall be capable of transmitting the design base shear and the overturning forces from the structure into the supporting soil. Stability against overturning and sliding shall be in accordance with Section 1605A.1.1.

In addition, the foundation and the connection of the superstructure elements to the foundation shall have the strength to resist, in addition to gravity loads, the lesser of the following seismic loads:

1. The strength of the superstructure elements.
2. The maximum forces that would occur in the fully yielded structural system.
3. Forces from the load combinations with overstrength factor in accordance with ASCE 7, Section 12.4.3.2.

Exceptions:

1. Where referenced standards specify the use of higher design loads.
2. When it can be demonstrated that inelastic deformation of the foundation and superstructure-to-foundation connection will not result in a weak story or cause collapse of the structure.
3. Where basic structural system consists of light framed walls with shear panels, unless the reference standard specifies the use of higher design loads.

Where the computation of the seismic overturning moment is by the equivalent lateral-force method or the modal analysis method, reduction in overturning moment permitted by section 12.13.4 of ASCE 7 may be used.

Where moment resistance is assumed at the base of the superstructure elements, the rotation and flexural deformation of the foundation as well as deformation of the superstructure-to-foundation connection shall be considered in the drift and deformation compatibility analyses.

1616A.1.17 ASCE 7, Section 13.1.3. [OSHPD 1 & 4]
Modify ASCE 7 Section 13.1.3 by the following:

The design of supports and attachments for all non-structural components shall have a component importance factor, I_p , equal to 1.5.

Exception: Freestanding skilled nursing or acute psychiatric buildings, not providing services/systems, utilities, or access/egress to general acute care buildings designated as SPC 3 or higher in accordance with Chapter 6 of the California Administrative Code, shall be permitted to use component importance factor, I_p , as shown in Table 1616A.1.17.

TABLE 1616A.1.17

COMPONENT IMPORTANCE FACTOR (I_p) FOR FREESTANDING SKILLED NURSING AND ACUTE PSYCHIATRIC BUILDINGS

| DESCRIPTION | IMPORTANCE FACTOR (I_p) |
|--|-----------------------------|
| Architectural components | 1.0 |
| Mechanical and electrical components | 1.5 |
| Medical devices | 1.5 |
| Piping, including in line components | 1.5 |
| HVAC ducts, including in line components | 1.0 |
| Electrical raceways | 1.0 |

1. Components required for life safety purposes after an earthquake, including emergency and standby power systems, fire protection sprinkler systems, fire alarm control panels, and egress stairways shall have a component importance factor (I_p) of 1.5.

1616A.1.18 ASCE 7, Section 13.1.4. Replace ASCE 7, Section 13.1.4, with the following:

13.1.4 Exemptions. The following nonstructural components are exempt from the requirements of this section:

1. Furniture (except storage cabinets as noted in Table 13.5-1).
2. Temporary or moveable (mobile) equipment.

Exceptions:

- a) Equipment shall be anchored if it is permanently attached to the building utility services such as electricity, gas or water. For the purposes of this requirement, "permanently attached" shall include all electrical connections except plugs for duplex receptacles.
- b) The enforcement agency shall be permitted to require temporary attachments for movable equipment which is usually stationed in one place and heavier than 400 pounds, when they are not in use for a period longer than 8 hours at a time.
3. Architectural, mechanical and electrical components in Seismic Design Categories D, E or F where all of the following apply:
 - a. The component is positively attached to the structure;
 - b. Flexible connections are provided at seismic separation joints and between the component and associated ductwork, piping and conduit; and either:
 - i. The component weighs 400 pounds (1780 N) or less and has a center of mass located 4 feet

(1.22 m) or less above the adjacent floor or roof level that directly support the component;

Exception: Special Seismic Certification requirements of this code in accordance with Section 1705A.12.4 shall be applicable.

or

- ii. The component weighs 20 pounds (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.

Exception: The enforcement agency shall be permitted to require attachments for equipment with hazardous contents to be shown on construction documents irrespective of weight.

1616A.1.19 ASCE 7, Section 13.4 Replace ASCE 7, Sections 13.4.2.3, with the following:

13.4.2.3 Post-installed anchors in concrete and masonry.

Post-installed anchors in concrete used for component anchorage shall be pre-qualified for seismic applications in accordance with ACI 355.2, ICC-ES AC193 or ICC-ES AC308. Post-installed anchors in masonry used for component anchorage shall be pre-qualified for seismic applications in accordance with ICC-ES AC01, AC58 or AC106.

Use of screw anchors shall be limited to dry interior conditions. Re-use of screw anchors or screw anchor holes shall not be permitted.

1616A.1.20 ASCE 7, Section 13.5.6. Replace ASCE 7, Section 13.5.6 with the following:

13.5.6 Suspended ceilings. Suspended ceilings shall be in accordance with this section.

13.5.6.1 Seismic forces. The weight of the ceiling, W_p , shall include the ceiling grid; ceiling tiles or 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/m²).

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

13.5.6.2 Seismic design requirements. Suspended acoustical tile or lay-in panel ceilings shall be designed in accordance with ASTM E 580, Section 5.2.8, and the requirements of Sections 13.5.6.2.1 and 13.5.6.2.2, or be designed in accordance with Section 13.2.1.(1), or be seismically qualified in accordance with Sections 13.2.5 or 13.2.6.

13.5.6.2.1 Industry standard construction for acoustical tile or lay-in panel ceilings. Acoustical tile or lay-in panel ceilings in Seismic Design Categories D, E, and F shall be designed and installed in accordance with ASTM C 635, ASTM C 636, and ASTM E 580, Section 5 - Seismic Design Categories D, E, and F as modified by Section 13.5.6.2.2.

13.5.6.2.2 Modification to ASTM E 580. Modify ASTM E 580 by the following:

1. **Exitways.** Lay-in ceiling assemblies in exitways of hospitals and essential services build-

ings shall be installed with a main runner or cross runner surrounding all sides of each piece of tile, board or panel and each light fixture or grille. A cross runner that supports another cross runner shall be considered as a main runner for the purpose of structural classification. Splices or intersections of such runners shall be attached with through connectors such as pop rivets, screws, pins, plates with end tabs or other approved connectors.

2. **Corridors and lobbies.** Expansion joints shall be provided in the ceiling at intersections of corridors and at junctions of corridors and lobbies or other similar areas.
3. **Lay-in panels.** Metal panels and panels weighing more than $\frac{1}{2}$ pounds per square foot (24 N/m^2) other than acoustical tiles shall be positively attached to the ceiling suspension runners.
4. **Lateral force bracing.** Lateral force bracing is required for all ceiling areas except that they shall be permitted to be omitted in rooms with floor areas up to 144 square feet when perimeter support in accordance with ASTM E 580, Sections 5.2.2 and 5.2.3, are provided and perimeter walls are designed to carry the ceiling lateral forces. Restraint wires shall be secured with four tight twists in $1\frac{1}{2}$ inches, or an approved alternate connection.
5. **Ceiling fixtures.** Fixtures installed in acoustical tile or lay-in panel ceilings shall be mounted in a manner that will not compromise ceiling performance.

All recessed or drop-in light fixtures and grilles shall be supported directly from the fixture housing to the structure above with a minimum of two 12 gage wires located at diagonally opposite corners. Leveling and positioning of fixtures may be provided by the ceiling grid. Fixture support wires may be slightly loose to allow the fixture to seat in the grid system. Fixtures shall not be supported from main runners or cross runners if the weight of the fixtures causes the total dead load to exceed the deflection capability of the ceiling suspension system.

Fixtures shall not be installed so that the main runners or cross runners will be eccentrically loaded.

Surface-mounted fixtures shall be attached to the main runner with at least two positive clamping devices made of material with a minimum of 14 gage. Rotational spring catches do not comply. A 12 gage suspension wire shall be attached to each clamping device and to the structure above.

6. **Partitions.** Where the suspended ceiling system is required to provide lateral support for the permanent or relocatable partitions, the connection of the partition to the ceiling system, the ceiling system members and their connections, and the lateral force bracing shall be designed to support the reaction force of the partition from prescribed loads applied perpendicular to the face of the partition. Partition connectors, the suspended ceiling system and the lateral-force bracing shall all be engineered to suit the individual partition application and shall be shown or defined in the drawings or specifications.

1616A.1.21 ASCE 7, Section 13.5.7. [OSHPD 1 & 4]
Modify ASCE 7, Section 13.5.7, by the following:

All access floors shall be special access floors in accordance with Section 13.5.7.2.

1616A.1.22 Reserved.

1616A.1.23 ASCE 7, Section 13.6.5. Modify ASCE 7, Section 13.6.5.6, Exceptions 1 and 2, as follows:

Exceptions:

1. Design for the seismic forces of Section 13.3 shall not be required for raceways where either:
 - a. Trapeze assemblies are used to support raceways and the total weight of the raceway supported by trapeze assemblies is less than 10 lb/ft (146 N/m), or
 - b. The raceway is supported by hangers and each hanger in the raceway run is 12 in. (305 mm) or less in length from the raceway support point to the supporting structure. Where rod hangers are used with a diameter greater than $\frac{3}{8}$ inch, they shall be equipped with swivels to prevent inelastic bending in the rod.
2. Design for the seismic forces of Section 13.3 shall not be required for conduit, regardless of the value of I_p , where the conduit is up to 2.5 in. (64 mm) trade size.

1616A.1.24 ASCE 7, Section 13.6.7. Replace ASCE 7, Section 13.6.7, Exceptions 1 and 2, with the following:

Exceptions:

The following exceptions pertain to ductwork not designed to carry toxic, highly toxic, or flammable gases or used for smoke control:

1. Design for the seismic forces of Section 13.3 shall not be required for ductwork where either:
 - a. Trapeze assemblies are used to support ductwork and the total weight of the ductwork supported by trapeze assemblies is less than 10 lb/ft (146 N/m); or

- b. The ductwork is supported by hangers and each hanger in the duct run is 12 in. (305 mm) or less in length from the duct support point to the supporting structure. Where rod hangers are used with a diameter greater than $\frac{3}{8}$ inch, they shall be equipped with swivels to prevent inelastic bending in the rod.
- 2. Design for the seismic forces of Section 13.3 shall not be required where provisions are made to avoid impact with larger ducts or mechanical components or to protect the ducts in the event of such impact; and HVAC ducts have a cross-sectional area of 6 ft² (0.557 m²) or less, or weigh 10 lb/ft (146 N/m) or less.

1616A.1.25 ASCE 7, Section 13.6.8.2. Modify ASCE 7, Section 13.6.8.2 by adding exception as follows:

Exception: Anchor capacities shall be determined in accordance with material chapters of this code in lieu of using those in NFPA 13 and demand shall be based on ASCE 7.

1616A.1.26 ASCE 7, Section 13.6.8.3. Replace ASCE 7, Section 13.6.8.3 with the following:

13.6.8.3 Exceptions. Design of piping systems and attachments for the seismic forces of Section 13.3 shall not be required where one of the following conditions apply:

- 1. Trapeze assemblies are used to support piping whereby no single pipe exceeds the limits set forth in 3a. or b. below and the total weight of the piping supported by the trapeze assemblies is less than 10 lb/ft (146 N/m).
- 2. The piping is supported by hangers and each hanger in the piping run is 12 in. (305 mm) or less in length from the top of the pipe to the supporting structure. Where pipes are supported on a trapeze, the trapeze shall be supported by hangers having a length of 12 in. (305 mm) or less. Where rod hangers are used with a diameter greater than $\frac{3}{8}$ inch, they shall be equipped with swivels, eye nuts or other devices to prevent bending in the rod.
- 3. Piping having an R_p in Table 13.6-1 of 4.5 or greater is used and provisions are made to avoid impact with other structural or nonstructural components or to protect the piping in the event of such impact and where the following size requirements are satisfied:
 - a. For Seismic Design Categories D, E or F and values of I_p greater than one, the nominal pipe size shall be 1 inch (25 mm) or less.
 - b. For Seismic Design Categories D, E or F, where $I_p = 1.0$ the nominal pipe size shall be 3 inches (80 mm) or less.

The exceptions above shall not apply to elevator piping.

1616A.1.27 ASCE 7, Section 13.6.10.1. Modify ASCE 7, Section 13.6.10.1, by adding Section 13.6.10.1.1 as follows:

13.6.10.1.1 Elevators guide rail support. The design of guide rail support-bracket fastenings and the supporting structural framing shall use the weight of the counterweight or maximum weight of the car plus not less than 40 percent of its rated load. The seismic forces shall be assumed to be distributed one third to the top guiding members and two thirds to the bottom guiding members of cars and counterweights, unless other substantiating data are provided. In addition to the requirements of ASCE 7, Section 13.6.10.1, the minimum seismic forces shall be 0.5g acting in any horizontal direction.

1616A.1.28 ASCE 7, Section 13.6.10.4. Replace ASCE 7, Section 13.6.10.4, as follows:

13.6.10.4 Retainer plates. Retainer plates are required at the top and bottom of the car and counterweight, except where safety devices acceptable to the enforcement agency are provided which meet all requirements of the retainer plates, including full engagement of the machined portion of the rail. The design of the car, cab stabilizers, counterweight guide rails and counterweight frames for seismic forces shall be based on the following requirements:

1. The seismic force shall be computed per the requirements of ASCE 7 Section 13.6.10.1. The minimum horizontal acceleration shall be 0.5g for all buildings.
2. W_p shall equal the weight of the counterweight or the maximum weight of the car plus not less than 40 percent of its rated load.
3. With the car or counterweight located in the most adverse position, the stress in the rail shall not exceed the limitations specified in these regulations, nor shall the deflection of the rail relative to its supports exceed the deflection listed below:

| RAIL SIZE (weight per foot of length, pounds) | WIDTH OF MACHINED SURFACE (inches) | ALLOWABLE RAIL DEFLECTION (inches) |
|---|--|--|
| 8 | 1 $\frac{1}{4}$ | 0.20 |
| 11 | 1 $\frac{1}{2}$ | 0.30 |
| 12 | 1 $\frac{3}{4}$ | 0.40 |
| 15 | 1 $\frac{31}{32}$ | 0.50 |
| 18 $\frac{1}{2}$ | 1 $\frac{31}{32}$ | 0.50 |
| 22 $\frac{1}{2}$ | 2 | 0.50 |
| 30 | 2 $\frac{1}{4}$ | 0.50 |

For SI: 1 inch = 25 mm, 1 foot = 305 mm, 1 pound = 0.454 kg.

Note: Deflection limitations are given to maintain a consistent factor of safety against disengagement of retainer plates from the guide rails during an earthquake.

4. Where guide rails are continuous over supports and rail joints are within 2 feet (610 mm) of their supporting brackets, a simple span may be assumed.
5. The use of spreader brackets is allowed.

6. Cab stabilizers and counterweight frames shall be designed to withstand computed lateral load with a minimum horizontal acceleration of 0.5g.

1616A.1.29 ASCE 7, Section 16.1.4. Remove ASCE 7, Sections 16.1.4.1 and 16.1.4.2, and modify Section 16.1.4, by the following:

Maximum scaled base shears used to determine forces and drifts shall not be less than the base shear calculated using the equivalent lateral force procedure of Section 12.8.

1616A.1.30 ASCE 7, Section 16.2.2. Modify ASCE 7, Section 16.2.2, by adding the following:

Requirements of this section shall be deemed to be satisfied for new buildings, using acceptance criteria, in Section 16.2.4.2, by the nonlinear modeling parameters in ASCE 41.

1616A.1.31 ASCE 7, Section 16.2.3. Modify ASCE 7, Section 16.2.3, by adding the following:

Requirements of this section shall be deemed to be satisfied by using load combinations in Sections 12.4.2.3 and 12.4.3.2 with 25 percent of the required live loads.

1616A.1.32 ASCE 7, Section 16.2.4. Modify ASCE 7, Section 16.2.4, by the following:

- a) Where site is located within 3.1 miles (5 km) of an active fault at least seven ground motions shall be analyzed and response parameters shall be based on larger of the average of the maximum response with ground motions applied as follows:

1. Each of the ground motions shall have their maximum component at the fundamental period aligned in one direction.
2. Each of the ground motion's maximum component shall be rotated orthogonal to the previous analysis direction.

- b) Where site is located more than 3.1 miles (5 km) from an active fault at least 10 ground motions shall be analyzed. The ground motions shall be applied such that one-half shall have their maximum component aligned in one direction and the other half aligned in the orthogonal direction. The average of the maximum response of all the analyses shall be used for design.

1616A.1.33 [OSHPD 1 & 4] ASCE 7, Section 16.2.4.1. Replace ASCE 7 exception to Section 16.2.3 by the following:

Where this standard requires the consideration of the load combinations with overstrength factor of Section 12.4.3.2, average demand from MCE analysis obtained from suite of analysis in accordance with Section 16.2.4 shall be used with Immediate Occupancy (IO) acceptance criteria in Section 16.2.4.2.

1616A.1.34 ASCE 7, Section 16.2.4.2 [OSHPD 1 & 4] Modify ASCE 7, Section 16.2.4.2, by the following:

Acceptance criteria for elements subjected to deformation beyond their linear range of response shall be based on ASCE 41 for Immediate Occupancy (IO) at Design Earthquake (DE) and Life Safety (LS) at Maximum Considered Earthquake (MCE). For LS acceptance criteria at MCE, primary components shall be within the acceptance criteria for primary components and secondary components shall be within the acceptance criteria for secondary components.

1616A.1.35 ASCE 7, Section 17.2.1. Modify ASCE 7, Section 17.2.1, by adding the following:

The importance factor, I_p , for parts and portions of a seismically isolated building shall be the same as that required for a fixed-base building of the same risk category.

1616A.1.36 ASCE 7, Section 17.2.4.7. Modify ASCE 7, Section 17.2.4.7, by adding the following:

The effects of uplift and/or rocking shall be explicitly accounted for in the analysis and in the testing of the isolator units.

1616A.1.37 ASCE 7, Section 17.2.5.2. Modify ASCE 7, Section 17.2.5.2, by adding the following:

The separation requirements for the building above the isolation system and adjacent buildings shall be the sum of the factored displacements for each building. The factors to be used in determining separations shall be:

1. For seismically isolated buildings, the deformation resulting from the analyses using the maximum considered earthquake unmodified by R_p .
2. For fixed based buildings, C_d times the elastic deformations resulting from an equivalent static analysis using the seismic base shear computed via ASCE 7, Section 12.8.

1616A.1.38 ASCE 7, Section 17.4. Modify ASCE 7, Section 17.4.2, by adding the following:

17.4.2.3 Linear procedures. Linear procedures shall be limited to structures located at sites with S_1 less than 0.6g.

1616A.1.39 ASCE 7, Section 17.6 Modify ASCE 7, Section 17.6, by the following:

17.6.1.1 Minimum seismic force. For the response spectrum and linear response history procedures, V_b and V_s shall not be taken less than those calculated in accordance with Equations 17.5-7 and 17.5-8.

1616A.1.40 ASCE 7, Section 18.3.1. Modify ASCE 7, Section 18.3.1, by replacing the third paragraph with the following:

If the calculated force in an element of the seismic force resisting system does not exceed 1.5 times its nominal strength for the Risk-Targeted Maximum Considered Earthquake (MCE_R) nor its nominal strength for the design earthquake (DE), the element is permitted to be modeled as linear. For this section, the MCE_R and DE response shall be based on largest response due to a sin-

gle ground motion and not the average response of suite of ground motions.

1616A.1.41 Earthquake motion measuring instrumentation and monitoring. [OSHPD 1 & 4] Modify ASCE 7 by the following:

Scope: For buildings with a seismic isolation system, a damping system or a lateral force resisting system (LFRS) not listed in ASCE 7 Table 12.2-1, earthquake motion measuring instrumentation and monitoring shall be required. Monitoring requirements shall also apply to welded steel moment frame buildings constructed under a permit issued prior to October 25, 1994.

Instrumentation: There shall be a sufficient number of instruments to characterize the response of the building during an earthquake and shall include at least one tri-axial free field instrument or equivalent. A proposal for instrumentation and equipment specifications shall be forwarded to the enforcement agency for review and approval. The owner of the building shall be responsible for the implementation of the instrumentation program. Maintenance of the instrumentation and removal/processing of the records shall be the responsibility of the enforcement agency.

The instruments shall be interconnected for common start and common timing. Each instrument shall be located so that access is maintained at all times and is unobstructed by room contents. A sign stating "MAINTAIN CLEAR ACCESS TO THIS INSTRUMENT" shall be posted in a conspicuous location.

Monitoring: After every significant seismic events, where the ground shaking acceleration at the site exceeds 0.3g, or the acceleration at any monitored building level exceeds 0.8g, as measured by the seismic monitoring system in the building, the owner shall retain a structural engineer to make an inspection of the structural system. The inspection shall include viewing the performance of the building, reviewing the strong motion records, and a visual examination of the isolators, dampers and connections for deterioration, offset or physical damage. A report for each inspection, including conclusions on the continuing adequacy of the structural system, shall be submitted to the enforcement agency.

1616A.1.42 Operational nonstructural performance level requirements. [OSHPD 1 & 4] New general acute care hospitals and new building(s) required for general acute care services shall satisfy Operational Nonstructural Performance Level (NPC-5) requirements.

Exception: A new building which is required for general acute care services that is added to an existing general acute care hospital and which has a building area of 4,000 square feet (371 m^2) or less, need not satisfy the NPC-5 requirements until the deadline specified in California Administrative Code (Part 1, Title 24 CCR), Chapter 6.

Hospitals and buildings designed and constructed to the provisions of this code for new construction shall be

deemed to satisfy Operational Nonstructural Performance Level (NPC-5) requirements when:

1. The facility has on-site supplies of water and holding tanks for sewage and liquid waste, sufficient to support 72 hours of emergency operations for the hospital or building, which are integrated into the building plumbing systems in accordance with the California Plumbing Code.
2. An on-site emergency system as defined in the California Electrical Code is incorporated into the building electrical system for critical care areas. Additionally, the system shall provide for radiological service and an onsite fuel supply for 72 hours of acute care operation.

Emergency and standby generators shall not be located below the higher of the Design Flood Elevation (DFE) or Base Flood Elevation (BFE) plus two feet ($BFE + 2\text{ ft.}$) and shall be located at an elevation close to grade for easy accessibility from outside for maintenance.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 17 – STRUCTURAL TESTS AND SPECIAL INSPECTIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.

See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | X | | X | X | | | | | | | X | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 1702 - Approved agency | | | X | X | | | | | | | | | | | | | | | | |
| 1704.2 | | | X | X | | | | | | | X | | | | | | | | | |
| 1704.2.3 | X | | | | | | | | | | | | | | | | | | | |
| 1705.5.3 | | | | | | | | | | | X | | | | | | | | | |
| 1707.1 | X | | X | X | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

CHAPTER 17

STRUCTURAL TESTS AND SPECIAL INSPECTIONS

SECTION 1701 GENERAL

1701.1 Scope. The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Materials of construction and tests shall conform to the applicable standards listed in this code.

1701.2 New materials. New building materials, equipment, appliances, systems or methods of construction not provided for in this code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this chapter and in the approved rules to determine character, quality and limitations of use.

1701.3 Used materials. The use of second-hand materials that meet the minimum requirements of this code for new materials shall be permitted.

SECTION 1702 DEFINITIONS

1702.1 Definitions. The following terms are defined in Chapter 2:

> APPROVED AGENCY.

APPROVED FABRICATOR.

CERTIFICATE OF COMPLIANCE.

DESIGNATED SEISMIC SYSTEM.

FABRICATED ITEM.

INSPECTION CERTIFICATE.

INTUMESCENT FIRE-RESISTANT COATINGS.

MAIN WINDFORCE-RESISTING SYSTEM.

MASTIC FIRE-RESISTANT COATINGS.

SPECIAL INSPECTION.

Continuous special inspection.

Periodic special inspection.

SPECIAL INSPECTOR.

SPRAYED FIRE-RESISTANT MATERIALS.

STRUCTURAL OBSERVATION.

SECTION 1703 APPROVALS

1703.1 Approved agency. An approved agency shall provide all information as necessary for the building official to determine that the agency meets the applicable requirements.

1703.1.1 Independence. An approved agency shall be objective, competent and independent from the contractor

responsible for the work being inspected. The agency shall also disclose possible conflicts of interest so that objectivity can be confirmed.

1703.1.2 Equipment. An approved agency shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.

1703.1.3 Personnel. An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and/or inspections.

1703.2 Written approval. Any material, appliance, equipment, system or method of construction meeting the requirements of this code shall be approved in writing after satisfactory completion of the required tests and submission of required test reports.

1703.3 Approved record. For any material, appliance, equipment, system or method of construction that has been approved, a record of such approval, including the conditions and limitations of the approval, shall be kept on file in the building official's office and shall be open to public inspection at appropriate times.

1703.4 Performance. Specific information consisting of test reports conducted by an approved testing agency in accordance with the appropriate referenced standards, or other such information as necessary, shall be provided for the building official to determine that the material meets the applicable code requirements.

1703.4.1 Research and investigation. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any material or assembly. If it is determined that the evidence submitted is satisfactory proof of performance for the use intended, the building official shall approve the use of the material or assembly subject to the requirements of this code. The costs, reports and investigations required under these provisions shall be paid by the applicant.

1703.4.2 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

1703.5 Labeling. Where materials or assemblies are required by this code to be labeled, such materials and assemblies shall be labeled by an approved agency in accordance with Section 1703. Products and materials required to be labeled shall be labeled in accordance with the procedures set forth in Sections 1703.5.1 through 1703.5.4.

1703.5.1 Testing. An approved agency shall test a representative sample of the product or material being labeled to the relevant standard or standards. The approved agency shall maintain a record of the tests performed. The record

shall provide sufficient detail to verify compliance with the test standard.

1703.5.2 Inspection and identification. The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the product or material that is to be labeled. The inspection shall verify that the labeled product or material is representative of the product or material tested.

1703.5.3 Label information. The label shall contain the manufacturer's or distributor's identification, model number, serial number or definitive information describing the product or material's performance characteristics and approved agency's identification.

1703.5.4 Method of labeling. Information required to be permanently identified on the product shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

1703.6 Evaluation and follow-up inspection services. Where structural components or other items regulated by this code are not visible for inspection after completion of a prefabricated assembly, the applicant shall submit a report of each prefabricated assembly. The report shall indicate the complete details of the assembly, including a description of the assembly and its components, the basis upon which the assembly is being evaluated, test results and similar information and other data as necessary for the building official to determine conformance to this code. Such a report shall be approved by the building official.

1703.6.1 Follow-up inspection. The applicant shall provide for special inspections of fabricated items in accordance with Section 1704.2.5.

1703.6.2 Test and inspection records. Copies of necessary test and inspection records shall be filed with the building official.

SECTION 1704 SPECIAL INSPECTIONS, CONTRACTOR RESPONSIBILITY AND STRUCTURAL OBSERVATIONS

1704.1 General. This section provides minimum requirements for special inspections, the statement of special inspections, contractor responsibility and structural observations.

1704.2 Special inspections. Where application is made for construction as described in this section, the owner or the registered design professional in responsible charge acting as the owner's agent shall employ one or more approved agencies to perform inspections during construction on the types of work listed under Section 1705. These inspections are in addition to the inspections identified in Section 110.

Exceptions:

1. Special inspections are not required for construction of a minor nature or as warranted by conditions in the jurisdiction as approved by the building official.

2. Unless otherwise required by the building official, special inspections are not required for Group U occupancies that are accessory to a residential occupancy including, but not limited to, those listed in Section 312.1.

3. Special inspections are not required for portions of structures designed and constructed in accordance with the cold-formed steel light-frame construction provisions of Section 2211.7 or the conventional light-frame construction provisions of Section 2308. *[OSHPD 2] Not permitted by OSHPD.*

4. *[HCD 1] The provisions of Health and Safety Code Division 13, Part 6 and the California Code of Regulations, Title 25, Division 1, Chapter 3, commencing with Section 3000, shall apply to the construction and inspection of factory-built housing as defined in Health and Safety Code Section 19971.*

1704.2.1 Special inspector qualifications. The special inspector shall provide written documentation to the building official demonstrating his or her competence and relevant experience or training. Experience or training shall be considered relevant when the documented experience or training is related in complexity to the same type of special inspection activities for projects of similar complexity and material qualities. These qualifications are in addition to qualifications specified in other sections of this code.

The registered design professional in responsible charge and engineers of record involved in the design of the project are permitted to act as the approved agency and their personnel are permitted to act as the special inspector for the work designed by them, provided they qualify as special inspectors.

1704.2.2 Access for special inspection. The construction or work for which special inspection is required shall remain accessible and exposed for special inspection purposes until completion of the required special inspections.

1704.2.3 Statement of special inspections. The applicant shall submit a statement of special inspections in accordance with Section 107.1 *Chapter 1, Division II*, as a condition for permit issuance. This statement shall be in accordance with Section 1704.3.

Exception: A statement of special inspections is not required for portions of structures designed and constructed in accordance with the cold-formed steel light-frame construction provisions of Section 2211.7 or the conventional light-frame construction provisions of Section 2308.

1704.2.4 Report requirement. Special inspectors shall keep records of inspections. The special inspector shall furnish inspection reports to the building official, and to the registered design professional in responsible charge. Reports shall indicate that work inspected was or was not completed in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the contractor for correction. If they are not corrected, the discrepancies shall be brought to the attention of the building official and to the registered design

professional in responsible charge prior to the completion of that phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon prior to the start of work by the applicant and the building official.

1704.2.5 Inspection of fabricators. Where fabrication of structural load-bearing members and assemblies is being performed on the premises of a fabricator's shop, special inspection of the fabricated items shall be required by this section and as required elsewhere in this code.

1704.2.5.1 Fabrication and implementation procedures. The special inspector shall verify that the fabricator maintains detailed fabrication and quality control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards. The special inspector shall review the procedures for completeness and adequacy relative to the code requirements for the fabricator's scope of work.

Exception: Special inspections as required by Section 1704.2.5 shall not be required where the fabricator is approved in accordance with Section 1704.2.5.2.

1704.2.5.2 Fabricator approval. Special inspections required by Section 1705 are not required where the work is done on the premises of a fabricator registered and approved to perform such work without special inspection. Approval shall be based upon review of the fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved special inspection agency. At completion of fabrication, the approved fabricator shall submit a certificate of compliance to the building official stating that the work was performed in accordance with the approved construction documents.

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1704.3 Statement of special inspections. Where special inspection or testing is required by Section 1705, the registered design professional in responsible charge shall prepare a statement of special inspections in accordance with Section 1704.3.1 for submittal by the applicant in accordance with Section 1704.2.3.

Exception: The statement of special inspections is permitted to be prepared by a qualified person approved by the building official for construction not designed by a registered design professional.

1704.3.1 Content of statement of special inspections. The statement of special inspections shall identify the following:

1. The materials, systems, components and work required to have special inspection or testing by the building official or by the registered design professional responsible for each portion of the work.
2. The type and extent of each special inspection.
3. The type and extent of each test.

4. Additional requirements for special inspection or testing for seismic or wind resistance as specified in Sections 1705.10, 1705.11 and 1705.12.

5. For each type of special inspection, identification as to whether it will be continuous special inspection or periodic special inspection.

1704.3.2 Seismic requirements in the statement of special inspections. Where Section 1705.11 or 1705.12 specifies special inspection, testing or qualification for seismic resistance, the statement of special inspections shall identify the designated seismic systems and seismic force-resisting systems that are subject to special inspections.

1704.3.3 Wind requirements in the statement of special inspections. Where Section 1705.10 specifies special inspection for wind requirements, the statement of special inspections shall identify the main windforce-resisting systems and wind-resisting components subject to special inspection.

1704.4 Contractor responsibility. Each contractor responsible for the construction of a main wind- or seismic force-resisting system, designated seismic system or a wind- or seismic-resisting component listed in the statement of special inspections shall submit a written statement of responsibility to the building official and the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain acknowledgement of awareness of the special requirements contained in the statement of special inspection.

1704.5 Structural observations. Where required by the provisions of Section 1704.5.1 or 1704.5.2, the owner shall employ a registered design professional to perform structural observations as defined in Section 1702.

Prior to the commencement of observations, the structural observer shall submit to the building official a written statement identifying the frequency and extent of structural observations.

At the conclusion of the work included in the permit, the structural observer shall submit to the building official a written statement that the site visits have been made and identify any reported deficiencies which, to the best of the structural observer's knowledge, have not been resolved.

1704.5.1 Structural observations for seismic resistance. Structural observations shall be provided for those structures assigned to Seismic Design Category D, E or F where one or more of the following conditions exist:

1. The structure is classified as Risk Category III or IV in accordance with Table 1604.5.
2. The height of the structure is greater than 75 feet (22 860 mm) above the base.
3. The structure is assigned to Seismic Design Category E, is classified as Risk Category I or II in accordance with Table 1604.5, and is greater than two stories above grade plane.
4. When so designated by the registered design professional responsible for the structural design.

5. When such observation is specifically required by the building official.

1704.5.2 Structural observations for wind requirements. Structural observations shall be provided for those structures sited where V_{asd} as determined in accordance with Section 1609.3.1 exceeds 110 mph (49 m/sec), where one or more of the following conditions exist:

1. The structure is classified as Risk Category III or IV in accordance with Table 1604.5.
2. The building height of the structure is greater than 75 feet (22 860 mm).
3. When so designated by the registered design professional responsible for the structural design.
4. When such observation is specifically required by the building official.

SECTION 1705 REQUIRED VERIFICATION AND INSPECTION

1705.1 General. Verification and inspection of elements of buildings and structures shall be as required by this section.

1705.1.1 Special cases. Special inspections shall be required for proposed work that is, in the opinion of the building official, unusual in its nature, such as, but not limited to, the following examples:

1. Construction materials and systems that are alternatives to materials and systems prescribed by this code.
2. Unusual design applications of materials described in this code.
3. Materials and systems required to be installed in accordance with additional manufacturer's instructions that prescribe requirements not contained in this code or in standards referenced by this code.

1705.2 Steel construction. The special inspections for steel elements of buildings and structures shall be as required in this section.

Exception: Special inspection of the steel fabrication process shall not be required where the fabricator does not perform any welding, thermal cutting or heating operation of any kind as part of the fabrication process. In such cases, the fabricator shall be required to submit a detailed procedure for material control that demonstrates the fabricator's ability to maintain suitable records and procedures such that, at any time during the fabrication process, the material specification, and grade for the main stress-carrying elements are capable of being determined. Mill test reports shall be identifiable to the main stress-carrying elements when required by the approved construction documents.

**TABLE 1705.2.2
REQUIRED VERIFICATION AND INSPECTION OF STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL**

| VERIFICATION AND INSPECTION | CONTINUOUS | PERIODIC | REFERENCED STANDARD ^a |
|--|------------|----------|---------------------------------------|
| 1. Material verification of cold-formed steel deck: | | | |
| a. Identification markings to conform to ASTM standards specified in the approved construction documents. | — | X | Applicable ASTM material standards |
| b. Manufacturer's certified test reports. | — | X | |
| 2. Inspection of welding: | | | |
| a. Cold-formed steel deck: | | | |
| 1) Floor and roof deck welds. | — | X | AWS D1.3 |
| b. Reinforcing steel: | | | |
| 1) Verification of weldability of reinforcing steel other than ASTM A 706. | — | X | |
| 2) Reinforcing steel resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement. | X | — | AWS D1.4 ACI 318: Section 3.5.2 |
| 3) Shear reinforcement. | X | — | |
| 4) Other reinforcing steel. | — | X | |

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705.11, Special inspections for seismic resistance.

1705.2.1 Structural steel. Special inspection for structural steel shall be in accordance with the quality assurance inspection requirements of AISC 360.

1705.2.2 Steel construction other than structural steel. Special inspection for steel construction other than structural steel shall be in accordance with Table 1705.2.2 and this section.

1705.2.2.1 Welding. Welding inspection and welding inspector qualification shall be in accordance with this section.

1705.2.2.1.1 Cold-formed steel. Welding inspection and welding inspector qualification for cold-

formed steel floor and roof decks shall be in accordance with AWS D1.3.

1705.2.2.1.2 Reinforcing steel. Welding inspection and welding inspector qualification for reinforcing steel shall be in accordance with AWS D1.4 and ACI 318.

1705.2.2.2 Cold-formed steel trusses spanning 60 feet or greater. Where a cold-formed steel truss clear span is 60 feet (1828 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

TABLE 1705.3
REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION

| VERIFICATION AND INSPECTION | CONTINUOUS | PERIODIC | REFERENCED STANDARD ^a | IBC REFERENCE |
|---|------------|----------|--|------------------------|
| 1. Inspection of reinforcing steel, including prestressing tendons, and placement. | — | X | ACI 318: 3.5, 7.1-7.7 | 1910.4 |
| 2. Inspection of reinforcing steel welding in accordance with Table 1705.2.2, Item 2b. | — | — | AWS D1.4 ACI 318: 3.5.2 | — |
| 3. Inspection of anchors cast in concrete where allowable loads have been increased or where strength design is used. | — | X | ACI 318: 8.1.3, 21.2.8 | 1908.5, 1909.1 |
| 4. Inspection of anchors post-installed in hardened concrete members ^b . | — | X | ACI 318: 3.8.6, 8.1.3, 21.2.8 | 1909.1 |
| 5. Verifying use of required design mix. | — | X | ACI 318: Ch. 4, 5.2-5.4 | 1904.2, 1910.2, 1910.3 |
| 6. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete. | X | — | ASTM C 172 ASTM C 31 ACI 318: 5.6, 5.8 | 1910.10 |
| 7. Inspection of concrete and shotcrete placement for proper application techniques. | X | — | ACI 318: 5.9, 5.10 | 1910.6, 1910.7, 1910.8 |
| 8. Inspection for maintenance of specified curing temperature and techniques. | — | X | ACI 318: 5.11-5.13 | 1910.9 |
| 9. Inspection of prestressed concrete: | X | — | ACI 318: 18.20 | — |
| a. Application of prestressing forces. | X | — | ACI 318: 18.18.4 | — |
| b. Grouting of bonded prestressing tendons in the seismic force-resisting system. | — | — | | |
| 10. Erection of precast concrete members. | — | X | ACI 318: Ch. 16 | — |
| 11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs. | — | X | ACI 318: 6.2 | — |
| 12. Inspect formwork for shape, location and dimensions of the concrete member being formed. | — | X | ACI 318: 6.1.1 | — |

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705.11, Special inspections for seismic resistance.

b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with ACI 355.2 or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

1705.3 Concrete construction. The special inspections and verifications for concrete construction shall be as required by this section and Table 1705.3.

Exception: Special inspections shall not be required for:

1. Isolated spread concrete footings of buildings three stories or less above grade plane that are fully supported on earth or rock.
2. Continuous concrete footings supporting walls of buildings three stories or less above grade plane that are fully supported on earth or rock where:
 - 2.1. The footings support walls of light-frame construction;
 - 2.2. The footings are designed in accordance with Table 1809.7; or
 - 2.3. The structural design of the footing is based on a specified compressive strength, f'_c , no greater than 2,500 pounds per square inch (psi) (17.2 MPa), regardless of the compressive strength specified in the construction documents or used in the footing construction.
3. Nonstructural concrete slabs supported directly on the ground, including prestressed slabs on grade, where the effective prestress in the concrete is less than 150 psi (1.03 MPa).
4. Concrete foundation walls constructed in accordance with Table 1807.1.6.2.
5. Concrete patios, driveways and sidewalks, on grade.

1705.3.1 Materials. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapter 3 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapter 3 of ACI 318. Weldability of reinforcement, except that which conforms to ASTM A 706, shall be determined in accordance with the requirements of Section 3.5.2 of ACI 318.

1705.4 Masonry construction. Masonry construction shall be inspected and verified in accordance with TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6 quality assurance program requirements.

Exception: Special inspections shall not be required for:

1. Empirically designed masonry, glass unit masonry or masonry veneer designed by Section 2109, 2110 or Chapter 14, respectively, where they are part of structures classified as Risk Category I, II or III in accordance with Section 1604.5.
2. Masonry foundation walls constructed in accordance with Table 1807.1.6.3(1), 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4).
3. Masonry fireplaces, masonry heaters or masonry chimneys installed or constructed in accordance with Section 2111, 2112 or 2113, respectively.

1705.4.1 Empirically designed masonry, glass unit masonry and masonry veneer in Risk Category IV. The minimum special inspection program for empirically

designed masonry, glass unit masonry or masonry veneer designed by Section 2109, 2110 or Chapter 14, respectively, in structures classified as Risk Category IV, in accordance with Section 1604.5, shall comply with TMS 402/ACI 530/ASCE 5 Level B Quality Assurance.

1705.4.2 Vertical masonry foundation elements. Special inspection shall be performed in accordance with Section 1705.4 for vertical masonry foundation elements.

1705.5 Wood construction. Special inspections of the fabrication process of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704.2.5. Special inspections of site-built assemblies shall be in accordance with this section.

1705.5.1 High-load diaphragms. High-load diaphragms designed in accordance with Section 2306.2 shall be installed with special inspections as indicated in Section 1704.2. The special inspector shall inspect the wood structural panel sheathing to ascertain whether it is of the grade and thickness shown on the approved building plans. Additionally, the special inspector must verify the nominal size of framing members at adjoining panel edges, the nail or staple diameter and length, the number of fastener lines and that the spacing between fasteners in each line and at edge margins agrees with the approved building plans.

1705.5.2 Metal-plate-connected wood trusses spanning 60 feet or greater. Where a truss clear span is 60 feet (1828 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

1705.5.3 [OSHPD 2] Manufactured trusses and assemblies. The fabrication of trusses and other assemblages constructed using wood and metal members, or using light metal plate connectors, shall be continuously inspected by a qualified inspector approved by the enforcement agency. The inspector shall furnish the architect, structural engineer and the enforcement agency with a report that the lumber species, grades and moisture content; type of glue, temperature and gluing procedure; type of metal members and metal plate connectors; and the workmanship conform in every material respect with the duly approved plans and specifications. Each inspected truss shall be stamped by the inspector with an identifying mark.

1705.6 Soils. Special inspections for existing site soil conditions, fill placement and load-bearing requirements shall be as required by this section and Table 1705.6. The approved geotechnical report, and the construction documents prepared by the registered design professionals shall be used to determine compliance. During fill placement, the special inspector shall determine that proper materials and procedures are used in accordance with the provisions of the approved geotechnical report.

Exception: Where Section 1803 does not require reporting of materials and procedures for fill placement, the special inspector shall verify that the in-place dry density of the compacted fill is not less than 90 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D 1557.

1705.7 Driven deep foundations. Special inspections shall be performed during installation and testing of driven deep foundation elements as required by Table 1705.7. The approved instruction documents prepared by the registered design professionals, shall be used to determine compliance.

1705.8 Cast-in-place deep foundations. Special inspections shall be performed during installation and testing of cast-in-place deep foundation elements as required by Table 1705.8. The approved geotechnical report, and the construction documents prepared by the registered design professionals, shall be used to determine compliance.

1705.9 Helical pile foundations. Special inspections shall be performed continuously during installation of helical pile foundations. The information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation

data as required by the registered design professional in responsible charge. The approved geotechnical report and the construction documents prepared by the registered design professional shall be used to determine compliance.

1705.10 Special inspections for wind resistance. Special inspections itemized in Sections 1705.10.1 through 1705.10.3, unless exempted by the exceptions to Section 1704.2, are required for buildings and structures constructed in the following areas:

1. In wind Exposure Category B, where V_{asd} as determined in accordance with Section 1609.3.1 is 120 miles per hour (52.8 m/sec) or greater.
2. In wind Exposure Category C or D, where V_{asd} as determined in accordance with Section 1609.3.1 is 110 mph (49 m/sec) or greater.

**TABLE 1705.6
REQUIRED VERIFICATION AND INSPECTION OF SOILS**

| VERIFICATION AND INSPECTION TASK | CONTINUOUS DURING TASK LISTED | PERIODICALLY DURING TASK LISTED |
|--|-------------------------------|---------------------------------|
| 1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity. | — | X |
| 2. Verify excavations are extended to proper depth and have reached proper material. | — | X |
| 3. Perform classification and testing of compacted fill materials. | — | X |
| 4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill. | X | — |
| 5. Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly. | — | X |

**TABLE 1705.7
REQUIRED VERIFICATION AND INSPECTION OF DRIVEN DEEP FOUNDATION ELEMENTS**

| VERIFICATION AND INSPECTION TASK | CONTINUOUS DURING TASK LISTED | PERIODICALLY DURING TASK LISTED |
|---|-------------------------------|---------------------------------|
| 1. Verify element materials, sizes and lengths comply with the requirements. | X | — |
| 2. Determine capacities of test elements and conduct additional load tests, as required. | X | — |
| 3. Observe driving operations and maintain complete and accurate records for each element. | X | — |
| 4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element. | X | — |
| 5. For steel elements, perform additional inspections in accordance with Section 1705.2. | — | — |
| 6. For concrete elements and concrete-filled elements, perform additional inspections in accordance with Section 1705.3. | — | — |
| 7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge. | — | — |

**TABLE 1705.8
REQUIRED VERIFICATION AND INSPECTION OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS**

| VERIFICATION AND INSPECTION TASK | CONTINUOUS DURING TASK LISTED | PERIODICALLY DURING TASK LISTED |
|---|-------------------------------|---------------------------------|
| 1. Observe drilling operations and maintain complete and accurate records for each element. | X | — |
| 2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes. | X | — |
| 3. For concrete elements, perform additional inspections in accordance with Section 1705.3. | — | — |

1705.10.1 Structural wood. Continuous special inspection is required during field gluing operations of elements of the main windforce-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of components within the main windforce-resisting system, including wood shear walls, wood diaphragms, drag struts, braces and hold-downs.

Exception: Special inspection is not required for wood shear walls, shear panels and diaphragms, including nailing, bolting, anchoring and other fastening to other components of the main windforce-resisting system, where the fastener spacing of the sheathing is more than 4 inches (102 mm) on center.

1705.10.2 Cold-formed steel light-frame construction. Periodic special inspection is required during welding operations of elements of the main windforce-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of components within the main windforce-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

Exception: Special inspection is not required for cold-formed steel light-frame shear walls, braces, diaphragms, collectors (drag struts) and hold-downs where either of the following apply:

1. The sheathing is gypsum board or fiberboard.
2. The sheathing is wood structural panel or steel sheets on only one side of the shear wall, shear panel or diaphragm assembly and the fastener spacing of the sheathing is more than 4 inches (102 mm) on center (o.c.).

1705.10.3 Wind-resisting components. Periodic special inspection is required for the following systems and components:

1. Roof cladding.
2. Wall cladding.

1705.11 Special inspections for seismic resistance. Special inspections itemized in Sections 1705.11.1 through 1705.11.8, unless exempted by the exceptions of Section 1704.2, are required for the following:

1. The seismic force-resisting systems in structures assigned to Seismic Design Category C, D, E or F in accordance with Sections 1705.11.1 through 1705.11.3, as applicable.

2. Designated seismic systems in structures assigned to Seismic Design Category C, D, E or F in accordance with Section 1705.11.4.

3. Architectural, mechanical and electrical components in accordance with Sections 1705.11.5 and 1705.11.6.

4. Storage racks in structures assigned to Seismic Design Category D, E or F in accordance with Section 1705.11.7.

5. Seismic isolation systems in accordance with Section 1705.11.8.

Exception: Special inspections itemized in Sections 1705.11.1 through 1705.11.8 are not required for structures designed and constructed in accordance with one of the following:

1. The structure consists of light-frame construction; the design spectral response acceleration at short periods, S_{DS} , as determined in Section 1613.3.4, does not exceed 0.5; and the building height of the structure does not exceed 35 feet (10 668 mm).
2. The seismic force-resisting system of the structure consists of reinforced masonry or reinforced concrete; the design spectral response acceleration at short periods, S_{DS} , as determined in Section 1613.3.4, does not exceed 0.5; and the building height of the structure does not exceed 25 feet (7620 mm).
3. The structure is a detached one- or two-family dwelling not exceeding two stories above grade plane and does not have any of the following horizontal or vertical irregularities in accordance with Section 12.3 of ASCE 7:
 - 3.1. Torsional or extreme torsional irregularity.
 - 3.2. Nonparallel systems irregularity.
 - 3.3. Stiffness-soft story or stiffness-extreme soft story irregularity.
 - 3.4. Discontinuity in lateral strength-weak story irregularity.

1705.11.1 Structural steel. Special inspection for structural steel shall be in accordance with the quality assurance requirements of AISC 341.

Exception: Special inspections of structural steel in structures assigned to Seismic Design Category C that are not specifically detailed for seismic resistance, with a response modification coefficient, R , of 3 or less, excluding cantilever column systems.

1705.11.2 Structural wood. Continuous special inspection is required during field gluing operations of elements of the seismic force-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of components within the seismic force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.

Exception: Special inspection is not required for wood shear walls, shear panels and diaphragms, including nailing, bolting, anchoring and other fastening to other components of the seismic force-resisting system, where the fastener spacing of the sheathing is more than 4 inches (102 mm) on center (o.c.).

1705.11.3 Cold-formed steel light-frame construction. Periodic special inspection is required during welding operations of elements of the seismic force-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of components within the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

Exception: Special inspection is not required for cold-formed steel light-frame shear walls, braces, diaphragms, collectors (drag struts) and hold-downs where either of the following apply:

1. The sheathing is gypsum board or fiberboard.
2. The sheathing is wood structural panel or steel sheets on only one side of the shear wall, shear panel or diaphragm assembly and the fastener spacing of the sheathing is more than 4 inches (102 mm) o.c.

1705.11.4 Designated seismic systems. The special inspector shall examine designated seismic systems requiring seismic qualification in accordance with Section 1705.12.3 and verify that the label, anchorage or mounting conforms to the certificate of compliance.

1705.11.5 Architectural components. Periodic special inspection is required during the erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to Seismic Design Category D, E or F.

Exceptions:

1. Special inspection is not required for exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer 30 feet (9144 mm) or less in height above grade or walking surface.

2. Special inspection is not required for exterior cladding and interior and exterior veneer weighing 5 psf (24.5 N/m^2) or less.

3. Special inspection is not required for interior nonbearing walls weighing 15 psf (73.5 N/m^2) or less.

1705.11.5.1 Access floors. Periodic special inspection is required for the anchorage of access floors in structures assigned to Seismic Design Category D, E or F.

1705.11.6 Mechanical and electrical components. Special inspection for mechanical and electrical components shall be as follows:

1. Periodic special inspection is required during the anchorage of electrical equipment for emergency or standby power systems in structures assigned to Seismic Design Category C, D, E or F;
2. Periodic special inspection is required during the anchorage of other electrical equipment in structures assigned to Seismic Design Category E or F;
3. Periodic special inspection is required during the installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to Seismic Design Category C, D, E or F;
4. Periodic special inspection is required during the installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to Seismic Design Category C, D, E or F; and
5. Periodic special inspection is required during the installation and anchorage of vibration isolation systems in structures assigned to Seismic Design Category C, D, E or F where the construction documents require a nominal clearance of $\frac{1}{4}$ inch (6.4 mm) or less between the equipment support frame and restraint.

1705.11.7 Storage racks. Periodic special inspection is required during the anchorage of storage racks 8 feet (2438 mm) or greater in height in structures assigned to Seismic Design Category D, E or F.

1705.11.8 Seismic isolation systems. Periodic special inspection shall be provided for seismic isolation systems during the fabrication and installation of isolator units and energy dissipation devices.

1705.12 Testing and qualification for seismic resistance. The testing and qualification specified in Sections 1705.12.1 through 1705.12.4, unless exempted from special inspections by the exceptions of Section 1704.2 are required as follows:

1. The seismic force-resisting systems in structures assigned to Seismic Design Category C, D, E or F shall meet the requirements of Sections 1705.12.1 and 1705.12.2, as applicable.
2. Designated seismic systems in structures assigned to Seismic Design Category C, D, E or F and subject to the certification requirements of ASCE 7 Section 13.2.2 shall comply with Section 1705.12.3.

3. Architectural, mechanical and electrical components in structures assigned to Seismic Design Category C, D, E or F and where the requirements of ASCE 7 Section 13.2.1 are met by submittal of manufacturer's certification, in accordance with Item 2 therein, shall comply with Section 1705.12.3.
4. The seismic isolation system in seismically isolated structures shall meet the testing requirements of Section 1705.12.4.

1705.12.1 Concrete reinforcement. Where reinforcement complying with ASTM A 615 is used to resist earthquake-induced flexural and axial forces in special moment frames, special structural walls and coupling beams connecting special structural walls, in structures assigned to Seismic Design Category B, C, D, E or F, the reinforcement shall comply with Section 21.1.5.2 of ACI 318. Certified mill test reports shall be provided for each shipment of such reinforcement. Where reinforcement complying with ASTM A 615 is to be welded, chemical tests shall be performed to determine weldability in accordance with Section 3.5.2 of ACI 318.

1705.12.2 Structural steel. Testing for structural steel shall be in accordance with the quality assurance requirements of AISC 341.

Exception: Testing for structural steel in structures assigned to Seismic Design Category C that are not specifically detailed for seismic resistance, with a response modification coefficient, R , of 3 or less, excluding cantilever column systems.

1705.12.3 Seismic certification of nonstructural components. The registered design professional shall specify on the construction documents the requirements for certification by analysis, testing or experience data for nonstructural components and designated seismic systems in accordance with Section 13.2 of ASCE 7, where such certification is required by Section 1705.12.

1705.12.4 Seismic isolation systems. Seismic isolation systems shall be tested in accordance with Section 17.8 of ASCE 7.

1705.13 Sprayed fire-resistant materials. Special inspections for sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be in accordance with Sections 1705.13.1 through 1705.13.6. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents. The tests set forth in this section shall be based on samplings from specific floor, roof and wall assemblies and structural members. Special inspections shall be performed after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, where applicable.

1705.13.1 Physical and visual tests. The special inspections shall include the following tests and observations to demonstrate compliance with the listing and the fire-resistance rating:

1. Condition of substrates.
2. Thickness of application.

3. Density in pounds per cubic foot (kg/m^3).
4. Bond strength adhesion/cohesion.
5. Condition of finished application.

1705.13.2 Structural member surface conditions. The surfaces shall be prepared in accordance with the approved fire-resistance design and the written instructions of approved manufacturers. The prepared surface of structural members to be sprayed shall be inspected before the application of the sprayed fire-resistant material.

1705.13.3 Application. The substrate shall have a minimum ambient temperature before and after application as specified in the written instructions of approved manufacturers. The area for application shall be ventilated during and after application as required by the written instructions of approved manufacturers.

1705.13.4 Thickness. No more than 10 percent of the thickness measurements of the sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be less than the thickness required by the approved fire-resistance design, but in no case less than the minimum allowable thickness required by Section 1705.13.4.1.

1705.13.4.1 Minimum allowable thickness. For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus $\frac{1}{4}$ inch (6.4 mm). For design thicknesses less than 1 inch (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent. Thickness shall be determined in accordance with ASTM E 605. Samples of the sprayed fire-resistant materials shall be selected in accordance with Sections 1705.13.4.2 and 1705.13.4.3.

1705.13.4.2 Floor, roof and wall assemblies. The thickness of the sprayed fire-resistant material applied to floor, roof and wall assemblies shall be determined in accordance with ASTM E 605, making not less than four measurements for each 1,000 square feet (93 m^2) of the sprayed area, or portion thereof, in each story.

1705.13.4.3 Cellular decks. Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. A minimum of four measurements shall be made, located symmetrically within the square area.

1705.13.4.4 Fluted decks. Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. A minimum of four measurements shall be made, located symmetrically within the square area, including one each of the following: valley, crest and sides. The average of the measurements shall be reported.

1705.13.4.5 Structural members. The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E 605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

1705.13.4.6 Beams and girders. At beams and girders thickness measurements shall be made at nine locations around the beam or girder at each end of a 12-inch (305 mm) length.

1705.13.4.7 Joists and trusses. At joists and trusses, thickness measurements shall be made at seven locations around the joist or truss at each end of a 12-inch (305 mm) length.

1705.13.4.8 Wide-flanged columns. At wide-flanged columns, thickness measurements shall be made at 12 locations around the column at each end of a 12-inch (305 mm) length.

1705.13.4.9 Hollow structural section and pipe columns. At hollow structural section and pipe columns, thickness measurements shall be made at a minimum of four locations around the column at each end of a 12-inch (305 mm) length.

1705.13.5 Density. The density of the sprayed fire-resistant material shall not be less than the density specified in the approved fire-resistance design. Density of the sprayed fire-resistant material shall be determined in accordance with ASTM E 605. The test samples for determining the density of the sprayed fire-resistant materials shall be selected as follows:

1. From each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m^2) or portion thereof of the sprayed area in each story.
2. From beams, girders, trusses and columns at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m^2) of floor area or portion thereof in each story.

1705.13.6 Bond strength. The cohesive/adhesive bond strength of the cured sprayed fire-resistant material applied to floor, roof and wall assemblies and structural members shall not be less than 150 pounds per square foot (psf) (7.18 kN/m^2). The cohesive/adhesive bond strength shall be determined in accordance with the field test specified in ASTM E 736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1705.13.6.1 through 1705.13.6.3.

1705.13.6.1 Floor, roof and wall assemblies. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m^2) of the sprayed area, or portion thereof, in each story.

1705.13.6.2 Structural members. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from beams, girders, trusses, columns and other structural members at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m^2) of floor area or portion thereof in each story.

1705.13.6.3 Primer, paint and encapsulant bond tests. Bond tests to qualify a primer, paint or encapsulant

shall be conducted when the sprayed fire-resistant material is applied to a primed, painted or encapsulated surface for which acceptable bond-strength performance between these coatings and the fire-resistant material has not been determined. A bonding agent approved by the SFRM manufacturer shall be applied to a primed, painted or encapsulated surface where the bond strengths are found to be less than required values.

1705.14 Mastic and intumescent fire-resistant coatings. Special inspections for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be in accordance with AWCI 12-B. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents.

1705.15 Exterior insulation and finish systems (EIFS). Special inspections shall be required for all EIFS applications.

Exceptions:

1. Special inspections shall not be required for EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior.
2. Special inspections shall not be required for EIFS applications installed over masonry or concrete walls.

1705.15.1 Water-resistive barrier coating. A water-resistive barrier coating complying with ASTM E 2570 requires special inspection of the water-resistive barrier coating when installed over a sheathing substrate.

1705.16 Fire-resistant penetrations and joints. In high-rise buildings or in buildings assigned to Risk Category III or IV in accordance with Section 1604.5, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems, and perimeter fire barrier systems that are tested and listed in accordance with Sections 714.3.1.2, 714.4.1.2, 715.3 and 715.4 shall be in accordance with Section 1705.16.1 or 1705.16.2.

1705.16.1 Penetration firestops. Inspections of penetration firestop systems that are tested and listed in accordance with Sections 714.3.1.2 and 714.4.1.2 shall be conducted by an approved inspection agency in accordance with ASTM E 2174.

1705.16.2 Fire-resistant joint systems. Inspection of fire-resistant joint systems that are tested and listed in accordance with Sections 715.3 and 715.4 shall be conducted by an approved inspection agency in accordance with ASTM E 2393.

[F] 1705.17 Special inspection for smoke control. Smoke control systems shall be tested by a special inspector.

[F] 1705.17.1 Testing scope. The test scope shall be as follows:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow

measurements and detection and control verification.

[F] 1705.17.2 Qualifications. Special inspection agencies for smoke control shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

SECTION 1706 DESIGN STRENGTHS OF MATERIALS

1706.1 Conformance to standards. The design strengths and permissible stresses of any structural material that are identified by a manufacturer's designation as to manufacture and grade by mill tests, or the strength and stress grade is otherwise confirmed to the satisfaction of the building official, shall conform to the specifications and methods of design of accepted engineering practice or the approved rules in the absence of applicable standards.

1706.2 New materials. For materials that are not specifically provided for in this code, the design strengths and permissible stresses shall be established by tests as provided for in Section 1707.

SECTION 1707 ALTERNATIVE TEST PROCEDURE

1707.1 General. In the absence of approved rules or other approved standards, the building official shall make, or cause to be made, the necessary tests and investigations; or the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in Section 104.11 *Chapter 1, Division II*. The cost of all tests and other investigations required under the provisions of this code shall be borne by the applicant.

[BSC] *In the absence of approved rules or other approved standards, the building official shall make, or cause to be made, the necessary tests and investigations; or the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in Section 1.2.2, Chapter 1, Division I. The cost of all tests and other investigations required under the provisions of this code shall be borne by the applicant.*

[HCD 1 & HCD 2] *In the absence of approved rules or other approved standards, the building official shall make or cause to be made the necessary tests and investigations, or the building official shall accept duly authenticated reports from approved agencies with respect to the quality and manner of use of new materials or assemblies as provided for in Section 1.8.7, Chapter 1, Division 1. The cost of all tests and other investigations required under the provisions of this code shall be borne by the applicant.*

SECTION 1708 TEST SAFE LOAD

1708.1 Where required. Where proposed construction is not capable of being designed by approved engineering analysis, or where proposed construction design method does not comply with the applicable material design standard, the system of construction or the structural unit and the connections shall be subjected to the tests prescribed in Section 1710. The building official shall accept certified reports of such tests conducted by an approved testing agency, provided that such tests meet the requirements of this code and approved procedures.

SECTION 1709 IN-SITU LOAD TESTS

1709.1 General. Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. If the structural assessment determines that the load-bearing capacity is less than that required by the code, load tests shall be conducted in accordance with Section 1709.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

1709.2 Test standards. Structural components and assemblies shall be tested in accordance with the appropriate referenced standards. In the absence of a standard that contains an applicable load test procedure, the test procedure shall be developed by a registered design professional and approved. The test procedure shall simulate loads and conditions of application that the completed structure or portion thereof will be subjected to in normal use.

1709.3 In-situ load tests. In-situ load tests shall be conducted in accordance with Section 1709.3.1 or 1709.3.2 and shall be supervised by a registered design professional. The test shall simulate the applicable loading conditions specified in Chapter 16 as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

1709.3.1 Load test procedure specified. Where a referenced standard contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific load factors or acceptance criteria, the load factors and acceptance criteria in Section 1709.3.2 shall apply.

1709.3.2 Load test procedure not specified. In the absence of applicable load test procedures contained

within a standard referenced by this code or acceptance criteria for a specific material or method of construction, such existing structure shall be subjected to a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components that are not a part of the seismic load-resisting system, the test load shall be equal to two times the unfactored design loads. The test load shall be left in place for a period of 24 hours. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

1. Under the design load, the deflection shall not exceed the limitations specified in Section 1604.3.
2. Within 24 hours after removal of the test load, the structure shall have recovered not less than 75 percent of the maximum deflection.
3. During and immediately after the test, the structure shall not show evidence of failure.

SECTION 1710 PRECONSTRUCTION LOAD TESTS

1710.1 General. In evaluating the physical properties of materials and methods of construction that are not capable of being designed by approved engineering analysis or do not comply with the applicable referenced standards, the structural adequacy shall be predetermined based on the load test criteria established in this section.

1710.2 Load test procedures specified. Where specific load test procedures, load factors and acceptance criteria are included in the applicable referenced standards, such test procedures, load factors and acceptance criteria shall apply. In the absence of specific test procedures, load factors or acceptance criteria, the corresponding provisions in Section 1710.3 shall apply.

1710.3 Load test procedures not specified. Where load test procedures are not specified in the applicable referenced standards, the load-bearing and deformation capacity of structural components and assemblies shall be determined on the basis of a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components and assemblies that are not a part of the seismic force-resisting system, the test shall be as specified in Section 1710.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

1710.3.1 Test procedure. The test assembly shall be subjected to an increasing superimposed load equal to not less than two times the superimposed design load. The test load shall be left in place for a period of 24 hours. The tested assembly shall be considered to have successfully met the test requirements if the assembly recovers not less than 75 percent of the maximum deflection within 24 hours after the removal of the test load. The test assembly shall then be reloaded and subjected to an increasing superimposed load until either structural failure occurs or the superimposed load is equal to two and one-half times the load at which the deflection limitations specified in

Section 1710.3.2 were reached, or the load is equal to two and one-half times the superimposed design load. In the case of structural components and assemblies for which deflection limitations are not specified in Section 1710.3.2, the test specimen shall be subjected to an increasing superimposed load until structural failure occurs or the load is equal to two and one-half times the desired superimposed design load. The allowable superimposed design load shall be taken as the lesser of:

1. The load at the deflection limitation given in Section 1710.3.2.
2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.

1710.3.2 Deflection. The deflection of structural members under the design load shall not exceed the limitations in Section 1604.3.

1710.4 Wall and partition assemblies. Load-bearing wall and partition assemblies shall sustain the test load both with and without window framing. The test load shall include all design load components. Wall and partition assemblies shall be tested both with and without door and window framing.

1710.5 Exterior window and door assemblies. The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1710.5.1 or 1710.5.2.

Exception: Structural wind load design pressures for window units smaller than the size tested in accordance with Section 1710.5.1 or 1710.5.2 shall be permitted to be higher than the design value of the tested unit provided such higher pressures are determined by accepted engineering analysis. All components of the small unit shall be the same as the tested unit. Where such calculated design pressures are used, they shall be validated by an additional test of the window unit having the highest allowable design pressure.

1710.5.1 Exterior windows and doors. Exterior windows and sliding doors shall be tested and labeled as conforming to AAMA/WDMA/CSA101/I.S.2/A440. The label shall state the name of the manufacturer, the approved labeling agency and the product designation as specified in AAMA/ WDMA/CSA101/I.S.2/A440. Exterior side-hinged doors shall be tested and labeled as conforming to AAMA/WDMA/CSA101/I.S.2/A440 or comply with Section 1710.5.2. Products tested and labeled as conforming to AAMA/WDMA/CSA 101/I.S.2/A440 shall not be subject to the requirements of Sections 2403.2 and 2403.3.

1710.5.2 Exterior windows and door assemblies not provided for in Section 1710.5.1. Exterior window and door assemblies shall be tested in accordance with ASTM E 330. Structural performance of garage doors and rolling doors shall be determined in accordance with either ASTM E 330 or ANSI/DASMA 108, and shall meet the acceptance criteria of ANSI/DASMA 108. Exterior window and door assemblies containing glass shall comply with Section 2403. The design pressure for testing shall be calculated in accordance with Chapter 16. Each assembly

shall be tested for 10 seconds at a load equal to 1.5 times the design pressure.

1710.6 Skylights and sloped glazing. Unit skylights and tubular daylighting devices (TDDs) shall comply with the requirements of Section 2405. All other skylights and sloped glazing shall comply with the requirements of Chapter 24.

1710.7 Test specimens. Test specimens and construction shall be representative of the materials, workmanship and details normally used in practice. The properties of the materials used to construct the test assembly shall be determined on the basis of tests on samples taken from the load assembly or on representative samples of the materials used to construct the load test assembly. Required tests shall be conducted or witnessed by an approved agency.

SECTION 1711 MATERIAL AND TEST STANDARDS

1711.1 Joist hangers. Testing of joist hangers shall be in accordance with Sections 1711.1.1 through 1711.1.3, as applicable.

1711.1.1 General. The vertical load-bearing capacity, torsional moment capacity and deflection characteristics of joist hangers shall be determined in accordance with ASTM D 1761 using lumber having a specific gravity of 0.49 or greater, but not greater than 0.55, as determined in accordance with AF&PA NDS for the joist and headers.

Exception: The joist length shall not be required to exceed 24 inches (610 mm).

1711.1.2 Vertical load capacity for joist hangers. The vertical load-bearing capacity for the joist hanger shall be determined by testing a minimum of three joist hanger assemblies as specified in ASTM D 1761. If the ultimate vertical load for any one of the tests varies more than 20 percent from the average ultimate vertical load, at least three additional tests shall be conducted. The allowable vertical load-bearing of the joist hanger shall be the lowest value determined from the following:

1. The lowest ultimate vertical load for a single hanger from any test divided by three (where three tests are conducted and each ultimate vertical load does not vary more than 20 percent from the average ultimate vertical load).
2. The average ultimate vertical load for a single hanger from all tests divided by three (where six or more tests are conducted).
3. The average from all tests of the vertical loads that produce a vertical movement of the joist with respect to the header of $\frac{1}{8}$ inch (3.2 mm).
4. The sum of the allowable design loads for nails or other fasteners utilized to secure the joist hanger to the wood members and allowable bearing loads that contribute to the capacity of the hanger.

5. The allowable design load for the wood members forming the connection.

1711.1.2.1 Design value modifications for joist hangers. Allowable design values for joist hangers that are determined by Item 4 or 5 in Section 1711.1.2 shall be permitted to be modified by the appropriate load duration factors as specified in AF&PA NDS but shall not exceed the direct loads as determined by Item 1, 2 or 3 in Section 1711.1.2. Allowable design values determined by Item 1, 2 or 3 in Section 1711.1.2 shall not be modified by load duration factors.

1711.1.3 Torsional moment capacity for joist hangers. The torsional moment capacity for the joist hanger shall be determined by testing at least three joist hanger assemblies as specified in ASTM D 1761. The allowable torsional moment of the joist hanger shall be the average torsional moment at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is $\frac{1}{8}$ inch (3.2 mm).

1711.2 Concrete and clay roof tiles. Testing of concrete and clay roof tiles shall be in accordance with Sections 1711.2.1 and 1711.2.2, as applicable.

1711.2.1 Overturning resistance. Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with SBCCI SSTD 11 and Chapter 15.

1711.2.2 Wind tunnel testing. Where concrete and clay roof tiles do not satisfy the limitations in Chapter 16 for rigid tile, a wind tunnel test shall be used to determine the wind characteristics of the concrete or clay tile roof covering in accordance with SBCCI SSTD 11 and Chapter 15.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 17A – STRUCTURAL TESTS AND SPECIAL INSPECTIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.

See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | X | X | X | | | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |

CHAPTER 17A

SPECIAL INSPECTIONS AND TESTS

SECTION 1701A GENERAL

1701A.1 Scope. The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Materials of construction and tests shall conform to the applicable standards listed in this code.

1701A.1.1 Application. *The scope of application of Chapter 17A is as follows:*

1. *Structures regulated by the Division of the State Architect-Structural Safety, which include those applications listed in Sections 1.9.2.1 (DSA-SS), and 1.9.2.2 (DSA-SS/CC). These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.*
2. *Structures regulated by the Office of Statewide Health Planning and Development (OSHPD), which include those applications listed in Sections 1.10.1, and 1.10.4. These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 17 and any applicable amendments therein.

1701A.1.2 Amendments in this chapter. DSA-SS adopts this chapter and all amendments.

Exceptions: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect - Structural Safety:
[DSA-SS] For applications listed in Section 1.9.2.1.
[DSA-SS/CC] For applications listed in Section 1.9.2.2.*
2. *Office of Statewide Health Planning and Development:
[OSHPD 1] – For applications listed in Section 1.10.1.
[OSHPD 4] – For applications listed in Section 1.10.4.*

1701A.1.3 Reference to other chapters.

1701A.1.3.1 [DSA-SS/CC] Where reference within this chapter is made to sections in Chapters 16A, 19A, 21A,

22A, and 34A, the provisions in Chapters 16, 19, 21, 22, and 34 respectively shall apply instead.

1701A.2 New materials. New building materials, equipment, appliances, systems or methods of construction not provided for in this code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this chapter and in the approved rules to determine character, quality and limitations of use.

1701A.3 Used materials. The use of second-hand materials that meet the minimum requirements of this code for new materials shall be permitted.

1701A.4 Special inspectors. [OSHPD 1 and 4] In addition to the inspector(s) of record required by the California Administrative Code (CCR, Title 24, Part 1), Section 7-144, the owner shall employ one or more special inspectors who shall provide inspections during construction on the types of work listed under Chapters 17A, 18A, 19A, 20, 21A, 22A, 23, 25, 34A, and noted in the Test, Inspection, and Observation (TIO) program required by Sections 7-141, 7-145 and 7-149, of the California Administrative Code. Test, Inspection and Observation (TIO) program shall satisfy requirements of Sections 1704A.2.3 and 1704A.5.

1701A.5 Special inspectors. [DSA-SS & DSA-SS/CC] In addition to the project inspector required by the California Administrative Code (CCR, Title 24, Part 1), Section 4-333, the owner shall employ one or more special inspectors who shall provide inspections during construction on the types of work listed under Chapters 17A, 18A, 19A, 20, 21A, 22A, 23, 25 and 34 of the California Building Code and noted in the special test, inspection and observation plan required by Section 4-335 of the California Administrative Code.

SECTION 1702A DEFINITIONS

1702A.1 Definitions. The following terms are defined in Chapter 2, except those defined below which shall, for the purposes of this section, have the meanings shown herein.

APPROVED AGENCY.

APPROVED FABRICATOR.

CERTIFICATE OF COMPLIANCE.

DESIGNATED SEISMIC SYSTEM.

FABRICATED ITEM.

INSPECTION CERTIFICATE.

INTUMESCENT FIRE-RESISTANT COATINGS.

MAIN WINDFORCE-RESISTING SYSTEM.

MASTIC FIRE-RESISTANT COATINGS.

PROJECT INSPECTOR. [DSA-SS, DSA-SS/CC] *The person approved to provide inspection in accordance with the California Administrative Code, Section 4-333(b). The term "project inspector" is synonymous with "inspector of record."*

SPECIAL INSPECTION.

Continuous special inspection. *The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.*

Periodic special inspection. *The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.*

SPECIAL INSPECTOR.

SPRAYED FIRE-RESISTANT MATERIALS.

STRUCTURAL OBSERVATION.

SECTION 1703A APPROVALS

1703A.1 Approved agency. An approved agency shall provide all information as necessary for the building official to determine that the agency meets the applicable requirements.

1703A.1.1 Independence. An approved agency shall be objective, competent and independent from the contractor responsible for the work being inspected. The agency shall also disclose possible conflicts of interest so that objectivity can be confirmed.

1703A.1.2 Equipment. An approved agency shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.

1703A.1.3 Personnel. An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and/or inspections.

1703A.2 Written approval. Any material, appliance, equipment, system or method of construction meeting the requirements of this code shall be approved in writing after satisfactory completion of the required tests and submission of required test reports.

1703A.3 Approved record. For any material, appliance, equipment, system or method of construction that has been approved, a record of such approval, including the conditions and limitations of the approval, shall be kept on file in the building official's office and shall be open to public inspection at appropriate times.

1703A.4 Performance. Specific information consisting of test reports conducted by an approved testing agency in accordance with the appropriate referenced standards, or other such information as necessary, shall be provided for the building official to determine that the material meets the applicable code requirements.

1703A.4.1 Research and investigation. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any material or assembly. If it is determined that the evidence submitted is satisfactory proof of performance for the use intended, the building official shall approve the use of the material or assembly subject to the requirements of this code. The costs, reports and investigations required under these provisions shall be paid by the applicant.

1703A.4.2 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

1703A.5 Labeling. Where materials or assemblies are required by this code to be labeled, such materials and assemblies shall be labeled by an approved agency in accordance with Section 1703A. Products and materials required to be labeled shall be labeled in accordance with the procedures set forth in Sections 1703A.5.1 through 1703A.5.4.

1703A.5.1 Testing. An approved agency shall test a representative sample of the product or material being labeled to the relevant standard or standards. The approved agency shall maintain a record of the tests performed. The record shall provide sufficient detail to verify compliance with the test standard.

1703A.5.2 Inspection and identification. The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the product or material that is to be labeled. The inspection shall verify that the labeled product or material is representative of the product or material tested.

1703A.5.3 Label information. The label shall contain the manufacturer's or distributor's identification, model number, serial number or definitive information describing the product or material's performance characteristics and approved agency's identification.

1703A.5.4 Method of labeling. Information required to be permanently identified on the product shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

1703A.6 Evaluation and follow-up inspection services. Where structural components or other items regulated by this code are not visible for inspection after completion of a prefabricated assembly, the applicant shall submit a report of each prefabricated assembly. The report shall indicate the complete details of the assembly, including a description of the assembly and its components, the basis upon which the assembly is being evaluated, test results and similar information and other data as necessary for the building official to determine conformance to this code. Such a report shall be approved by the building official.

1703A.6.1 Follow-up inspection. The applicant shall provide for special inspections of fabricated items in accordance with Section 1704.2.5.

1703A.6.2 Test and inspection records. Copies of necessary test and inspection records shall be filed with the building official.

SECTION 1704A SPECIAL INSPECTIONS, CONTRACTOR RESPONSIBILITY AND STRUCTURAL OBSERVATIONS

1704A.1 General. This section provides minimum requirements for special inspections, the statement of special inspections, contractor responsibility and structural observations.

1704A.2 Special inspections. Where application is made for construction as described in this section, the owner shall employ one or more approved agencies to perform inspections during construction on the types of work listed under Section 1705A. These inspections are in addition to the inspections identified in Section 110.

Exception: Special inspections are not required for construction of a minor nature or as warranted by conditions in the jurisdiction, as approved by the building official.

1704A.2.1 Special inspector qualifications. The special inspector shall provide written documentation to the building official demonstrating his or her competence and relevant experience or training. Experience or training shall be considered relevant when the documented experience or training is related in complexity to the same type of special inspection activities for projects of similar complexity and material qualities. These qualifications are in addition to qualifications specified in other sections of this code.

The registered design professional in responsible charge and engineers of record involved in the design of the project are permitted to act as the approved agency and their personnel are permitted to act as the special inspector for the work designed by them, provided they qualify as special inspectors.

1704A.2.2 Access for special inspection. The construction or work for which special inspection is required shall remain accessible and exposed for special inspection purposes until completion of the required special inspections.

1704A.2.3 Statement of special inspections. The applicant shall submit a statement of special inspections *prepared by the registered design professional in general responsible charge* in accordance with Section 107.1 as a condition for *construction documents review*. This statement shall be in accordance with Section 1704A.3.

1704A.2.4 Report requirement. *The inspector(s) of record and special inspectors shall keep records of inspections. The inspector of record and special inspector shall furnish inspection reports to the building official, and to the registered design professional in responsible charge as required by the California Administrative Code.* Reports shall indicate that work inspected was or was not completed in conformance to approved construction documents *as required by Title 24 Parts 1 and 2*. Discrepancies shall be brought to the immediate attention of the contractor for correction. If they are not corrected, the discrepancies shall be brought to the attention of the building

official and to the registered design professional in responsible charge prior to the completion of that phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon prior to the start of work by the applicant and the building official.

1704A.2.5 Inspection of fabricators. Where fabrication of structural load-bearing members and assemblies is being performed on the premises of a fabricator's shop, special inspection of the fabricated items shall be required by this section and as required elsewhere in this code.

1704A.2.5.1 Fabrication and implementation procedures. The special inspector shall verify that the fabricator maintains detailed fabrication and quality control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards. The special inspector shall review the procedures for completeness and adequacy relative to the code requirements for the fabricator's scope of work.

1704A.3 Statement of special inspections. Where special inspection or testing is required by Section 1705, the registered design professional in responsible charge shall prepare a statement of special inspections in accordance with Section 1704.3.1 for submittal by the applicant in accordance with Section 1704A.2.3.

Exception: The statement of special inspections is permitted to be prepared by a qualified person approved by the building official for construction not designed by a registered design professional.

1704A.3.1 Content of statement of special inspections. The statement of special inspections shall identify the following:

1. The materials, systems, components and work required to have special inspection or testing by the building official or by the registered design professional responsible for each portion of the work.
2. The type and extent of each special inspection.
3. The type and extent of each test.
4. Additional requirements for special inspection or testing for seismic or wind resistance as specified in Sections 1705A.10, 1705A.11 and 1705A.12.
5. For each type of special inspection, identification as to whether it will be continuous special inspection or periodic special inspection.

1704A.3.2 Seismic requirements in the statement of special inspections. Where Section 1705A.11 or 1705A.12 specifies special inspection, testing or *certification* for seismic resistance, the statement of special inspections shall identify the *equipment/components that require special seismic certification* and seismic force-resisting systems that are subject to special inspections.

1704A.3.3 Wind requirements in the statement of special inspections. Where Section 1705A.10 specifies spe-

cial inspection for wind requirements, the statement of special inspections shall identify the main windforce-resisting systems and wind-resisting components subject to special inspection.

1704A.4 Contractor responsibility. Each contractor responsible for the construction of a main wind- or seismic force-resisting system, *installation of equipment/components requiring special seismic certification* or a wind- or seismic-resisting component listed in the statement of special inspections shall submit a written statement of responsibility to the building official and the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain acknowledgement of awareness of the special requirements contained in the statement of special inspection.

1704A.5 Structural observations. The owner shall employ a registered design professional to perform structural observations as defined in Section 1702A.

Prior to the commencement of observations, the structural observer shall submit to the building official a written statement identifying the frequency and extent of structural observations.

At the conclusion of the work included in the permit, the structural observer shall submit to the building official a written statement that the site visits have been made and identify any reported deficiencies which, to the best of the structural observer's knowledge, have not been resolved.

SECTION 1705A REQUIRED VERIFICATION AND INSPECTION

1705A.1 General. Verification and inspection of elements of buildings and structures shall be as required by this section.

1705A.1.1 Special cases. Special inspections shall be required for proposed work that is, in the opinion of the building official, unusual in its nature, such as, but not limited to, the following examples:

1. Construction materials and systems that are alternatives to materials and systems prescribed by this code.
2. Unusual design applications of materials described in this code.
3. Materials and systems required to be installed in accordance with additional manufacturer's instructions that prescribe requirements not contained in this code or in standards referenced by this code.

1705A.2 Steel construction. The special inspections for steel elements of buildings and structures shall be as required in this section.

Exception: Special inspection of the steel fabrication process shall not be required where the fabricator does not perform any welding, thermal cutting or heating operation of any kind as part of the fabrication process. In such cases, the fabricator shall be required to submit a detailed procedure for material control that demonstrates the fabri-

cator's ability to maintain suitable records and procedures such that, at any time during the fabrication process, the material specification, and grade for the main stress-carrying elements are capable of being determined. Mill test reports shall be identifiable to the main stress-carrying elements when required by the approved construction documents.

1705A.2.1 Structural steel. Special inspections and tests of structural steel shall be in accordance with the quality assurance requirements of this section and Chapter 22A.

AISC 360, Chapter N and AISC 341, Chapter J are adopted, except as noted below:

The following provisions of AISC 360, Chapter N are not adopted:

- N4., Item 2. (*Quality Assurance Inspector Qualifications*)
- N5., Item 2. (*Quality Assurance*)
- N5., Item 3. (*Coordinated Inspection*)
- N5., Item 4. (*Inspection of Welding*)
- N7 (*Approved Fabricators and Erectors*)
- N8 (*Nonconforming Material and Workmanship*)

In addition to the quality assurance inspection requirements contained in AISC 360, Section N5, Item 6 (Inspection of High Strength Bolting), the requirements of Table 1705A.2.1 of the California Building Code shall apply.

In addition to the quality assurance requirements contained in AISC 360, Section N6 (Minimum Requirements for Inspection of Composite Construction), the requirements of Table 1705A.2.1 of the California Building Code shall apply.

1705A.2.2 Steel construction. Special inspection for steel construction shall be in accordance with Table 1705A.2.1 and this section.

1705A.2.2.1 Welding. Welding inspection and welding inspector qualification shall be in accordance with this section.

1705A.2.2.1.1 Cold-formed steel. Welding inspection and welding inspector qualification for cold-formed steel floor and roof decks shall be in accordance with AWS D1.3.

1705A.2.2.1.2 Reinforcing steel. Welding inspection and welding inspector qualification for reinforcing steel shall be in accordance with AWS D1.4 and ACI 318.

1705A.2.2.2 Cold-formed steel trusses spanning 60 feet or greater. Where a cold-formed steel truss clear span is 60 feet (18 288 mm) or greater, the special

TABLE 1705A.2.1
REQUIRED VERIFICATION AND INSPECTION OF STEEL CONSTRUCTION

| VERIFICATION AND INSPECTION | CONTINUOUS | PERIODIC | REFERENCED STANDARD ^a | CBC REFERENCE |
|--|------------|----------|---|---------------|
| 1. Material verification of high strength bolts, nuts and washers: | | | | |
| a. Identification markings to conform to ASTM standards specified in the approved construction documents. | | X | AISC 360, Section A3.3 and applicable ASTM material standards | |
| b. Manufacturer's certificate of compliance required. | | X | | |
| 2. Inspection of high strength bolting: | | | | |
| a. Snug tight joints. | | X | AISC 360, Section M2.5 | |
| b. Pretensioned and slip critical joints using turn of nut with matchmarking, twist off bolt or direct tension indicator methods of installation | | X | | |
| c. Pretensioned and slip critical joints using turn of nut without matchmarking or calibrated wrench methods of installation. | X | | | |
| 3. Material verification of structural steel and cold formed steel deck: | | | | |
| a. For structural steel, identification markings to conform to AISC 360. | | X | AISC 360, Section A3.1 | 2203A.1 |
| b. For other steel, identification markings to conform to ASTM standards specified in the approved construction documents. | | X | Applicable ASTM material standards | |
| c. Manufacturer's certified test reports. | — | X | | |
| 4. Material verification of weld filler materials: | | | | |
| a. Identification markings to conform to AWS specification in the approved construction documents. | | X | AISC 360, Section A3.5 and applicable AWS A5 documents | — |
| b. Manufacturer's certificate of compliance required. | | X | — | — |
| 5. Inspection of welding: | | | | |
| a. Structural steel and cold-formed steel deck: | | | | |
| 1. Complete and partial joint penetration groove welds | X | | AWS D1.1 | 1705A.2.2 |
| 2. Multipass fillet welds. | X | | | |
| 3. Single pass fillet welds > 5/16" | X | | | |
| 4. Plug and slot welds. | X | — | | |
| 5. Single pass fillet welds ≤ 5/16" | | X | | |
| 6. Floor and roof deck welds. | — | X | | |
| b. Reinforcing steel: | | | | |
| 1. Verification of weldability of reinforcing steel other than ASTM A 706. | — | X | AWS D1.4. ACI 318: Section 3.5.2 | — |
| 2. Reinforcing steel resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement. | X | | | |
| 3. Shear reinforcement. | X | | | |
| 4. Other reinforcing steel. | | X | | |
| 6. Inspection of steel frame joint details for compliance: | | | | |
| a. Details such as bracing and stiffening. | | X | 1705A.2.2 | |
| b. Member locations. | — | X | | |
| c. Application of joint details at each connection. | | X | | |

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705A.11, Special inspections for seismic resistance.

inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

1705A.2.2.3 Steel joist and joist girder inspection. Special inspection is required during the manufacture and welding of steel joists or joist girders. The special inspector shall verify that proper quality control procedures and tests have been employed for all materials and the manufacturing process, and shall perform visual inspection of the finished product. The special inspector shall place a distinguishing mark, and/or tag with this distinguishing mark, on each inspected joist or joist girder. This mark or tag shall remain on the joist or joist girder throughout the job site receiving and erection process.

1705A.2.2.4 Light-framed steel truss inspection. The manufacture of cold-formed light framed steel trusses shall be continuously inspected by a qualified special inspector approved by the enforcement agency. The special inspector shall verify conformance of materials and manufacture with approved plans and specifications. The special inspector shall place a distinguishing mark, and/or tag with this distinguishing mark, on each inspected truss. This mark or tag shall remain on the truss throughout the job site receiving and erection process.

1705A.2.2.5 Inspection of structural welding. Inspection of all shop and field welding operations shall be made by a qualified welding inspector approved by the enforcement agency. The minimum requirements for a qualified welding inspector shall be as those for an AWS certified welding inspector (CWI), as defined in the provisions of the AWS QC1. All welding inspectors shall be as approved by the enforcement agency.

The welding inspector shall make a systematic daily record of all welds. In addition to other required records, this record shall include:

1. Identification marks of welders.
2. List of defective welds.
3. Manner of correction of defects.

The welding inspector shall check the material, details of construction and procedure, as well as workmanship of the welds. The inspector shall verify that the installation of end-welded stud shear connectors is in accordance with the requirements of AWS D1.1 and the approved plans and specifications. The inspector shall furnish the architect, structural engineer, and the enforcement agency with a verified report that the welding is proper and has been done in conformity with AWS D1.1, D1.8, and the approved construction documents.

1705A.3 Concrete construction. The special inspections and verifications for concrete construction shall be as required by this section and Table 1705A.3.

Exception: Special inspections shall not be required for concrete patios, driveways and sidewalks, on grade.

1705A.3.1 Materials. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapter 3 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapter 3 of ACI 318. Weldability of reinforcement, except that which conforms to ASTM A 706, shall be determined in accordance with the requirements of Section 3.5.2 of ACI 318.

1705A.3.2 Batch plant inspection. Except as provided under Section 1705A.3.3, the quality and quantity of materials used in transit-mixed concrete and in batched aggregates shall be continuously inspected by an approved special inspector at the location where materials are measured.

1705A.3.3 Waiver of continuous batch plant inspection. Continuous batch plant inspection may be waived by the registered design professional, subject to approval by the enforcement agency under either of the following conditions:

1. The concrete plant complies fully with the requirements of ASTM C 94, Sections 8 and 9, and has a current certificate from the National Ready Mixed Concrete Association or another agency acceptable to the enforcement agency. The certification shall indicate that the plant has automatic batching and recording capabilities.
2. For single -story light-framed - buildings and isolated foundations supporting equipment only, where the specified compressive strength f'_c of the concrete delivered to the jobsite is 3,500 psi (24.13 MPa) and where the f'_c used in design is not greater than 3,000 psi (20.68 MPa).

When continuous batch plant inspection is waived, the following periodic inspection requirements shall apply and shall be described in the construction documents:

1. Qualified technician of the testing laboratory shall check the first batch at the start of the day.
2. Licensed weighmaster to positively identify materials as to quantity and certify to each load by a batch ticket.
3. Batch tickets, including material quantities and weights shall accompany the load, shall be transmitted to the inspector of record by a truck driver with load identified thereon. The load shall not be placed without a batch ticket identifying the mix. The inspector will keep a

TABLE 1705.A.3
REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION

| VERIFICATION AND INSPECTION | CONTINUOUS | PERIODIC | REFERENCED STANDARD ^a | IBC REFERENCE |
|---|------------|----------|--|------------------------|
| 1. Inspection of reinforcing steel, including prestressing tendons, and placement. | — | X | ACI 318: 3.5, 7.1-7.7 | 1910.4 |
| 2. Inspection of reinforcing steel welding in accordance with Table 1705.2.2, Item 2b. | — | — | AWS D1.4 ACI 318: 3.5.2 | — |
| 3. Inspection of anchors cast in concrete where allowable loads have been increased or where strength design is used. | — | X | ACI 318: 8.1.3, 21.2.8 | 1908.5, 1909.1 |
| 4. Inspection of anchors post-installed in hardened concrete members ^b . | — | X | ACI 318: 3.8.6, 8.1.3, 21.2.8 | 1909.1 |
| 5. Verifying use of required design mix. | — | X | ACI 318: Ch. 4, 5.2-5.4 | 1904.2, 1910.2, 1910.3 |
| 6. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete. | X | — | ASTM C 172 ASTM C 31 ACI 318: 5.6, 5.8 | 1910.10 |
| 7. Inspection of concrete and shotcrete placement for proper application techniques. | X | — | ACI 318: 5.9, 5.10 | 1910.6, 1910.7, 1910.8 |
| 8. Inspection for maintenance of specified curing temperature and techniques. | — | X | ACI 318: 5.11-5.13 | 1910.9 |
| 9. Inspection of prestressed concrete: | | | | |
| a. Application of prestressing forces. | X | | ACI 318: 18.20 | |
| b. Grouting of bonded prestressing tendons in the seismic force-resisting system. | X | — | ACI 318: 18.18.4 | — |
| 10. Erection of precast concrete members. | — | X | ACI 318: Ch. 16 | — |
| 11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs. | — | X | ACI 318: 6.2 | — |
| 12. Inspect formwork for shape, location and dimensions of the concrete member being formed. | — | X | ACI 318: 6.1.1 | — |
| 13. <i>Inspection of adhesive anchors in horizontal and upwardly inclined positions.^c</i> | — | X | ACI 318: D.9.2.2 | — |

For SI: 1 inch = 25.4 mm.

- a. Where applicable, see also Section 1705.11, Special inspections for seismic resistance.
- b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with ACI 355.2 or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.
- c. *Installation of all adhesive anchors in horizontal and upwardly inclined positions shall be performed by an ACI/CRSI certified adhesive anchor installer.*

daily record of placements, identifying each truck, its load, and time of receipt, and approximate location of deposit in the structure and will transmit a copy of the daily record to the enforcement agency.

1705A.3.4 Inspection of prestressed concrete.

- 1. *In addition to the general inspection required for concrete work, all plant fabrication of prestressed concrete members or tensioning of posttensioned members constructed at the site shall be continuously inspected by an inspector specially approved for this purpose by the enforcement agency.*

2. *The prestressed concrete plant fabrication inspector shall check the materials, equipment, tensioning procedure and construction of the prestressed members and prepare daily written reports. The inspector shall make a verified report identifying the members by mark and shall include such pertinent data as lot numbers of tendons used, tendon jacking forces, age and strength of concrete at time of tendon release and such other information that may be required.*
3. *The inspector of prestressed members posttensioned at the site shall check the condition of the prestressing tendons, anchorage assemblies and concrete in the area of the anchorage, the tensioning equipment and the tensioning procedure and prepare daily written reports. The inspector shall make a verified report of the prestressing operation identifying the members or tendons by mark and including such pertinent data as the initial cable slack, net elongation of tendons, jacking force developed, and such other information as may be required.*
4. *The verified reports of construction shall show that of the inspector's own personal knowledge, the work covered by the report has been performed and materials used and installed in every material respect in compliance with the duly approved plans and specifications for plant fabrication inspection. The verified report shall be accompanied by test reports required for materials used. For site posttensioning inspections the verified report shall be accompanied by copies of calibration charts, certified by an approved testing laboratory, showing the relationship between gage readings and force applied by the jacks used in the prestressing procedure*

1705A.3.5 Concrete preplacement inspection. Concrete shall not be placed until the forms and reinforcement have been inspected, all preparations for the placement have been completed, and the preparations have been checked by the inspector of record.

1705A.3.6 Placing record. A record shall be kept on the site of the time and date of placing the concrete in each portion of the structure. Such record shall be kept until the completion of the structure and shall be open to the inspection of the enforcement agency.

1705A.4 Masonry construction. Masonry construction shall be inspected and verified in accordance with TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6 quality assurance program, as set forth in Table 1.19.3, Level C requirements. Inspection and testing of post-installed anchors in masonry shall be required in accordance with requirements for concrete in Chapters 17A and 19A

1705A.4.1 Glass unit masonry and masonry veneer in Risk Categories II, III, or IV. The minimum special inspection program for glass unit masonry or masonry veneer designed by Section 2110A or Chapter 14, respectively, in structures classified as Risk Categories II, III, or IV, in accordance with Section 1604A.5, shall comply

with TMS 402/ACI 530/ASCE 5 Level B Quality Assurance.

1705A.4.2 Vertical masonry foundation elements. Special inspection shall be performed in accordance with Section 1705.4 for vertical masonry foundation elements.

1705A.5 Wood construction. Special inspections of the fabrication process of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704A.2.5 except as modified in this section. Special inspections of site-built assemblies shall be in accordance with this section.

1705A.5.1 High-load diaphragms. High-load diaphragms designed in accordance with Section 2306.2 shall be installed with special inspections as indicated in Section 1704A.2. The special inspector shall inspect the wood structural panel sheathing to ascertain whether it is of the grade and thickness shown on the approved building plans. Additionally, the special inspector must verify the nominal size of framing members at adjoining panel edges, the nail or staple diameter and length, the number of fastener lines and that the spacing between fasteners in each line and at edge margins agrees with the approved building plans.

1705A.5.2 Metal-plate-connected wood trusses spanning 60 feet or greater. Where a truss clear span is 60 feet (18 288 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

1705A.5.3 Wood structural elements and assemblies. Special inspection of wood structural elements and assemblies is required, as specified in this section, to ensure conformance with approved drawings and specifications, and applicable standards.

The special inspector shall furnish a verified report to the design professional in general responsible charge of construction observation, the structural engineer, and the enforcement agency, in accordance with the California Administrative Code and this chapter. The verified report shall list all inspected members or trusses, and shall indicate whether or not the inspected members or trusses conform with applicable standards and the approved drawings and specifications. Any nonconforming items shall be indicated on the verified report.

1705A.5.4 Structural glued laminated timber. Manufacture of all structural glued laminated timber shall be continuously inspected by a qualified special inspector approved by the enforcement agency.

The special inspector shall verify that proper quality control procedures and tests have been employed for all materials and the manufacturing process, and shall perform visual inspection of the finished product. Each inspected member shall be stamped by the special inspector with an identification mark.

Exception: Special Inspection is not required for non-custom members of $5\frac{1}{8}$ inch maximum width and 18 inch maximum depth, and with a maximum clear span

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of 32 feet, manufactured and marked in accordance with ANSI/AITC A 190.1 Section 6.1.1 for noncustom members.

1705A.5.5 Manufactured open web trusses. The manufacture of open web trusses shall be continuously inspected by a qualified special inspector approved by the enforcement agency.

The special inspector shall verify that proper quality control procedures and tests have been employed for all materials and the manufacturing process, and shall perform visual inspection of the finished product. Each inspected truss shall be stamped with an identification mark by the special inspector.

1705A.5.6 Timber connectors. The installation of all split ring and shear plate timber connectors, and timber rivets shall be continuously inspected by a qualified inspector approved by the enforcement agency. The inspector shall furnish the architect, structural engineer and the enforcement agency with a report duly verified by him that the materials, timber connectors and workmanship conform to the approved plans and specifications.

1705A.6 Soils. Special inspections for existing site soil conditions, fill placement and load-bearing requirements shall be as required by this section and Table 1705A.6. The approved geotechnical report, and the construction documents prepared by the registered design professionals shall be used to determine compliance. During fill placement, the special inspector shall determine that proper materials and procedures are used in accordance with the provisions of the approved geotechnical report.

Exception: Where Section 1803A does not require reporting of materials and procedures for fill placement, the special inspector shall verify that the in-place dry density of the compacted fill is not less than 90 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D 1557.

1705A.6.1 Soil fill. All fills used to support the foundations of any building or structure shall be continuously inspected by the geotechnical engineer or his or her qualified representative. It shall be the responsibility of the geotechnical engineer to verify that fills meet the requirements of the approved construction documents and to coordinate all fill inspection and testing during the construction involving such fills.

The duties of the geotechnical engineer or his or her qualified representative shall include, but need not be limited to, the inspection of cleared areas and benches prepared to receive fill; inspection of the removal of all unsuitable soils and other materials; the approval of soils to be used as fill material; the inspection of placement and compaction of fill materials; the testing of the completed fills; the inspection or review of geotechnical drainage devices, buttress fills or other similar protective measures in accordance with the approved construction documents.

A verified report shall be submitted by the geotechnical engineer as required by the California Administrative Code. The report shall indicate that all tests and inspection required by the approved construction documents were completed and that the tested materials and/or inspected work meet the requirements of the approved construction documents.

1705A.7 Driven deep foundations. Special inspections shall be performed during installation and testing of driven deep foundation elements as required by Table 1705A.7. The approved instruction documents prepared by the registered design professionals, shall be used to determine compliance.

1705A.7.1 Driven deep foundations observation. The installation of driven deep foundations shall be continuously observed by a qualified representative of the geotechnical engineer responsible for that portion of the project.

The representative of the geotechnical engineer shall make a report of the deep foundation pile-driving operation giving such pertinent data as the physical characteristics of the deep foundation pile-driving equipment, identifying marks for each deep foundation pile, the total depth of embedment for each deep foundation; and when the allowable deep foundation pile loads are determined by a dynamic load formula, the design formula used, and the permanent penetration under the last 10 blows. One copy of the report shall be sent to the enforcement agency.

1705A.8 Cast-in-place deep foundations. Special inspections shall be performed during installation and testing of cast-in-place deep foundation elements as required by Table 1705.8. The approved geotechnical report, and the construction documents prepared by the registered design professionals, shall be used to determine compliance.

TABLE 1705A.6
REQUIRED VERIFICATION AND INSPECTION OF SOILS

| VERIFICATION AND INSPECTION TASK | CONTINUOUS DURING TASK LISTED | PERIODICALLY DURING TASK LISTED |
|--|-------------------------------|---------------------------------|
| 1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity. | — | X |
| 2. Verify excavations are extended to proper depth and have reached proper material. | — | X |
| 3. Perform classification and testing of compacted fill materials. | — | X |
| 4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill. | X | — |
| 5. Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly. | — | X |

TABLE 1705A.7
REQUIRED VERIFICATION AND INSPECTION OF DRIVEN DEEP FOUNDATION ELEMENTS

| VERIFICATION AND INSPECTION TASK | CONTINUOUS DURING TASK LISTED | PERIODICALLY DURING TASK LISTED |
|---|-------------------------------|---------------------------------|
| 1. Verify element materials, sizes and lengths comply with the requirements. | X | — |
| 2. Determine capacities of test elements and conduct additional load tests, as required. | X | — |
| 3. Observe driving operations and maintain complete and accurate records for each element. | X | — |
| 4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element. | X | — |
| 5. For steel elements, perform additional inspections in accordance with Section 1705A.2. | — | — |
| 6. For concrete elements and concrete-filled elements, perform additional inspections in accordance with Section 1705A.3. | — | — |
| 7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge. | — | — |

TABLE 1705.8
REQUIRED VERIFICATION AND INSPECTION OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS

| VERIFICATION AND INSPECTION TASK | CONTINUOUS DURING TASK LISTED | PERIODICALLY DURING TASK LISTED |
|---|-------------------------------|---------------------------------|
| 1. Observe drilling operations and maintain complete and accurate records for each element. | X | — |
| 2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes. | X | — |
| 3. For concrete elements, perform additional inspections in accordance with Section 1705.3. | — | — |

1705A.9 Helical pile foundations. Special inspections shall be performed continuously during installation of helical pile foundations. The information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the registered design professional in responsible charge. The approved geotechnical report and the construction documents prepared by the registered design professional shall be used to determine compliance.

1705A.10 Special inspections for wind resistance. Special inspections itemized in Sections 1705A.10.1 through 1705A.10.3, unless exempted by the exceptions to Section 1704A.2, are required for buildings and structures constructed in the following areas:

1. In wind Exposure Category B, where V_{asd} as determined in accordance with Section 1609.3.1 is 120 miles per hour (52.8 m/sec) or greater.
2. In wind Exposure Category C or D, where V_{asd} as determined in accordance with Section 1609.3.1 is 110 mph (49 m/sec) or greater.

1705A.10.1 Structural wood. Continuous special inspection is required during field gluing operations of elements of the main windforce-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of components within the main windforce-resisting system, including wood shear walls, wood diaphragms, drag struts, braces and hold-downs.

1705A.10.2 Cold-formed steel light-frame construction. Periodic special inspection is required during welding operations of elements of the main windforce-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of components within the main windforce-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

1705A.10.3 Wind-resisting components. Periodic special inspection is required for the following systems and components:

1. Roof cladding.
2. Wall cladding.

1705A.11 Special inspections for seismic resistance. Special inspections itemized in Sections 1705A.11.1 through 1705A.11.8, unless exempted by the exceptions of Section 1704A.2, are required for the following:

1. The seismic force-resisting systems in structures assigned to Seismic Design Category D, E or F in accordance with Sections 1705A.11.1 through 1705A.11.3, as applicable.
2. *Equipment/components requiring special seismic certification* assigned to Seismic Design Category D, E or F in accordance with Section 1705A.11.4.
3. Architectural, mechanical and electrical components in accordance with Sections 1705A.11.5 and 1705A.11.6.
4. Storage racks in structures assigned to Seismic Design Category D, E or F in accordance with Section 1705A.11.7.
5. Seismic isolation and damping systems in accordance with Section 1705A.11.8.

1705A.11.1 Structural steel. Special inspection for structural steel shall be in accordance with the quality assurance requirements of AISC 341 as modified by Section 1705A.2.1 of this code.

1705A.11.2 Structural wood. Continuous special inspection is required during field gluing operations of elements of the seismic force-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of components within the seismic force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.

1705A.11.3 Cold-formed steel light-frame construction. Periodic special inspection is required during welding operations of elements of the seismic force-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of components within the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

1705A.11.4 Special inspection for special seismic certification. The special inspector shall examine *equipment and components requiring special seismic certification* in accordance with Section 1705A.12.4 and verify that the label, anchorage or mounting conforms to the certificate of compliance.

1705A.11.5 Architectural components. Periodic special inspection is required during the erection and fastening of exterior cladding, interior and exterior nonbearing walls, ceilings, and interior and exterior veneer in structures assigned to Seismic Design Category D, E or F.

1705A.11.5.1 Access floors. Periodic special inspection is required for the anchorage of access floors in structures assigned to Seismic Design Category D, E or F.

1705A.11.6 Mechanical and electrical components. Special inspection for mechanical and electrical components shall be as follows:

1. Periodic special inspection is required during the anchorage of electrical equipment for emergency or standby power systems in structures assigned to Seismic Design Category D, E or F;
2. Periodic special inspection is required during the anchorage of other electrical equipment in structures assigned to Seismic Design Category D, E or F;
3. Periodic special inspection is required during the installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to Seismic Design Category D, E or F;
4. Periodic special inspection is required during the installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to Seismic Design Category D, E or F; and
5. Periodic special inspection is required during the installation and anchorage of vibration isolation systems in structures assigned to Seismic Design Category D, E or F where the construction documents require a nominal clearance of $\frac{1}{4}$ inch (6.4 mm) or less between the equipment support frame and restraint.

1705A.11.7 Storage racks. Periodic special inspection is required during the anchorage of storage racks 8 feet (2438 mm) or greater in height in structures assigned to Seismic Design Category D, E or F.

1705A.11.8 Seismic isolation and damping systems. Periodic special inspection shall be provided for seismic isolation systems during the fabrication and installation of isolator units and energy dissipation devices. *Continuous special inspection is required for prototype and production testing of isolator units and damping devices.*

1705A.12 Testing and certification for seismic resistance. The testing and *certification* specified in Sections 1705A.12.1 through 1705A.12.4, unless exempted from special inspections by the exceptions of Section 1704A.2 are required as follows:

1. The seismic force-resisting systems in structures assigned to Seismic Design Category D, E or F shall meet the requirements of Sections 1705A.12.1 and 1705A.12.2, as applicable.
2. *Equipment and components* in structures assigned to Seismic Design Category D, E or F shall comply with the *special seismic certification* requirements of Section 1705A.12.4.
3. Architectural, mechanical and electrical components in structures assigned to Seismic Design Category D, E or F and where the requirements of ASCE 7 Section 13.2.1, Item 2, are met by submittal of manufacturer's certification, shall comply with Section 1705A.12.3.
4. The seismic isolation system in seismically isolated structures and damping devices, shall meet the testing requirements of Section 1705A.12.5.

1705A.12.1 Concrete reinforcement. Where reinforcement complying with ASTM A 615 is used to resist earth-

quake-induced flexural and axial forces in special moment frames, special structural walls and coupling beams connecting special structural walls, in structures assigned to Seismic Design Category B, C, D, E or F, the reinforcement shall comply with Section 21.1.5.2 of ACI 318. Certified mill test reports shall be provided for each shipment of such reinforcement. Where reinforcement complying with ASTM A 615 is to be welded, chemical tests shall be performed to determine weldability in accordance with Section 3.5.2 of ACI 318.

1705A.12.2 Structural steel. Testing for structural steel shall be in accordance with the quality assurance requirements of AISC 341.

Exception: Testing for structural steel in structures assigned to Seismic Design Category C that are not specifically detailed for seismic resistance, with a response modification coefficient, R , of 3 or less, excluding cantilever column systems.

1705A.12.3 Manufacturer's certification of nonstructural components. The registered design professional shall specify on the construction documents the requirements for manufacturer's certification by analysis, testing or experience data for nonstructural components, in accordance with Section 13.2.1, Item 2 of ASCE 7, where such certification is required by Section 1705A.12.

Seismic sway braces satisfying requirements of FM 1950 shall be deemed to satisfy the requirements of this Section.

1705A.12.4 Special seismic certification. [OSHPD 1 & 4] The registered design professional shall specify on the construction documents the requirements for special seismic certification by analysis, testing or experience data for equipment and components listed in Section 1705A.12.4.1.

Active or energized equipment and components shall be certified exclusively on the basis of approved shake table testing in accordance with ICC-ES AC 156.

Minimum of two equipment/components shall be tested for a product line with similar structural configuration. Where a range of products are tested, the two equipment/components shall be either the largest and smallest, or approved alternative representative equipment/components.

Exception: When a single product (and not a product line with more than one product with variations) is certified and manufacturing process is ISO 9001 certified, one test shall be permitted.

All tests shall be performed by an independent laboratory having accreditation to the International Standards Organization (ISO) accreditation standard 17025 or shall be under the responsible charge of an independent California licensed engineer. Test reports shall be reviewed and accepted by an independent California licensed structural engineer.

For a multicomponent system, where active or energized components are certified by tests, connecting elements, attachments, and supports can be justified by supporting analysis.

1705A.12.4.1 Special seismic certification shall be required for the following systems, equipment, and components:

1. Emergency and standby power systems.
2. Elevator equipment (excluding elevator cabs).
3. Components with hazardous contents.
4. Exhaust and smoke control fans.
5. Switchgear and switchboards.
6. Motor control centers.
7. Radiography and fluoroscopy systems in fluoroscopy rooms.
8. CT (Computerized Tomography) systems.
9. Air conditioning units.
10. Air handling units.
11. Chillers, evaporators, and condensers.
12. Cooling towers.
13. Transformers.
14. Electrical substations.
15. UPS and batteries.
16. Distribution panels.
17. Control panels.
18. Power isolation and correction systems.
19. Motorized surgical lighting systems.
20. Motorized operating table systems.

Exceptions:

1. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with this code.
2. Movable (mobile) and temporary equipment/components that are not anchored to structure or permanently attached to the building utility services such as electricity, gas or water. For the purposes of this requirement, "permanently attached" shall include all electrical connections except plugs for duplex receptacles.
3. Pipes, ducts, conduits and cable trays, excluding in-line equipment and components.
4. Underground tanks.
5. Electric motors and pumps not more than 10 hp rigidly supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with this code.
6. Components where importance factor, I_p , is permitted to be 1.0 by this code.

1705A.12.5 Seismic isolation and damping systems. Seismic isolation and damping systems shall be tested in accordance with Sections 17.8 and 18.9 of ASCE 7.

Prototype and production testing and associated acceptance criteria for isolator units and damping devices shall be subject to preapproval by the building official. Testing exemption for similar units shall require approval by the building official.

1705A.13 Sprayed fire-resistant materials. Special inspections for sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be in accordance with Sections 1705.13.1 through 1705.13.6. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents. The tests set forth in this section shall be based on samplings from specific floor, roof and wall assemblies and structural members. Special inspections shall be performed after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, where applicable.

1705A.13.1 Physical and visual tests. The special inspections shall include the following tests and observations to demonstrate compliance with the listing and the fire-resistance rating:

1. Condition of substrates.
2. Thickness of application.
3. Density in pounds per cubic foot (kg/m^3).
4. Bond strength adhesion/cohesion.
5. Condition of finished application.

1705A.13.2 Structural member surface conditions. The surfaces shall be prepared in accordance with the approved fire-resistance design and the written instructions of approved manufacturers. The prepared surface of structural members to be sprayed shall be inspected before the application of the sprayed fire-resistant material.

1705A.13.3 Application. The substrate shall have a minimum ambient temperature before and after application as specified in the written instructions of approved manufacturers. The area for application shall be ventilated during and after application as required by the written instructions of approved manufacturers.

1705A.13.4 Thickness. No more than 10 percent of the thickness measurements of the sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be less than the thickness required by the approved fire-resistance design, but in no case less than the minimum allowable thickness required by Section 1705A.13.4.1.

1705A.13.4.1 Minimum allowable thickness. For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus $\frac{1}{4}$ inch (6.4 mm). For design thicknesses less than 1 inch (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent. Thickness shall be determined in accordance with ASTM E 605. Samples of the sprayed

fire-resistant materials shall be selected in accordance with Sections 1705A.13.4.2 and 1705A.13.4.3.

1705A.13.4.2 Floor, roof and wall assemblies. The thickness of the sprayed fire-resistant material applied to floor, roof and wall assemblies shall be determined in accordance with ASTM E 605, making not less than four measurements for each 1,000 square feet (93 m^2) of the sprayed area, or portion thereof, in each story.

1705A.13.4.3 Cellular decks. Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. A minimum of four measurements shall be made, located symmetrically within the square area.

1705A.13.4.4 Fluted decks. Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. A minimum of four measurements shall be made, located symmetrically within the square area, including one each of the following: valley, crest and sides. The average of the measurements shall be reported.

1705A.13.4.5 Structural members. The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E 605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

1705A.13.4.6 Beams and girders. At beams and girders thickness measurements shall be made at nine locations around the beam or girder at each end of a 12-inch (305 mm) length.

1705A.13.4.7 Joists and trusses. At joists and trusses, thickness measurements shall be made at seven locations around the joist or truss at each end of a 12-inch (305 mm) length.

1705A.13.4.8 Wide-flanged columns. At wide-flanged columns, thickness measurements shall be made at 12 locations around the column at each end of a 12-inch (305 mm) length.

1705A.13.4.9 Hollow structural section and pipe columns. At hollow structural section and pipe columns, thickness measurements shall be made at a minimum of four locations around the column at each end of a 12-inch (305 mm) length.

1705A.13.5 Density. The density of the sprayed fire-resistant material shall not be less than the density specified in the approved fire-resistance design. Density of the sprayed fire-resistant material shall be determined in accordance with ASTM E 605. The test samples for determining the density of the sprayed fire-resistant materials shall be selected as follows:

1. From each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m^2) or portion thereof of the sprayed area in each story.
2. From beams, girders, trusses and columns at the rate of not less than one sample for each type of struc-

tural member for each 2,500 square feet (232 m^2) of floor area or portion thereof in each story.

1705A.13.6 Bond strength. The cohesive/adhesive bond strength of the cured sprayed fire-resistant material applied to floor, roof and wall assemblies and structural members shall not be less than 150 pounds per square foot (psf) (7.18 kN/m^2). The cohesive/adhesive bond strength shall be determined in accordance with the field test specified in ASTM E 736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1705A.13.6.1 through 1705A.13.6.3.

1705A.13.6.1 Floor, roof and wall assemblies. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m^2) of the sprayed area, or portion thereof, in each story.

1705A.13.6.2 Structural members. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from beams, girders, trusses, columns and other structural members at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m^2) of floor area or portion thereof in each story.

1705A.13.6.3 Primer, paint and encapsulant bond tests. Bond tests to qualify a primer, paint or encapsulant shall be conducted when the sprayed fire-resistant material is applied to a primed, painted or encapsulated surface for which acceptable bond-strength performance between these coatings and the fire-resistant material has not been determined. A bonding agent approved by the SFRM manufacturer shall be applied to a primed, painted or encapsulated surface where the bond strengths are found to be less than required values.

1705A.14 Mastic and intumescence fire-resistant coatings. Special inspections for mastic and intumescence fire-resistant coatings applied to structural elements and decks shall be in accordance with AWCI 12-B. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents.

* **1705A.15 Exterior insulation and finish systems (EIFS).** Special inspections shall be required for all EIFS applications.

Exceptions:

1. Special inspections shall not be required for EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior.
2. Special inspections shall not be required for EIFS applications installed over masonry or concrete walls.

1705A.15.1 Water-resistive barrier coating. A water-resistive barrier coating complying with ASTM E 2570 requires special inspection of the water-resistive barrier coating when installed over a sheathing substrate.

1705A.16 Fire-resistant penetrations and joints. In high-rise buildings or in buildings assigned to Risk Category III or IV in accordance with Section 1604A.5, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems, and perimeter fire barrier systems that are tested and listed in accordance with Sections 714A.3.1.2, 714A.4.1.2, 715A.3 and 715A.4 shall be in accordance with Section 1705A.16.1 or 1705A.16.2.

1705A.16.1 Penetration firestops. Inspections of penetration firestop systems that are tested and listed in accordance with Sections 714A.3.1.2 and 714A.4.1.2 shall be conducted by an approved inspection agency in accordance with ASTM E 2174.

1705A.16.2 Fire-resistant joint systems. Inspection of fire-resistant joint systems that are tested and listed in accordance with Sections 715A.3 and 715A.4 shall be conducted by an approved inspection agency in accordance with ASTM E 2393.

1705A.17 Special inspection for smoke control. Smoke control systems shall be tested by a special inspector.

1705A.17.1 Testing scope. The test scope shall be as follows:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification.

1705A.17.2 Qualifications. Special inspection agencies for smoke control shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

1705A.18 Shotcrete. All shotcrete work shall be continuously inspected during placing by an inspector specially approved for that purpose by the enforcement agency. The special shotcrete inspector shall check the materials, placing equipment, details of construction and construction procedure. The inspector shall furnish a verified report that of his or her own personal knowledge the work covered by the report has been performed and materials used and installed in every material respect in compliance with the duly approved plans and specifications.

1705A.18.1 Visual examination for structural soundness of in-place shotcrete. Completed shotcrete work shall be checked visually for reinforcing bar embedment, voids, rock pockets, sand streaks and similar deficiencies by examining a minimum of three 3-inch (76 mm) cores taken from three areas chosen by the design engineer which represent the worst congestion of reinforcing bars occurring in the project. Extra reinforcing bars may be added to noncongested areas and cores may be taken from these areas. The cores shall be examined by the special inspector and a report submitted to the enforcement agency prior to final approval of the shotcrete.

Exception: Shotcrete work fully supported on earth, minor repairs, and when, in the opinion of the enforcement agency, no special hazard exists.

SECTION 1706A DESIGN STRENGTHS OF MATERIALS

1706A.1 Conformance to standards. The design strengths and permissible stresses of any structural material that are identified by a manufacturer's designation as to manufacture and grade by mill tests, or the strength and stress grade is otherwise confirmed to the satisfaction of the building official, shall conform to the specifications and methods of design of accepted engineering practice or the approved rules in the absence of applicable standards.

1706A.2 New materials. For materials that are not specifically provided for in this code, the design strengths and permissible stresses shall be established by tests as provided for in Section 1707A.

SECTION 1707A ALTERNATIVE TEST PROCEDURE

1707A.1 General. In the absence of approved rules or other approved standards, the building official shall make, or cause to be made, the necessary tests and investigations; or the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in Section 104.11. The cost of all tests and other investigations required under the provisions of this code shall be borne by the applicant.

SECTION 1708A TEST SAFE LOAD

1708A.1 Where required. Where proposed construction is not capable of being designed by approved engineering analysis, or where proposed construction design method does not comply with the applicable material design standard, the system of construction or the structural unit and the connections shall be subjected to the tests prescribed in Section 1710A. The building official shall accept certified reports of such tests conducted by an approved testing agency, provided that such tests meet the requirements of this code and approved procedures.

SECTION 1709A IN-SITU LOAD TESTS

1709A.1 General. Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. If the structural assessment determines that the load-bearing

capacity is less than that required by the code, load tests shall be conducted in accordance with Section 1709A.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

1709A.2 Test standards. Structural components and assemblies shall be tested in accordance with the appropriate referenced standards. In the absence of a standard that contains an applicable load test procedure, the test procedure shall be developed by a registered design professional and approved. The test procedure shall simulate loads and conditions of application that the completed structure or portion thereof will be subjected to in normal use.

1709A.3 In-situ load tests. In-situ load tests shall be conducted in accordance with Section 1709A.3.1 or 1709A.3.2 and shall be supervised by a registered design professional. The test shall simulate the applicable loading conditions specified in Chapter 16A as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

1709A.3.1 Load test procedure specified. Where a referenced standard contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific load factors or acceptance criteria, the load factors and acceptance criteria in Section 1709A.3.2 shall apply.

1709A.3.2 Load test procedure not specified. In the absence of applicable load test procedures contained within a standard referenced by this code or acceptance criteria for a specific material or method of construction, such existing structure shall be subjected to a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components that are not a part of the seismic load-resisting system, the test load shall be equal to two times the unfactored design loads. The test load shall be left in place for a period of 24 hours. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

- Under the design load, the deflection shall not exceed the limitations specified in Section 1604A.3.
- Within 24 hours after removal of the test load, the structure shall have recovered not less than 75 percent of the maximum deflection.
- During and immediately after the test, the structure shall not show evidence of failure.

SECTION 1710A PRECONSTRUCTION LOAD TESTS

1710A.1 General. In evaluating the physical properties of materials and methods of construction that are not capable of being designed by approved engineering analysis or do not comply with the applicable referenced standards, the structural adequacy shall be predetermined based on the load test criteria established in this section.

1710A.2 Load test procedures specified. Where specific load test procedures, load factors and acceptance criteria are included in the applicable referenced standards, such test procedures, load factors and acceptance criteria shall apply. In the absence of specific test procedures, load factors or acceptance criteria, the corresponding provisions in Section 1710A.3 shall apply.

1710A.3 Load test procedures not specified. Where load test procedures are not specified in the applicable referenced standards, the load-bearing and deformation capacity of structural components and assemblies shall be determined on the basis of a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components and assemblies that are not a part of the seismic force-resisting system, the test shall be as specified in Section 1710A.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

1710A.3.1 Test procedure. The test assembly shall be subjected to an increasing superimposed load equal to not less than two times the superimposed design load. The test load shall be left in place for a period of 24 hours. The tested assembly shall be considered to have successfully met the test requirements if the assembly recovers not less than 75 percent of the maximum deflection within 24 hours after the removal of the test load. The test assembly shall then be reloaded and subjected to an increasing superimposed load until either structural failure occurs or the superimposed load is equal to two and one-half times the load at which the deflection limitations specified in Section 1710A.3.2 were reached, or the load is equal to two and one-half times the superimposed design load. In the case of structural components and assemblies for which deflection limitations are not specified in Section 1710A.3.2, the test specimen shall be subjected to an increasing superimposed load until structural failure occurs or the load is equal to two and one-half times the desired superimposed design load. The allowable superimposed design load shall be taken as the lesser of:

1. The load at the deflection limitation given in Section 1710A.3.2.
2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.

1710A.3.2 Deflection. The deflection of structural members under the design load shall not exceed the limitations in Section 1604.3.

1710A.4 Wall and partition assemblies. Load-bearing wall and partition assemblies shall sustain the test load both with and without window framing. The test load shall include all design load components. Wall and partition assemblies shall be tested both with and without door and window framing.

1710A.5 Exterior window and door assemblies. The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1710A.5.1 or 1710A.5.2.

Exception: Structural wind load design pressures for window units smaller than the size tested in accordance with Section 1710A.5.1 or 1710A.5.2 shall be permitted to be

higher than the design value of the tested unit provided such higher pressures are determined by accepted engineering analysis. All components of the small unit shall be the same as the tested unit. Where such calculated design pressures are used, they shall be validated by an additional test of the window unit having the highest allowable design pressure.

1710A.5.1 Exterior windows and doors. Exterior windows and sliding doors shall be tested and labeled as conforming to AAMA/WDMA/CSA101/I.S.2/A440. The label shall state the name of the manufacturer, the approved labeling agency and the product designation as specified in AAMA/ WDMA/CSA101/I.S.2/A440. Exterior side-hinged doors shall be tested and labeled as conforming to AAMA/WDMA/CSA101/I.S.2/A440 or comply with Section 1710.5.2. Products tested and labeled as conforming to AAMA/WDMA/CSA 101/I.S.2/A440 shall not be subject to the requirements of Sections 2403A.2 and 2403A.3.

1710A.5.2 Exterior windows and door assemblies not provided for in Section 1710A.5.1. Exterior window and door assemblies shall be tested in accordance with ASTM E 330. Structural performance of garage doors and rolling doors shall be determined in accordance with either ASTM E 330 or ANSI/DASMA 108, and shall meet the acceptance criteria of ANSI/DASMA 108. Exterior window and door assemblies containing glass shall comply with Section 2403. The design pressure for testing shall be calculated in accordance with Chapter 16. Each assembly shall be tested for 10 seconds at a load equal to 1.5 times the design pressure.

1710A.6 Skylights and sloped glazing. Unit skylights and tubular daylighting devices (TDDs) shall comply with the requirements of Section 2405. All other skylights and sloped glazing shall comply with the requirements of Chapter 24.

1710A.7 Test specimens. Test specimens and construction shall be representative of the materials, workmanship and details normally used in practice. The properties of the materials used to construct the test assembly shall be determined on the basis of tests on samples taken from the load assembly or on representative samples of the materials used to construct the load test assembly. Required tests shall be conducted or witnessed by an approved agency.

SECTION 1711A MATERIAL AND TEST STANDARDS

1711A.1 Joist hangers. Testing of joist hangers shall be in accordance with Sections 1711A.1.1 through 1711A.1.3, as applicable.

1711A.1.1 General. The vertical load-bearing capacity, torsional moment capacity and deflection characteristics of joist hangers shall be determined in accordance with ASTM D 1761 using lumber having a specific gravity of 0.49 or greater, but not greater than 0.55, as determined in accordance with AF&PA NDS for the joist and headers.

Exception: The joist length shall not be required to exceed 24 inches (610 mm).

1711A.1.2 Vertical load capacity for joist hangers. The vertical load-bearing capacity for the joist hanger shall be determined by testing a minimum of three joist hanger assemblies as specified in ASTM D 1761. If the ultimate vertical load for any one of the tests varies more than 20 percent from the average ultimate vertical load, at least three additional tests shall be conducted. The allowable vertical load-bearing of the joist hanger shall be the lowest value determined from the following:

1. The lowest ultimate vertical load for a single hanger from any test divided by three (where three tests are conducted and each ultimate vertical load does not vary more than 20 percent from the average ultimate vertical load).
2. The average ultimate vertical load for a single hanger from all tests divided by three (where six or more tests are conducted).
3. The average from all tests of the vertical loads that produce a vertical movement of the joist with respect to the header of $\frac{1}{8}$ inch (3.2 mm).
4. The sum of the allowable design loads for nails or other fasteners utilized to secure the joist hanger to the wood members and allowable bearing loads that contribute to the capacity of the hanger.
5. The allowable design load for the wood members forming the connection.

1711A.1.2.1 Design value modifications for joist hangers. Allowable design values for joist hangers that are determined by Item 4 or 5 in Section 1711A.1.2 shall be permitted to be modified by the appropriate load duration factors as specified in AF&PA NDS but shall not exceed the direct loads as determined by Item 1, 2 or 3 in Section 1711A.1.2. Allowable design values determined by Item 1, 2 or 3 in Section 1711A.1.2 shall not be modified by load duration factors.

1711A.1.3 Torsional moment capacity for joist hangers. The torsional moment capacity for the joist hanger shall be determined by testing at least three joist hanger assemblies as specified in ASTM D 1761. The allowable torsional moment of the joist hanger shall be the average torsional moment at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is $\frac{1}{8}$ inch (3.2 mm).

1711A.2 Concrete and clay roof tiles. Testing of concrete and clay roof tiles shall be in accordance with Sections 1711A.2.1 and 1711A.2.2, as applicable.

1711A.2.1 Overturning resistance. Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with SBCCI SSTD 11 and Chapter 15.

1711A.2.2 Wind tunnel testing. Where concrete and clay roof tiles do not satisfy the limitations in Chapter 16 for rigid tile, a wind tunnel test shall be used to determine the wind characteristics of the concrete or clay tile roof covering in accordance with SBCCI SSTD 11 and Chapter 15.

Notation for [OSHPD]:

Authority: Health and Safety Code Section 129850
Reference: Health and Safety Code Sections 1275, 129850 and 129790

Notation for [DSA-SS]:

Authority: Education Code Sections 17310 and 81142, and H&S Code Section 16022.
Reference: Education Code Sections 17280 through 17317, and 81130 through 81147, and Health and Safety Code Sections 16000 through 16023.

Notation for [DSA-SS/CC]:

Authority: Education Code Section 81053.
Reference: Education Code Sections 81052, 81053, and 81130 through 81147.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 18 – SOILS AND FOUNDATIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | | | | | | | | | | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | X | X | | | | | | | | X | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 1801.2 | | | | | | | | | | | | | | | | | | | | |
| 1803.1.1– 1803.1.1.5 | | | | X | X | | | | | | | | | | | | | | | |
| 1803.2 | | | | | | | | | | | | X | | | | | | | | |
| 1803.6 | | | | | | | | | | | | X | | | | | | | | |
| 1803.7 | | | | | | | | | | | | X | | | | | | | | |
| 1804.3.1 | | | | X | X | | | | | | | | | | | | | | | |
| 1805.4.1 | | | | X | X | | | | | | | | | | | | | | | |
| 1805.4.3 | | | | X | X | | | | | | | | | | | | | | | |
| 1810.3.1.5.1 | | | | | | | | | | | | X | | | | | | | | |
| 1810.3.10.4.1 | | | | | | | | | | | | X | | | | | | | | |
| 1810.3.10.4 | X | | | X | X | | | | | | | | | | | | | | | |

CHAPTER 18

SOILS AND FOUNDATIONS

SECTION 1801 GENERAL

1801.1 Scope. The provisions of this chapter shall apply to building and foundation systems.

1801.2 Design basis. Allowable bearing pressures, allowable stresses and design formulas provided in this chapter shall be used with the allowable stress design load combinations specified in Section 1605.3. The quality and design of materials used structurally in excavations and foundations shall comply with the requirements specified in Chapters 16, 19, 21, 22 and 23 of this code. Excavations and fills shall also comply with Chapter 33.

[HCD 1] For limited-density owner-built rural dwellings, pier foundations, stone masonry footings and foundations, pressure-treated lumber, poles or equivalent foundation materials or designs may be used, provided that the bearing is sufficient for the purpose intended.

SECTION 1802 DEFINITIONS

1802.1 Definitions. The following words and terms are defined in Chapter 2:

DEEP FOUNDATION.

DRILLED SHAFT.

Socketed drilled shaft.

HELICAL PILE.

MICROPILE.

SHALLOW FOUNDATION.

SECTION 1803 GEOTECHNICAL INVESTIGATIONS

1803.1 General. Geotechnical investigations shall be conducted in accordance with Section 1803.2 and reported in accordance with Section 1803.6. Where required by the building official or where geotechnical investigations involve in-situ testing, laboratory testing or engineering calculations, such investigations shall be conducted by a registered design professional.

1803.1.1 General and where required for applications listed in Section 1.8.2.1.1 regulated by the Department of Housing and Community Development. [HCD 1] Foundation and soils investigations shall be conducted in conformance with Health and Safety Code Sections 17953 through 17957 as summarized below.

1803.1.1.1 Preliminary soil report. Each city, county, or city and county shall enact an ordinance which

requires a preliminary soil report, prepared by a civil engineer who is registered by the state. The report shall be based upon adequate test borings or excavations, of every subdivision, where a tentative and final map is required pursuant to Section 66426 of the Government Code.

The preliminary soil report may be waived if the building department of the city, county, or city and county, or other enforcement agency charged with the administration and enforcement of the provisions of Section 1803.1.1, shall determine that, due to the knowledge such department has as to the soil qualities of the soil of the subdivision or lot, no preliminary analysis is necessary.

1803.1.1.2 Soil investigation by lot, necessity, preparation, and recommendations. If the preliminary soil report indicates the presence of critically expansive soils or other soil problems which, if not corrected, would lead to structural defects, such ordinance shall require a soil investigation of each lot in the subdivision.

The soil investigation shall be prepared by a civil engineer who is registered in this state. It shall recommend corrective action which is likely to prevent structural damage to each dwelling proposed to be constructed on the expansive soil.

1803.1.1.3 Approval, building permit conditions, appeal. The building department of each city, county, or city and county, or other enforcement agency charged with the administration and enforcement of the provisions of Section 1803.1.1, shall approve the soil investigation if it determines that the recommended action is likely to prevent structural damage to each dwelling to be constructed. As a condition to the building permit, the ordinance shall require that the approved recommended action be incorporated in the construction of each dwelling. Appeal from such determination shall be to the local appeals board.

1803.1.1.4 Liability. A city, county, city and county, or other enforcement agency charged with the administration and enforcement of the provisions of Section 1803.1.1, is not liable for any injury which arises out of any act or omission of the city, county, city and county, other enforcement agency, or a public employee or any other person under Section 1803.1.1.

1803.1.1.5 Alternate procedures. The governing body of any city, county, or city and county may enact an ordinance prescribing an alternate procedure which is equal to or more restrictive than the procedure specified in Section 1803.1.1.

1803.2 Investigations required. Geotechnical investigations shall be conducted in accordance with Sections 1803.3 through 1803.5.

Exception: The building official shall be permitted to waive the requirement for a geotechnical investigation where satisfactory data from adjacent areas is available that demonstrates an investigation is not necessary for any of the conditions in Sections 1803.5.1 through 1803.5.6 and Sections 1803.5.10 and 1803.5.11.

[OSHPD 2] Geotechnical reports are not required for one-story, wood-frame and light-steel-frame buildings of Type V construction and 4,000 square feet (371 m^2) or less in floor area, not located within Earthquake Fault Zones or Seismic Hazard Zones as shown in the most recently published maps from the California Geological Survey (CGS). Allowable foundation and lateral soil pressure values may be determined from Table 1806.2.

1803.3 Basis of investigation. Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility, liquefaction and expansiveness.

1803.3.1 Scope of investigation. The scope of the geotechnical investigation including the number and types of borings or soundings, the equipment used to drill or sample, the in-situ testing equipment and the laboratory testing program shall be determined by a registered design professional.

1803.4 Qualified representative. The investigation procedure and apparatus shall be in accordance with generally accepted engineering practice. The registered design professional shall have a fully qualified representative on site during all boring or sampling operations.

1803.5 Investigated conditions. Geotechnical investigations shall be conducted as indicated in Sections 1803.5.1 through 1803.5.12.

1803.5.1 Classification. Soil materials shall be classified in accordance with ASTM D 2487.

1803.5.2 Questionable soil. Where the classification, strength or compressibility of the soil is in doubt or where a load-bearing value superior to that specified in this code is claimed, the building official shall be permitted to require that a geotechnical investigation be conducted.

1803.5.3 Expansive soil. In areas likely to have expansive soil, the building official shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D 4318.

2. More than 10 percent of the soil particles pass a No. 200 sieve ($75 \mu\text{m}$), determined in accordance with ASTM D 422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.
4. Expansion index greater than 20, determined in accordance with ASTM D 4829.

1803.5.4 Ground-water table. A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet (1524 mm) below the elevation of the lowest floor level where such floor is located below the finished ground level adjacent to the foundation.

Exception: A subsurface soil investigation to determine the location of the ground-water table shall not be required where waterproofing is provided in accordance with Section 1805.

1803.5.5 Deep foundations. Where deep foundations will be used, a geotechnical investigation shall be conducted and shall include all of the following, unless sufficient data upon which to base the design and installation is otherwise available:

1. Recommended deep foundation types and installed capacities.
2. Recommended center-to-center spacing of deep foundation elements.
3. Driving criteria.
4. Installation procedures.
5. Field inspection and reporting procedures (to include procedures for verification of the installed bearing capacity where required).
6. Load test requirements.
7. Suitability of deep foundation materials for the intended environment.
8. Designation of bearing stratum or strata.
9. Reductions for group action, where necessary.

1803.5.6 Rock strata. Where subsurface explorations at the project site indicate variations or doubtful characteristics in the structure of the rock upon which foundations are to be constructed, a sufficient number of borings shall be made to a depth of not less than 10 feet (3048 mm) below the level of the foundations to provide assurance of the soundness of the foundation bed and its load-bearing capacity.

1803.5.7 Excavation near foundations. Where excavation will remove lateral support from any foundation, an investigation shall be conducted to assess the potential consequences and address mitigation measures.

1803.5.8 Compacted fill material. Where shallow foundations will bear on compacted fill material more than 12 inches (305 mm) in depth, a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of compacted fill material.

2. Specifications for material to be used as compacted fill.
3. Test methods to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill.
4. Maximum allowable thickness of each lift of compacted fill material.
5. Field test method for determining the in-place dry density of the compacted fill.
6. Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with Item 3.
7. Number and frequency of field tests required to determine compliance with Item 6.

1803.5.9 Controlled low-strength material (CLSM). Where shallow foundations will bear on controlled low-strength material (CLSM), a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of the CLSM.
2. Specifications for the CLSM.
3. Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.
4. Test methods for determining the acceptance of the CLSM in the field.
5. Number and frequency of field tests required to determine compliance with Item 4.

1803.5.10 Alternate setback and clearance. Where setbacks or clearances other than those required in Section 1808.7 are desired, the building official shall be permitted to require a geotechnical investigation by a registered design professional to demonstrate that the intent of Section 1808.7 would be satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.

1803.5.11 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, a geotechnical investigation shall be conducted, and shall include an evaluation of all of the following potential geologic and seismic hazards:

1. Slope instability.
2. Liquefaction.
3. Total and differential settlement.
4. Surface displacement due to faulting or seismically induced lateral spreading or lateral flow.

1803.5.12 Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, the geotechnical investigation required by Section 1803.5.11 shall also include all of the following as applicable:

1. The determination of dynamic seismic lateral earth pressures on foundation walls and retaining walls supporting more than 6 feet (1.83 m) of backfill height due to design earthquake ground motions.
2. The potential for liquefaction and soil strength loss evaluated for site peak ground acceleration, earthquake magnitude, and source characteristics consistent with the maximum considered earthquake ground motions. Peak ground acceleration shall be determined based on:
 - 2.1 A site-specific study in accordance with Section 21.5 of ASCE 7; or
 - 2.2 In accordance with Section 11.8.3 of ASCE 7.
3. An assessment of potential consequences of liquefaction and soil strength loss, including, but not limited to:
 - 3.1. Estimation of total and differential settlement;
 - 3.2. Lateral soil movement;
 - 3.3. Lateral soil loads on foundations;
 - 3.4. Reduction in foundation soil-bearing capacity and lateral soil reaction;
 - 3.5. Soil downdrag and reduction in axial and lateral soil reaction for pile foundations;
 - 3.6. Increases in soil lateral pressures on retaining walls; and
 - 3.7. Flotation of buried structures.
4. Discussion of mitigation measures such as, but not limited to:
 - 4.1. Selection of appropriate foundation type and depths;
 - 4.2. Selection of appropriate structural systems to accommodate anticipated displacements and forces;
 - 4.3. Ground stabilization; or
 - 4.4. Any combination of these measures and how they shall be considered in the design of the structure.

1803.6 Reporting. Where geotechnical investigations are required, a written report of the investigations shall be submitted to the building official by the owner or authorized agent at the time of permit application. This geotechnical report shall include, but need not be limited to, the following information:

1. A plot showing the location of the soil investigations.
2. A complete record of the soil boring and penetration test logs and soil samples.
3. A record of the soil profile.
4. Elevation of the water table, if encountered.
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the

effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and varying soil strength; and the effects of adjacent loads.

6. Expected total and differential settlement.
7. Deep foundation information in accordance with Section 1803.5.5.
8. Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. Compacted fill material properties and testing in accordance with Section 1803.5.8.
10. Controlled low-strength material properties and testing in accordance with Section 1803.5.9.
11. [OSHPD 2] The report shall consider the effects of seismic hazard in accordance with Section 1803.7.

>|| 1803.7 **Geohazard reports.** [OSHPD 2] Geohazard reports shall be required for all proposed construction.

Exceptions:

1. Reports are not required for one-story, wood-frame and light-steel-frame buildings of Type V construction and 4,000 square feet (371 m^2) or less in floor area, not located within Earthquake Fault Zones or Seismic Hazard Zones as shown in the most recently published maps from the California Geological Survey (CGS); nonstructural, associated structural or voluntary structural alterations and incidental structural additions or alterations, and structural repairs for other than earthquake damage.
2. A previous report for a specific site may be resubmitted, provided that a reevaluation is made and the report is found to be currently appropriate.

The purpose of the geohazard report shall be to identify geologic and seismic conditions that may require project mitigations. The reports shall contain data which provide an assessment of the nature of the site and potential for earthquake damage based on appropriate investigations of the regional and site geology, project foundation conditions and the potential seismic shaking at the site. The report shall be prepared by a California-certified engineering geologist in consultation with a California-registered geotechnical engineer.

The preparation of the geohazard report shall consider the most recent CGS Note 48; Checklist for the Review of Engineering Geology and Seismology Reports for California Public School, Hospitals, and Essential Services Buildings. In addition, the most recent version of CGS Special Publication 42, Fault Rupture Hazard Zones in California, shall be considered for project sites proposed within an Alquist-Priolo Earthquake Fault Zone. The most recent version of CGS Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California, shall be considered for project sites proposed within a Seismic Hazard Zone. All conclusions shall be fully supported by satisfactory data and analysis.

In addition to requirements in Sections 1803.5.11 and 1803.5.12, the report shall include, but shall not be limited to, the following:

1. Site geology.
2. Evaluation of the known active and potentially active faults, both regional and local.
3. Ground-motion parameters, as required by Section 1613 and ASCE 7.

SECTION 1804 EXCAVATION, GRADING AND FILL

1804.1 Excavation near foundations. Excavation for any purpose shall not remove lateral support from any foundation without first underpinning or protecting the foundation against settlement or lateral translation.

1804.2 Placement of backfill. The excavation outside the foundation shall be backfilled with soil that is free of organic material, construction debris, cobbles and boulders or with a controlled low-strength material (CLSM). The backfill shall be placed in lifts and compacted in a manner that does not damage the foundation or the waterproofing or damp-proofing material.

Exception: CLSM need not be compacted.

1804.3 Site grading. The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than one unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. If physical obstructions or lot lines prohibit 10 feet (3048 mm) of horizontal distance, a 5-percent slope shall be provided to an approved alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped a minimum of 2 percent where located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped a minimum of 2 percent away from the building.

Exception: Where climatic or soil conditions warrant, the slope of the ground away from the building foundation shall be permitted to be reduced to not less than one unit vertical in 48 units horizontal (2-percent slope).

The procedure used to establish the final ground level adjacent to the foundation shall account for additional settlement of the backfill.

1804.3.1 [HCD 1] Construction plans. Construction plans shall indicate how the site grading or drainage system will manage all surface water flows to keep water from entering buildings in accordance with the California Green Building Standards Code (CALGreen), Chapter 4, Division 4.1.

1804.4 Grading and fill in flood hazard areas. In flood hazard areas established in Section 1612.3, grading and/or fill shall not be approved:

1. Unless such fill is placed, compacted and sloped to minimize shifting, slumping and erosion during the rise and fall of flood water and, as applicable, wave action.

2. In floodways, unless it has been demonstrated through hydrologic and hydraulic analyses performed by a registered design professional in accordance with standard engineering practice that the proposed grading or fill, or both, will not result in any increase in flood levels during the occurrence of the design flood.
3. In flood hazard areas subject to high-velocity wave action, unless such fill is conducted and/or placed to avoid diversion of water and waves toward any building or structure.
4. Where design flood elevations are specified but floodways have not been designated, unless it has been demonstrated that the cumulative effect of the proposed flood hazard area encroachment, when combined with all other existing and anticipated flood hazard area encroachment, will not increase the design flood elevation more than 1 foot (305 mm) at any point.

1804.5 Compacted fill material. Where shallow foundations will bear on compacted fill material, the compacted fill shall comply with the provisions of an approved geotechnical report, as set forth in Section 1803.

Exception: Compacted fill material 12 inches (305 mm) in depth or less need not comply with an approved report, provided the in-place dry density is not less than 90 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D 1557. The compaction shall be verified by special inspection in accordance with Section 1705.6.

1804.6 Controlled low-strength material (CLSM). Where shallow foundations will bear on controlled low-strength material (CLSM), the CLSM shall comply with the provisions of an approved geotechnical report, as set forth in Section 1803.

SECTION 1805 DAMPROOFING AND WATERPROOFING

1805.1 General. Walls or portions thereof that retain earth and enclose interior spaces and floors below grade shall be waterproofed and dampproofed in accordance with this section, with the exception of those spaces containing groups other than residential and institutional where such omission is not detrimental to the building or occupancy.

Ventilation for crawl spaces shall comply with Section 1203.4.

1805.1.1 Story above grade plane. Where a basement is considered a story above grade plane and the finished ground level adjacent to the basement wall is below the basement floor elevation for 25 percent or more of the perimeter, the floor and walls shall be dampproofed in accordance with Section 1805.2 and a foundation drain shall be installed in accordance with Section 1805.4.2. The foundation drain shall be installed around the portion of the perimeter where the basement floor is below ground level. The provisions of Sections 1803.5.4, 1805.3 and 1805.4.1 shall not apply in this case.

1805.1.2 Under-floor space. The finished ground level of an under-floor space such as a crawl space shall not be located below the bottom of the footings. Where there is evidence that the ground-water table rises to within 6 inches (152 mm) of the ground level at the outside building perimeter, or that the surface water does not readily drain from the building site, the ground level of the under-floor space shall be as high as the outside finished ground level, unless an approved drainage system is provided. The provisions of Sections 1803.5.4, 1805.2, 1805.3 and 1805.4 shall not apply in this case.

1805.1.2.1 Flood hazard areas. For buildings and structures in flood hazard areas as established in Section 1612.3, the finished ground level of an under-floor space such as a crawl space shall be equal to or higher than the outside finished ground level on at least one side.

Exception: Under-floor spaces of Group R-3 buildings that meet the requirements of FEMA/FIA-TB-11.

1805.1.3 Ground-water control. Where the ground-water table is lowered and maintained at an elevation not less than 6 inches (152 mm) below the bottom of the lowest floor, the floor and walls shall be dampproofed in accordance with Section 1805.2. The design of the system to lower the ground-water table shall be based on accepted principles of engineering that shall consider, but not necessarily be limited to, permeability of the soil, rate at which water enters the drainage system, rated capacity of pumps, head against which pumps are to operate and the rated capacity of the disposal area of the system.

1805.2 Damproofing. Where hydrostatic pressure will not occur as determined by Section 1803.5.4, floors and walls for other than wood foundation systems shall be dampproofed in accordance with this section. Wood foundation systems shall be constructed in accordance with AF&PA PWF.

1805.2.1 Floors. Dampproofing materials for floors shall be installed between the floor and the base course required by Section 1805.4.1, except where a separate floor is provided above a concrete slab.

Where installed beneath the slab, dampproofing shall consist of not less than 6-mil (0.006 inch; 0.152 mm) polyethylene with joints lapped not less than 6 inches (152 mm), or other approved methods or materials. Where permitted to be installed on top of the slab, dampproofing shall consist of mopped-on bitumen, not less than 4-mil (0.004 inch; 0.102 mm) polyethylene, or other approved methods or materials. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1805.2.2 Walls. Dampproofing materials for walls shall be installed on the exterior surface of the wall, and shall extend from the top of the footing to above ground level.

Dampproofing shall consist of a bituminous material, 3 pounds per square yard (16 N/m^2) of acrylic modified cement, $\frac{1}{8}$ inch (3.2 mm) coat of surface-bonding mortar complying with ASTM C 887, any of the materials permit-

ted for waterproofing by Section 1805.3.2 or other approved methods or materials.

1805.2.2.1 Surface preparation of walls. Prior to application of dampproofing materials on concrete walls, holes and recesses resulting from the removal of form ties shall be sealed with a bituminous material or other approved methods or materials. Unit masonry walls shall be parged on the exterior surface below ground level with not less than $\frac{3}{8}$ inch (9.5 mm) of Portland cement mortar. The parging shall be coved at the footing.

Exception: Parging of unit masonry walls is not required where a material is approved for direct application to the masonry.

1805.3 Waterproofing. Where the ground-water investigation required by Section 1803.5.4 indicates that a hydrostatic pressure condition exists, and the design does not include a ground-water control system as described in Section 1805.1.3, walls and floors shall be waterproofed in accordance with this section.

1805.3.1 Floors. Floors required to be waterproofed shall be of concrete and designed and constructed to withstand the hydrostatic pressures to which the floors will be subjected.

Waterproofing shall be accomplished by placing a membrane of rubberized asphalt, butyl rubber, fully adhered/fully bonded HDPE or polyolefin composite membrane or not less than 6-mil [0.006 inch (0.152 mm)] polyvinyl chloride with joints lapped not less than 6 inches (152 mm) or other approved materials under the slab. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1805.3.2 Walls. Walls required to be waterproofed shall be of concrete or masonry and shall be designed and constructed to withstand the hydrostatic pressures and other lateral loads to which the walls will be subjected.

Waterproofing shall be applied from the bottom of the wall to not less than 12 inches (305 mm) above the maximum elevation of the ground-water table. The remainder of the wall shall be dampproofed in accordance with Section 1805.2.2. Waterproofing shall consist of two-ply hot-mopped felts, not less than 6-mil (0.006 inch; 0.152 mm) polyvinyl chloride, 40-mil (0.040 inch; 1.02 mm) polymer-modified asphalt, 6-mil (0.006 inch; 0.152 mm) polyethylene or other approved methods or materials capable of bridging nonstructural cracks. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1805.3.2.1 Surface preparation of walls. Prior to the application of waterproofing materials on concrete or masonry walls, the walls shall be prepared in accordance with Section 1805.2.2.1.

1805.3.3 Joints and penetrations. Joints in walls and floors, joints between the wall and floor and penetrations of the wall and floor shall be made water-tight utilizing approved methods and materials.

1805.4 Subsoil drainage system. Where a hydrostatic pressure condition does not exist, dampproofing shall be provided and a base shall be installed under the floor and a drain installed around the foundation perimeter. A subsoil drainage system designed and constructed in accordance with Section 1805.1.3 shall be deemed adequate for lowering the groundwater table.

1805.4.1 Floor base course. Floors of basements, except as provided for in Section 1805.1.1, shall be placed over a floor base course not less than 4 inches (102 mm) in thickness that consists of gravel or crushed stone containing not more than 10 percent of material that passes through a No. 4 (4.75 mm) sieve.

Exceptions:

1. Where a site is located in well-drained gravel or sand/gravel mixture soils, a floor base course is not required.
2. *[HCD1] When a capillary break is installed in accordance with the California Green Building Standards Code (CALGreen), Chapter 4, Division 4.5.*

1805.4.2 Foundation drain. A drain shall be placed around the perimeter of a foundation that consists of gravel or crushed stone containing not more than 10-percent material that passes through a No. 4 (4.75 mm) sieve. The drain shall extend a minimum of 12 inches (305 mm) beyond the outside edge of the footing. The thickness shall be such that the bottom of the drain is not higher than the bottom of the base under the floor, and that the top of the drain is not less than 6 inches (152 mm) above the top of the footing. The top of the drain shall be covered with an approved filter membrane material. Where a drain tile or perforated pipe is used, the invert of the pipe or tile shall not be higher than the floor elevation. The top of joints or the top of perforations shall be protected with an approved filter membrane material. The pipe or tile shall be placed on not less than 2 inches (51 mm) of gravel or crushed stone complying with Section 1805.4.1, and shall be covered with not less than 6 inches (152 mm) of the same material.

1805.4.3 Drainage discharge. The floor base and foundation perimeter drain shall discharge by gravity or mechanical means into an approved drainage system that complies with the *California Plumbing Code*.

Exception: Where a site is located in well-drained gravel or sand/gravel mixture soils, a dedicated drainage system is not required.

SECTION 1806 PRESUMPTIVE LOAD-BEARING VALUES OF SOILS

1806.1 Load combinations. The presumptive load-bearing values provided in Table 1806.2 shall be used with the allowable stress design load combinations specified in Section 1605.3. The values of vertical foundation pressure and lateral bearing pressure given in Table 1806.2 shall be permitted to be increased by one-third where used with the alternative

basic load combinations of Section 1605.3.2 that include wind or earthquake loads.

1806.2 Presumptive load-bearing values. The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and approved. Where the building official has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions. Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the building official deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

1806.3 Lateral load resistance. Where the presumptive values of Table 1806.2 are used to determine resistance to lateral loads, the calculations shall be in accordance with Sections 1806.3.1 through 1806.3.4.

1806.3.1 Combined resistance. The total resistance to lateral loads shall be permitted to be determined by combining the values derived from the lateral bearing pressure and the lateral sliding resistance specified in Table 1806.2.

1806.3.2 Lateral sliding resistance limit. For clay, sandy clay, silty clay, clayey silt, silt and sandy silt, in no case shall the lateral sliding resistance exceed one-half the dead load.

1806.3.3 Increase for depth. The lateral bearing pressures specified in Table 1806.2 shall be permitted to be increased by the tabular value for each additional foot (305 mm) of depth to a maximum of 15 times the tabular value.

1806.3.4 Increase for poles. Isolated poles for uses such as flagpoles or signs and poles used to support buildings that are not adversely affected by a $\frac{1}{2}$ inch (12.7 mm)

motion at the ground surface due to short-term lateral loads shall be permitted to be designed using lateral bearing pressures equal to two times the tabular values.

SECTION 1807 FOUNDATION WALLS, RETAINING WALLS AND EMBEDDED POSTS AND POLES

1807.1 Foundation walls. Foundation walls shall be designed and constructed in accordance with Sections 1807.1.1 through 1807.1.6. Foundation walls shall be supported by foundations designed in accordance with Section 1808.

1807.1.1 Design lateral soil loads. Foundation walls shall be designed for the lateral soil loads set forth in Section 1610.

1807.1.2 Unbalanced backfill height. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab on grade is provided and is in contact with the interior surface of the foundation wall, the unbalanced backfill height shall be permitted to be measured from the exterior finish ground level to the top of the interior concrete slab.

1807.1.3 Rubble stone foundation walls. Foundation walls of rough or random rubble stone shall not be less than 16 inches (406 mm) thick. Rubble stone shall not be used for foundation walls of structures assigned to Seismic Design Category C, D, E or F.

1807.1.4 Permanent wood foundation systems. Permanent wood foundation systems shall be designed and installed in accordance with AF&PA PWF. Lumber and plywood shall be treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B and Section 5.2) and shall be identified in accordance with Section 2303.1.8.1.

TABLE 1806.2
PRESUMPTIVE LOAD-BEARING VALUES

| CLASS OF MATERIALS | VERTICAL FOUNDATION PRESSURE (psf) | LATERAL BEARING PRESSURE (psf/ft below natural grade) | LATERAL SLIDING RESISTANCE | |
|--|------------------------------------|---|--------------------------------------|-----------------------------|
| | | | Coefficient of friction ^a | Cohesion (psf) ^b |
| 1. Crystalline bedrock | 12,000 | 1,200 | 0.70 | — |
| 2. Sedimentary and foliated rock | 4,000 | 400 | 0.35 | — |
| 3. Sandy gravel and/or gravel (GW and GP) | 3,000 | 200 | 0.35 | — |
| 4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC) | 2,000 | 150 | 0.25 | — |
| 5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH) | 1,500 | 100 | — | 130 |

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.

1807.1.5 Concrete and masonry foundation walls. Concrete and masonry foundation walls shall be designed in accordance with Chapter 19 or 21, as applicable.

Exception: Concrete and masonry foundation walls shall be permitted to be designed and constructed in accordance with Section 1807.1.6.

1807.1.6 Prescriptive design of concrete and masonry foundation walls. Concrete and masonry foundation walls that are laterally supported at the top and bottom shall be permitted to be designed and constructed in accordance with this section.

1807.1.6.1 Foundation wall thickness. The thickness of prescriptively designed foundation walls shall not be less than the thickness of the wall supported, except that foundation walls of at least 8-inch (203 mm) nominal width shall be permitted to support brick-veneered frame walls and 10-inch-wide (254 mm) cavity walls provided the requirements of Section 1807.1.6.2 or 1807.1.6.3 are met.

1807.1.6.2 Concrete foundation walls. Concrete foundation walls shall comply with the following:

- The thickness shall comply with the requirements of Table 1807.1.6.2.
- The size and spacing of vertical reinforcement shown in Table 1807.1.6.2 is based on the use of reinforcement with a minimum yield strength of 60,000 pounds per square inch (psi) (414 MPa). Vertical reinforcement with a minimum yield strength of 40,000 psi (276 MPa) or 50,000 psi (345 MPa) shall be permitted, provided the same size bar is used and the spacing shown in the table is reduced by multiplying the spacing by 0.67 or 0.83, respectively.
- Vertical reinforcement, when required, shall be placed nearest the inside face of the wall a distance, d , from the outside face (soil face) of the wall. The distance, d , is equal to the wall thickness, t , minus 1.25 inches (32 mm) plus one-half

TABLE 1807.1.6.2
CONCRETE FOUNDATION WALLS^{b,c}

| MAXIMUM WALL HEIGHT (feet) | MAXIMUM UNBALANCED BACKFILL HEIGHT ^a (feet) | MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) | | | | | | | | |
|----------------------------------|---|---|----------|------|-----------------|----------|----------|----------|----------|----------|
| | | Design lateral soil load ^a (psf per foot of depth) | | | | | | | | |
| | | 30 ^d | | | 45 ^d | | | 60 | | |
| | | 7.5 | 9.5 | 11.5 | 7.5 | 9.5 | 11.5 | 7.5 | 9.5 | 11.5 |
| 5 | 4 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 5 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| 6 | 4 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 5 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 6 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| 7 | 4 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 5 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 6 | PC | PC | PC | PC | PC | PC | #5 at 48 | PC | PC |
| | 7 | PC | PC | PC | #5 at 46 | PC | PC | #6 at 48 | PC | PC |
| 8 | 4 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 5 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 6 | PC | PC | PC | PC | PC | PC | #5 at 43 | PC | PC |
| | 7 | PC | PC | PC | #5 at 41 | PC | PC | #6 at 43 | PC | PC |
| | 8 | #5 at 47 | PC | PC | #6 at 43 | PC | PC | #6 at 32 | #6 at 44 | PC |
| 9 | 4 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 5 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 6 | PC | PC | PC | PC | PC | PC | #5 at 39 | PC | PC |
| | 7 | PC | PC | PC | #5 at 37 | PC | PC | #6 at 38 | #5 at 37 | PC |
| | 8 | #5 at 41 | PC | PC | #6 at 38 | #5 at 37 | PC | #7 at 39 | #6 at 39 | #4 at 48 |
| | 9 ^d | #6 at 46 | PC | PC | #7 at 41 | #6 at 41 | PC | #7 at 31 | #7 at 41 | #6 at 39 |
| 10 | 4 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 5 | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| | 6 | PC | PC | PC | PC | PC | PC | #5 at 37 | PC | PC |
| | 7 | PC | PC | PC | #6 at 48 | PC | PC | #6 at 35 | #6 at 48 | PC |
| | 8 | #5 at 38 | PC | PC | #7 at 47 | #6 at 47 | PC | #7 at 35 | #7 at 47 | #6 at 45 |
| | 9 ^d | #6 at 41 | #4 at 48 | PC | #7 at 37 | #7 at 48 | #4 at 48 | #6 at 22 | #7 at 37 | #7 at 47 |
| | 10 ^d | #7 at 45 | #6 at 45 | PC | #7 at 31 | #7 at 40 | #6 at 38 | #6 at 22 | #7 at 30 | #7 at 38 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

- For design lateral soil loads, see Section 1610.
- Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.2.
- "PC" means plain concrete.
- Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable (see Section 1610).
- For height of unbalanced backfill, see Section 1807.1.2.

the bar diameter, d_b , [$d = t - (1.25 + d_b / 2)$]. The reinforcement shall be placed within a tolerance of $\pm \frac{3}{8}$ inch (9.5 mm) where d is less than or equal to 8 inches (203 mm) or $\pm \frac{1}{2}$ inch (12.7 mm) where d is greater than 8 inches (203 mm).

4. In lieu of the reinforcement shown in Table 1807.1.6.2, smaller reinforcing bar sizes with closer spacings that provide an equivalent cross-sectional area of reinforcement per unit length shall be permitted.
5. Concrete cover for reinforcement measured from the inside face of the wall shall not be less than $\frac{3}{4}$ inch (19.1 mm). Concrete cover for reinforcement measured from the outside face of the wall shall not be less than $1\frac{1}{2}$ inches (38 mm) for No. 5 bars and smaller, and not less than 2 inches (51 mm) for larger bars.
6. Concrete shall have a specified compressive strength, f'_c , of not less than 2,500 psi (17.2 MPa).
7. The unfactored axial load per linear foot of wall shall not exceed $1.2 t f'_c$ where t is the specified wall thickness in inches.

1807.1.6.2.1 Seismic requirements. Based on the seismic design category assigned to the structure in accordance with Section 1613, concrete foundation walls designed using Table 1807.1.6.2 shall be subject to the following limitations:

1. Seismic Design Categories A and B. Not less than one No. 5 bar shall be provided around

window, door and similar sized openings. The bar shall be anchored to develop f_y in tension at the corners of openings.

2. Seismic Design Categories C, D, E and F. Tables shall not be used except as allowed for plain concrete members in Section 1905.1.8.

1807.1.6.3 Masonry foundation walls. Masonry foundation walls shall comply with the following:

1. The thickness shall comply with the requirements of Table 1807.1.6.3(1) for plain masonry walls or Table 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4) for masonry walls with reinforcement.
2. Vertical reinforcement shall have a minimum yield strength of 60,000 psi (414 MPa).
3. The specified location of the reinforcement shall equal or exceed the effective depth distance, d , noted in Tables 1807.1.6.3(2), 1807.1.6.3(3) and 1807.1.6.3(4) and shall be measured from the face of the exterior (soil) side of the wall to the center of the vertical reinforcement. The reinforcement shall be placed within the tolerances specified in TMS 602/ACI 530.1/ASCE 6, Article 3.4.B.8 of the specified location.
4. Grout shall comply with Section 2103.13.
5. Concrete masonry units shall comply with ASTM C 90.
6. Clay masonry units shall comply with ASTM C 652 for hollow brick, except compliance with

TABLE 1807.1.6.3(1)
PLAIN MASONRY FOUNDATION WALLS^{a, b, c}

| MAXIMUM WALL HEIGHT (feet) | MAXIMUM UNBALANCED BACKFILL HEIGHT ^e (feet) | MINIMUM NOMINAL WALL THICKNESS (inches) | | |
|-------------------------------|---|---|--------------------------|--------------------------|
| | | Design lateral soil load ^a (psf per foot of depth) | | |
| | | 30' ^f | 45' | 60 |
| 7 | 4 (or less) | 8 | 8 | 8 |
| | 5 | 8 | 10 | 10 |
| | 6 | 10 | 12 | 10 (solid ^c) |
| | 7 | 12 | 10 (solid ^c) | 10 (solid ^c) |
| 8 | 4 (or less) | 8 | 8 | 8 |
| | 5 | 8 | 10 | 12 |
| | 6 | 10 | 12 | 12 (solid ^c) |
| | 7 | 12 | 12 (solid ^c) | Note d |
| | 8 | 10 (solid ^c) | 12 (solid ^c) | Note d |
| 9 | 4 (or less) | 8 | 8 | 8 |
| | 5 | 8 | 10 | 12 |
| | 6 | 12 | 12 | 12 (solid ^c) |
| | 7 | 12 (solid ^c) | 12 (solid ^c) | Note d |
| | 8 | 12 (solid ^c) | Note d | Note d |
| | 9 ^f | Note d | Note d | Note d |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

- a. For design lateral soil loads, see Section 1610.
- b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.
- c. Solid grouted hollow units or solid masonry units.
- d. A design in compliance with Chapter 21 or reinforcement in accordance with Table 1807.1.6.3(2) is required.
- e. For height of unbalanced backfill, see Section 1807.1.2.
- f. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable (see Section 1610).

ASTM C 62 or ASTM C 216 shall be permitted where solid masonry units are installed in accordance with Table 1807.1.6.3(1) for plain masonry.

7. Masonry units shall be laid in running bond and installed with Type M or S mortar in accordance with Section 2103.9.
8. The unfactored axial load per linear foot of wall shall not exceed $1.2 t f'_m$ where t is the specified wall thickness in inches and f'_m is the specified compressive strength of masonry in pounds per square inch.
9. At least 4 inches (102 mm) of solid masonry shall be provided at girder supports at the top of hollow masonry unit foundation walls.
10. Corbeling of masonry shall be in accordance with Section 2104.2. Where an 8-inch (203 mm) wall is corbeled, the top corbel shall not

extend higher than the bottom of the floor framing and shall be a full course of headers at least 6 inches (152 mm) in length or the top course bed joint shall be tied to the vertical wall projection. The tie shall be W2.8 (4.8 mm) and spaced at a maximum horizontal distance of 36 inches (914 mm). The hollow space behind the corbelled masonry shall be filled with mortar or grout.

1807.1.6.3.1 Alternative foundation wall reinforcement. In lieu of the reinforcement provisions for masonry foundation walls in Table 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4), alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per linear foot (mm) of wall shall be permitted to be used, provided the spacing of reinforcement does not exceed 72 inches (1829 mm) and reinforcing bar sizes do not exceed No. 11.

TABLE 1807.1.6.3(2)
8-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE $d \geq 5$ INCHES^{a, b, c}

| MAXIMUM WALL HEIGHT (feet-inches) | MAXIMUM UNBALANCED BACKFILL HEIGHT ^d (feet-inches) | MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) | | |
|--------------------------------------|---|--|----------|----------|
| | | Design lateral soil load ^a (psf per foot of depth) | | |
| | | 30° | 45° | 60 |
| 7-4 | 4-0 (or less) | #4 at 48 | #4 at 48 | #4 at 48 |
| | 5-0 | #4 at 48 | #4 at 48 | #4 at 48 |
| | 6-0 | #4 at 48 | #5 at 48 | #5 at 48 |
| | 7-4 | #5 at 48 | #6 at 48 | #7 at 48 |
| 8-0 | 4-0 (or less) | #4 at 48 | #4 at 48 | #4 at 48 |
| | 5-0 | #4 at 48 | #4 at 48 | #4 at 48 |
| | 6-0 | #4 at 48 | #5 at 48 | #5 at 48 |
| | 7-0 | #5 at 48 | #6 at 48 | #7 at 48 |
| | 8-0 | #5 at 48 | #6 at 48 | #7 at 48 |
| 8-8 | 4-0 (or less) | #4 at 48 | #4 at 48 | #4 at 48 |
| | 5-0 | #4 at 48 | #4 at 48 | #5 at 48 |
| | 6-0 | #4 at 48 | #5 at 48 | #6 at 48 |
| | 7-0 | #5 at 48 | #6 at 48 | #7 at 48 |
| | 8-8 ^e | #6 at 48 | #7 at 48 | #8 at 48 |
| 9-4 | 4-0 (or less) | #4 at 48 | #4 at 48 | #4 at 48 |
| | 5-0 | #4 at 48 | #4 at 48 | #5 at 48 |
| | 6-0 | #4 at 48 | #5 at 48 | #6 at 48 |
| | 7-0 | #5 at 48 | #6 at 48 | #7 at 48 |
| | 8-0 | #6 at 48 | #7 at 48 | #8 at 48 |
| | 9-4 ^e | #7 at 48 | #8 at 48 | #9 at 48 |
| 10-0 | 4-0 (or less) | #4 at 48 | #4 at 48 | #4 at 48 |
| | 5-0 | #4 at 48 | #4 at 48 | #5 at 48 |
| | 6-0 | #4 at 48 | #5 at 48 | #6 at 48 |
| | 7-0 | #5 at 48 | #6 at 48 | #7 at 48 |
| | 8-0 | #6 at 48 | #7 at 48 | #8 at 48 |
| | 9-0 ^e | #7 at 48 | #8 at 48 | #9 at 48 |
| | 10-0 ^e | #7 at 48 | #9 at 48 | #9 at 48 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.

c. For alternative reinforcement, see Section 1807.1.6.3.1

d. For height of unbalanced backfill, see Section 1807.1.2

e. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.

TABLE 1807.1.6.3(3)
10-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE $d \geq 6.75$ INCHES^{a, b, c}

| MAXIMUM WALL HEIGHT (feet-inches) | MAXIMUM UNBALANCED BACKFILL HEIGHT ^d (feet-inches) | MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) | | |
|--------------------------------------|---|---|----------|----------|
| | | Design lateral soil load ^e (psf per foot of depth) | | |
| | | 30° | 45° | 60 |
| 7-4 | 4-0 (or less) | #4 at 56 | #4 at 56 | #4 at 56 |
| | 5-0 | #4 at 56 | #4 at 56 | #4 at 56 |
| | 6-0 | #4 at 56 | #4 at 56 | #5 at 56 |
| | 7-4 | #4 at 56 | #5 at 56 | #6 at 56 |
| 8-0 | 4-0 (or less) | #4 at 56 | #4 at 56 | #4 at 56 |
| | 5-0 | #4 at 56 | #4 at 56 | #4 at 56 |
| | 6-0 | #4 at 56 | #4 at 56 | #5 at 56 |
| | 7-0 | #4 at 56 | #5 at 56 | #6 at 56 |
| | 8-0 | #5 at 56 | #6 at 56 | #7 at 56 |
| 8-8 | 4-0 (or less) | #4 at 56 | #4 at 56 | #4 at 56 |
| | 5-0 | #4 at 56 | #4 at 56 | #4 at 56 |
| | 6-0 | #4 at 56 | #4 at 56 | #5 at 56 |
| | 7-0 | #4 at 56 | #5 at 56 | #6 at 56 |
| | 8-8 ^e | #5 at 56 | #7 at 56 | #8 at 56 |
| 9-4 | 4-0 (or less) | #4 at 56 | #4 at 56 | #4 at 56 |
| | 5-0 | #4 at 56 | #4 at 56 | #4 at 56 |
| | 6-0 | #4 at 56 | #5 at 56 | #5 at 56 |
| | 7-0 | #4 at 56 | #5 at 56 | #6 at 56 |
| | 8-0 | #5 at 56 | #6 at 56 | #7 at 56 |
| | 9-4 ^e | #6 at 56 | #7 at 56 | #7 at 56 |
| 10-0 | 4-0 (or less) | #4 at 56 | #4 at 56 | #4 at 56 |
| | 5-0 | #4 at 56 | #4 at 56 | #4 at 56 |
| | 6-0 | #4 at 56 | #5 at 56 | #5 at 56 |
| | 7-0 | #5 at 56 | #6 at 56 | #7 at 56 |
| | 8-0 | #5 at 56 | #7 at 56 | #8 at 56 |
| | 9-0 ^e | #6 at 56 | #7 at 56 | #9 at 56 |
| | 10-0 ^e | #7 at 56 | #8 at 56 | #9 at 56 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8, 1 pound per square foot per foot = 1.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.

c. For alternative reinforcement, see Section 1807.1.6.3.1.

d. For height of unbalanced backfill, See Section 1807.1.2.

e. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.

TABLE 1807.1.6.3(4)
12-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE $d \geq 8.75$ INCHES^{a, b, c}

| MAXIMUM WALL HEIGHT (feet-inches) | MAXIMUM UNBALANCED BACKFILL HEIGHT ^d (feet-inches) | MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) | | |
|--------------------------------------|---|---|----------|----------|
| | | Design lateral soil load ^a (psf per foot of depth) | | |
| | | 30° | 45° | 60 |
| 7-4 | 4 (or less) | #4 at 72 | #4 at 72 | #4 at 72 |
| | 5-0 | #4 at 72 | #4 at 72 | #4 at 72 |
| | 6-0 | #4 at 72 | #4 at 72 | #5 at 72 |
| | 7-4 | #4 at 72 | #5 at 72 | #6 at 72 |
| 8-0 | 4 (or less) | #4 at 72 | #4 at 72 | #4 at 72 |
| | 5-0 | #4 at 72 | #4 at 72 | #4 at 72 |
| | 6-0 | #4 at 72 | #4 at 72 | #5 at 72 |
| | 7-0 | #4 at 72 | #5 at 72 | #6 at 72 |
| | 8-0 | #5 at 72 | #6 at 72 | #8 at 72 |
| 8-8 | 4 (or less) | #4 at 72 | #4 at 72 | #4 at 72 |
| | 5-0 | #4 at 72 | #4 at 72 | #4 at 72 |
| | 6-0 | #4 at 72 | #4 at 72 | #5 at 72 |
| | 7-0 | #4 at 72 | #5 at 72 | #6 at 72 |
| | 8-8 ^e | #5 at 72 | #7 at 72 | #8 at 72 |
| 9-4 | 4 (or less) | #4 at 72 | #4 at 72 | #4 at 72 |
| | 5-0 | #4 at 72 | #4 at 72 | #4 at 72 |
| | 6-0 | #4 at 72 | #5 at 72 | #5 at 72 |
| | 7-0 | #4 at 72 | #5 at 72 | #6 at 72 |
| | 8-0 | #5 at 72 | #6 at 72 | #7 at 72 |
| | 9-4 ^e | #6 at 72 | #7 at 72 | #8 at 72 |
| 10-0 | 4 (or less) | #4 at 72 | #4 at 72 | #4 at 72 |
| | 5-0 | #4 at 72 | #4 at 72 | #4 at 72 |
| | 6-0 | #4 at 72 | #5 at 72 | #5 at 72 |
| | 7-0 | #4 at 72 | #6 at 72 | #6 at 72 |
| | 8-0 | #5 at 72 | #6 at 72 | #7 at 72 |
| | 9-0 ^e | #6 at 72 | #7 at 72 | #8 at 72 |
| | 10-0 ^e | #7 at 72 | #8 at 72 | #9 at 72 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

- a. For design lateral soil loads, see Section 1610.
- b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.
- c. For alternative reinforcement, see Section 1807.1.6.3.1.
- d. For height of unbalanced backfill, see Section 1807.1.2.
- e. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.

1807.1.6.3.2 Seismic requirements. Based on the seismic design category assigned to the structure in accordance with Section 1613, masonry foundation walls designed using Tables 1807.1.6.3(1) through 1807.1.6.3(4) shall be subject to the following limitations:

1. Seismic Design Categories A and B. No additional seismic requirements.
2. Seismic Design Category C. A design using Tables 1807.1.6.3(1) through 1807.1.6.3(4) is subject to the seismic requirements of Section 1.18.4.3 of TMS 402/ACI 530/ASCE 5.
3. Seismic Design Category D. A design using Tables 1807.1.6.3(2) through 1807.1.6.3(4) is subject to the seismic requirements of Section 1.18.4.4 of TMS 402/ACI 530/ASCE 5.
4. Seismic Design Categories E and F. A design using Tables 1807.1.6.3(2) through 1807.1.6.3(4) is subject to the seismic require-

ments of Section 1.18.4.5 of TMS 402/ACI 530/ASCE 5.

1807.2 Retaining walls. Retaining walls shall be designed in accordance with Sections 1807.2.1 through 1807.2.3.

1807.2.1 General. Retaining walls shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Where a keyway is extended below the wall base with the intent to engage passive pressure and enhance sliding stability, lateral soil pressures on both sides of the keyway shall be considered in the sliding analysis.

1807.2.2 Design lateral soil loads. Retaining walls shall be designed for the lateral soil loads set forth in Section 1610.

1807.2.3 Safety factor. Retaining walls shall be designed to resist the lateral action of soil to produce sliding and overturning with a minimum safety factor of 1.5 in each case. The load combinations of Section 1605 shall not apply to this requirement. Instead, design shall be based on 0.7 times nominal earthquake loads, 1.0 times other nomi-

nal loads, and investigation with one or more of the variable loads set to zero. The safety factor against lateral sliding shall be taken as the available soil resistance at the base of the retaining wall foundation divided by the net lateral force applied to the retaining wall.

Exception: Where earthquake loads are included, the minimum safety factor for retaining wall sliding and overturning shall be 1.1.

1807.3 Embedded posts and poles. Designs to resist both axial and lateral loads employing posts or poles as columns embedded in earth or in concrete footings in earth shall be in accordance with Sections 1807.3.1 through 1807.3.3.

1807.3.1 Limitations. The design procedures outlined in this section are subject to the following limitations:

1. The frictional resistance for structural walls and slabs on silts and clays shall be limited to one-half of the normal force imposed on the soil by the weight of the footing or slab.
2. Posts embedded in earth shall not be used to provide lateral support for structural or nonstructural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

Wood poles shall be treated in accordance with AWPA U1 for sawn timber posts (Commodity Specification A, Use Category 4B) and for round timber posts (Commodity Specification B, Use Category 4B).

1807.3.2 Design criteria. The depth to resist lateral loads shall be determined using the design criteria established in Sections 1807.3.2.1 through 1807.3.2.3, or by other methods approved by the building official.

1807.3.2.1 Nonconstrained. The following formula shall be used in determining the depth of embedment required to resist lateral loads where no lateral constraint is provided at the ground surface, such as by a rigid floor or rigid ground surface pavement, and where no lateral constraint is provided above the ground surface, such as by a structural diaphragm.

$$d = 0.5A \{1 + [1 + (4.36h/A)]^{1/2}\} \quad (\text{Equation 18-1})$$

where:

$$A = 2.34P/(S_1 b)$$

b = Diameter of round post or footing or diagonal dimension of square post or footing, feet (m).

d = Depth of embedment in earth in feet (m) but not over 12 feet (3.658 m) for purpose of computing lateral pressure.

h = Distance in feet (m) from ground surface to point of application of " P ".

P = Applied lateral force in pounds (kN).

S_1 = Allowable lateral soil-bearing pressure as set forth in Section 1806.2 based on a depth of one-third the depth of embedment in pounds per square foot (psf) (kPa).

1807.3.2.2 Constrained. The following formula shall be used to determine the depth of embedment required

to resist lateral loads where lateral constraint is provided at the ground surface, such as by a rigid floor or pavement.

$$d = \sqrt{\frac{4.25Ph}{S_3 b}} \quad (\text{Equation 18-2})$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3 b}} \quad (\text{Equation 18-3})$$

where:

M_g = Moment in the post at grade, in foot-pounds (kN-m).

S_3 = Allowable lateral soil-bearing pressure as set forth in Section 1806.2 based on a depth equal to the depth of embedment in pounds per square foot (kPa).

1807.3.2.3 Vertical load. The resistance to vertical loads shall be determined using the vertical foundation pressure set forth in Table 1806.2.

1807.3.3 Backfill. The backfill in the annular space around columns not embedded in poured footings shall be by one of the following methods:

1. Backfill shall be of concrete with a specified compressive strength of not less than 2,000 psi (13.8 MPa). The hole shall not be less than 4 inches (102 mm) larger than the diameter of the column at its bottom or 4 inches (102 mm) larger than the diagonal dimension of a square or rectangular column.
2. Backfill shall be of clean sand. The sand shall be thoroughly compacted by tamping in layers not more than 8 inches (203 mm) in depth.
3. Backfill shall be of controlled low-strength material (CLSM).

SECTION 1808 FOUNDATIONS

1808.1 General. Foundations shall be designed and constructed in accordance with Sections 1808.2 through 1808.9. Shallow foundations shall also satisfy the requirements of Section 1809. Deep foundations shall also satisfy the requirements of Section 1810.

1808.2 Design for capacity and settlement. Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that differential settlement is minimized. Foundations in areas with expansive soils shall be designed in accordance with the provisions of Section 1808.6.

1808.3 Design loads. Foundations shall be designed for the most unfavorable effects due to the combinations of loads specified in Section 1605.2 or 1605.3. The dead load is permitted to include the weight of foundations and overlying fill. Reduced live loads, as specified in Sections 1607.10 and 1607.12, shall be permitted to be used in the design of foundations.

1808.3.1 Seismic overturning. Where foundations are proportioned using the load combinations of Section 1605.2 or 1605.3.1, and the computation of seismic overturning effects is by equivalent lateral force analysis or modal analysis, the proportioning shall be in accordance with Section 12.13.4 of ASCE 7.

1808.4 Vibratory loads. Where machinery operations or other vibrations are transmitted through the foundation, consideration shall be given in the foundation design to prevent detrimental disturbances of the soil.

1808.5 Shifting or moving soils. Where it is known that the shallow subsoils are of a shifting or moving character, foundations shall be carried to a sufficient depth to ensure stability.

1808.6 Design for expansive soils. Foundations for buildings and structures founded on expansive soils shall be designed in accordance with Section 1808.6.1 or 1808.6.2.

Exception: Foundation design need not comply with Section 1808.6.1 or 1808.6.2 where one of the following conditions is satisfied:

1. The soil is removed in accordance with Section 1808.6.3; or
2. The building official approves stabilization of the soil in accordance with Section 1808.6.4.

1808.6.1 Foundations. Foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

1808.6.2 Slab-on-ground foundations. Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive soils shall be determined in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* or *PTI Standard Requirements for Analysis of Shallow Concrete Foundations on Expansive Soils*. Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *PTI Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils*. It shall be permitted to analyze and design such slabs by

other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

1808.6.3 Removal of expansive soil. Where expansive soil is removed in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive soils and shall comply with Section 1804.5 or 1804.6.

Exception: Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

1808.6.4 Stabilization. Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

1808.7 Foundations on or adjacent to slopes. The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall comply with Sections 1808.7.1 through 1808.7.5.

1808.7.1 Building clearance from ascending slopes. In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in Section 1808.7.5 and Figure 1808.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

1808.7.2 Foundation setback from descending slope surface. Foundations on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the foundation without detrimental settlement. Except as provided for in Section 1808.7.5 and Figure 1808.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

1808.7.3 Pools. The setback between pools regulated by this code and slopes shall be equal to one-half the building footing setback distance required by this section. That portion of the pool wall within a horizontal distance of 7 feet

(2134 mm) from the top of the slope shall be capable of supporting the water in the pool without soil support.

1808.7.4 Foundation elevation. On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the building official, provided it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

1808.7.5 Alternate setback and clearance. Alternate setbacks and clearances are permitted, subject to the approval of the building official. The building official shall be permitted to require a geotechnical investigation as set forth in Section 1803.5.10.

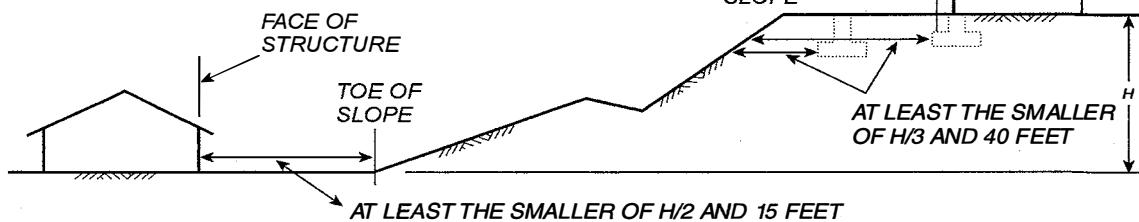
1808.8 Concrete foundations. The design, materials and construction of concrete foundations shall comply with Sections 1808.8.1 through 1808.8.6 and the provisions of Chapter 19.

Exception: Where concrete footings supporting walls of light-frame construction are designed in accordance with Table 1809.7, a specific design in accordance with Chapter 19 is not required.

1808.8.1 Concrete or grout strength and mix proportioning. Concrete or grout in foundations shall have a specified compressive strength (f'_c) not less than the largest applicable value indicated in Table 1808.8.1.

Where concrete is placed through a funnel hopper at the top of a deep foundation element, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 8 inches (204 mm). Where concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.

1808.8.2 Concrete cover. The concrete cover provided for prestressed and nonprestressed reinforcement in foundations shall be no less than the largest applicable value specified in Table 1808.8.2. Longitudinal bars spaced less than $1\frac{1}{2}$ inches (38 mm) clear distance apart shall be considered bundled bars for which the concrete cover provided shall also be no less than that required by Section 7.7.4 of ACI 318. Concrete cover shall be measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. Where concrete is placed in a temporary or permanent casing or a mandrel, the inside face of the casing or mandrel shall be considered the concrete surface.



For SI: 1 foot = 304.8 mm.

**FIGURE 1808.7.1
FOUNDATION CLEARANCES FROM SLOPES**

**TABLE 1808.8.1
MINIMUM SPECIFIED COMPRESSIVE STRENGTH f'_c OF CONCRETE OR GROUT**

| FOUNDATION ELEMENT OR CONDITION | SPECIFIED COMPRESSIVE STRENGTH, f'_c |
|--|--|
| 1. Foundations for structures assigned to Seismic Design Category A, B or C | 2,500 psi |
| 2a. Foundations for Group R or U occupancies of light-frame construction, two stories or less in height, assigned to Seismic Design Category D, E or F | 2,500 psi |
| 2b. Foundations for other structures assigned to Seismic Design Category D, E or F | 3,000 psi |
| 3. Precast nonprestressed driven piles | 4,000 psi |
| 4. Socketed drilled shafts | 4,000 psi |
| 5. Micropiles | 4,000 psi |
| 6. Precast prestressed driven piles | 5,000 psi |

For SI: 1 pound per square inch = 0.00689 MPa.

**TABLE 1808.8.2
MINIMUM CONCRETE COVER**

| FOUNDATION ELEMENT OR CONDITION | MINIMUM COVER |
|--|---|
| 1. Shallow foundations | In accordance with Section 7.7 of ACI 318 |
| 2. Precast non prestressed deep foundation elements Exposed to seawater Not manufactured under plant conditions Manufactured under plant control conditions | 3 inches 2 inches In accordance with Section 7.7.3 of ACI 318 |
| 3. Precast prestressed deep foundation elements Exposed to seawater Other | 2.5 inches In accordance with Section 7.7.3 of ACI 318 |
| 4. Cast-in-place deep foundation elements not enclosed by a steel pipe, tube or permanent casing | 2.5 inches |
| 5. Cast-in-place deep foundation elements enclosed by a steel pipe, tube or permanent casing | 1 inch |
| 6. Structural steel core within a steel pipe, tube or permanent casing | 2 inches |
| 7. Cast-in-place drilled shafts enclosed by a stable rock socket | 1.5 inches |

For SI: 1 inch = 25.4 mm.

1808.8.3 Placement of concrete. Concrete shall be placed in such a manner as to ensure the exclusion of any foreign matter and to secure a full-size foundation. Concrete shall not be placed through water unless a tremie or other method approved by the building official is used. Where placed under or in the presence of water, the concrete shall be deposited by approved means to ensure minimum segregation of the mix and negligible turbulence of the water. Where depositing concrete from the top of a deep foundation element, the concrete shall be chuted directly into smooth-sided pipes or tubes or placed in a rapid and continuous operation through a funnel hopper centered at the top of the element.

1808.8.4 Protection of concrete. Concrete foundations shall be protected from freezing during depositing and for a period of not less than five days thereafter. Water shall not be allowed to flow through the deposited concrete.

1808.8.5 Forming of concrete. Concrete foundations are permitted to be cast against the earth where, in the opinion of the building official, soil conditions do not require formwork. Where formwork is required, it shall be in accordance with Chapter 6 of ACI 318.

1808.8.6 Seismic requirements. See Section 1908 for additional requirements for foundations of structures assigned to Seismic Design Category C, D, E or F.

For structures assigned to Seismic Design Category D, E or F, provisions of ACI 318, Sections 21.12.1 through 21.12.4, shall apply where not in conflict with the provisions of Sections 1808 through 1810.

Exceptions:

1. Detached one- and two-family dwellings of light-frame construction and two stories or less above grade plane are not required to comply with the provisions of ACI 318, Sections 21.12.1 through 21.12.4.

2. Section 21.12.4.4(a) of ACI 318 shall not apply.

1808.9 Vertical masonry foundation elements. Vertical masonry foundation elements that are not foundation piers as defined in Section 202 shall be designed as piers, walls or columns, as applicable, in accordance with TMS 402/ACI 530/ASCE 5.

SECTION 1809 SHALLOW FOUNDATIONS

1809.1 General. Shallow foundations shall be designed and constructed in accordance with Sections 1809.2 through 1809.13.

1809.2 Supporting soils. Shallow foundations shall be built on undisturbed soil, compacted fill material or controlled low-strength material (CLSM). Compacted fill material shall be placed in accordance with Section 1804.5. CLSM shall be placed in accordance with Section 1804.6.

1809.3 Stepped footings. The top surface of footings shall be level. The bottom surface of footings shall be permitted to have a slope not exceeding one unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footing or where the surface of the ground slopes more than one unit vertical in 10 units horizontal (10-percent slope).

1809.4 Depth and width of footings. The minimum depth of footings below the undisturbed ground surface shall be 12 inches (305 mm). Where applicable, the requirements of Section 1809.5 shall also be satisfied. The minimum width of footings shall be 12 inches (305 mm).

1809.5 Frost protection. Except where otherwise protected from frost, foundations and other permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:

1. Extending below the frost line of the locality;

2. Constructing in accordance with ASCE 32; or
3. Erecting on solid rock.

Exception: Free-standing buildings meeting all of the following conditions shall not be required to be protected:

1. Assigned to Risk Category I, in accordance with Section 1604.5;
2. Area of 600 square feet (56 m^2) or less for light-frame construction or 400 square feet (37 m^2) or less for other than light-frame construction; and
3. Eave height of 10 feet (3048 mm) or less.

Shallow foundations shall not bear on frozen soil unless such frozen condition is of a permanent character.

1809.6 Location of footings. Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an approved manner or a greater slope has been properly established by engineering analysis.

1809.7 Prescriptive footings for light-frame construction. Where a specific design is not provided, concrete or masonry-unit footings supporting walls of light-frame construction shall be permitted to be designed in accordance with Table 1809.7.

**TABLE 1809.7
PREScriptive FOOTINGS SUPPORTING WALLS OF
LIGHT-FRAME CONSTRUCTION^{a, b, c, d, e}**

| NUMBER OF FLOORS SUPPORTED BY THE FOOTING ^f | WIDTH OF FOOTING (inches) | THICKNESS OF FOOTING (inches) |
|--|---------------------------|-------------------------------|
| 1 | 12 | 6 |
| 2 | 15 | 6 |
| 3 | 18 | 8 ^g |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Depth of footings shall be in accordance with Section 1809.4.
- b. The ground under the floor shall be permitted to be excavated to the elevation of the top of the footing.
- c. Interior stud bearing walls shall be permitted to be supported by isolated footings. The footing width and length shall be twice the width shown in this table, and footings shall be spaced not more than 6 feet on center.
- d. See Section 1905 for additional requirements for concrete footings of structures assigned to Seismic Design Category C, D, E or F.
- e. For thickness of foundation walls, see Section 1807.1.6.
- f. Footings shall be permitted to support a roof in addition to the stipulated number of floors. Footings supporting roof only shall be as required for supporting one floor.
- g. Plain concrete footings for Group R 3 occupancies shall be permitted to be 6 inches thick.

1809.8 Plain concrete footings. The edge thickness of plain concrete footings supporting walls of other than light-frame construction shall not be less than 8 inches (203 mm) where placed on soil or rock.

Exception: For plain concrete footings supporting Group R-3 occupancies, the edge thickness is permitted to be 6 inches (152 mm), provided that the footing does not extend beyond a distance greater than the thickness of the footing on either side of the supported wall.

1809.9 Masonry-unit footings. The design, materials and construction of masonry-unit footings shall comply with Sec-

tions 1809.9.1 and 1809.9.2, and the provisions of Chapter 21.

Exception: Where a specific design is not provided, masonry-unit footings supporting walls of light-frame construction shall be permitted to be designed in accordance with Table 1809.7.

1809.9.1 Dimensions. Masonry-unit footings shall be laid in Type M or S mortar complying with Section 2103.9 and the depth shall not be less than twice the projection beyond the wall, pier or column. The width shall not be less than 8 inches (203 mm) wider than the wall supported thereon.

1809.9.2 Offsets. The maximum offset of each course in brick foundation walls stepped up from the footings shall be $1\frac{1}{2}$ inches (38 mm) where laid in single courses, and 3 inches (76 mm) where laid in double courses.

1809.10 Pier and curtain wall foundations. Except in Seismic Design Categories D, E and F, pier and curtain wall foundations shall be permitted to be used to support light-frame construction not more than two stories above grade plane, provided the following requirements are met:

1. All load-bearing walls shall be placed on continuous concrete footings bonded integrally with the exterior wall footings.
2. The minimum actual thickness of a load-bearing masonry wall shall not be less than 4 inches (102 mm) nominal or $3\frac{5}{8}$ inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced 6 feet (1829 mm) on center (o.c.).
3. Piers shall be constructed in accordance with Chapter 21 and the following:
 - 3.1. The unsupported height of the masonry piers shall not exceed 10 times their least dimension.
 - 3.2. Where structural clay tile or hollow concrete masonry units are used for piers supporting beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar.
4. Hollow piers shall be capped with 4 inches (102 mm) of solid masonry or concrete or the cavities of the top course shall be filled with concrete or grout.
5. The maximum height of a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood frame walls and floors shall not be more than 4 feet (1219 mm) in height.
6. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for solid masonry, nor 12 inches (305 mm) for hollow masonry.

1809.11 Steel grillage footings. Grillage footings of structural steel shapes shall be separated with approved steel spac-

ers and be entirely encased in concrete with at least 6 inches (152 mm) on the bottom and at least 4 inches (102 mm) at all other points. The spaces between the shapes shall be completely filled with concrete or cement grout.

1809.12 Timber footings. Timber footings shall be permitted for buildings of Type V construction and as otherwise approved by the building official. Such footings shall be treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B). Treated timbers are not required where placed entirely below permanent water level, or where used as capping for wood piles that project above the water level over submerged or marsh lands. The compressive stresses perpendicular to grain in untreated timber footings supported upon treated piles shall not exceed 70 percent of the allowable stresses for the species and grade of timber as specified in the AF&PA NDS.

1809.13 Footing seismic ties. Where a structure is assigned to Seismic Design Category D, E or F, individual spread footings founded on soil defined in Section 1613.3.2 as Site Class E or F shall be interconnected by ties. Unless it is demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger footing design gravity load times the seismic coefficient, S_{Dg} , divided by 10 and 25 percent of the smaller footing design gravity load.

SECTION 1810 DEEP FOUNDATIONS

1810.1 General. Deep foundations shall be analyzed, designed, detailed and installed in accordance with Sections 1810.1 through 1810.4.

1810.1.1 Geotechnical investigation. Deep foundations shall be designed and installed on the basis of a geotechnical investigation as set forth in Section 1803.

1810.1.2 Use of existing deep foundation elements. Deep foundation elements left in place where a structure has been demolished shall not be used for the support of new construction unless satisfactory evidence is submitted to the building official, which indicates that the elements are sound and meet the requirements of this code. Such elements shall be load tested or redriven to verify their capacities. The design load applied to such elements shall be the lowest allowable load as determined by tests or redriving data.

1810.1.3 Deep foundation elements classified as columns. Deep foundation elements standing unbraced in air, water or fluid soils shall be classified as columns and designed as such in accordance with the provisions of this code from their top down to the point where adequate lateral support is provided in accordance with Section 1810.2.1.

Exception: Where the unsupported height to least horizontal dimension of a cast-in-place deep foundation element does not exceed three, it shall be permitted to

design and construct such an element as a pedestal in accordance with ACI 318.

1810.1.4 Special types of deep foundations. The use of types of deep foundation elements not specifically mentioned herein is permitted, subject to the approval of the building official, upon the submission of acceptable test data, calculations and other information relating to the structural properties and load capacity of such elements. The allowable stresses for materials shall not in any case exceed the limitations specified herein.

1810.2 Analysis. The analysis of deep foundations for design shall be in accordance with Sections 1810.2.1 through 1810.2.5.

1810.2.1 Lateral support. Any soil other than fluid soil shall be deemed to afford sufficient lateral support to prevent buckling of deep foundation elements and to permit the design of the elements in accordance with accepted engineering practice and the applicable provisions of this code.

Where deep foundation elements stand unbraced in air, water or fluid soils, it shall be permitted to consider them laterally supported at a point 5 feet (1524 mm) into stiff soil or 10 feet (3048 mm) into soft soil unless otherwise approved by the building official on the basis of a geotechnical investigation by a registered design professional.

1810.2.2 Stability. Deep foundation elements shall be braced to provide lateral stability in all directions. Three or more elements connected by a rigid cap shall be considered braced, provided that the elements are located in radial directions from the centroid of the group not less than 60 degrees (1 rad) apart. A two-element group in a rigid cap shall be considered to be braced along the axis connecting the two elements. Methods used to brace deep foundation elements shall be subject to the approval of the building official.

Deep foundation elements supporting walls shall be placed alternately in lines spaced at least 1 foot (305 mm) apart and located symmetrically under the center of gravity of the wall load carried, unless effective measures are taken to provide for eccentricity and lateral forces, or the foundation elements are adequately braced to provide for lateral stability.

Exceptions:

1. Isolated cast-in-place deep foundation elements without lateral bracing shall be permitted where the least horizontal dimension is no less than 2 feet (610 mm), adequate lateral support in accordance with Section 1810.2.1 is provided for the entire height and the height does not exceed 12 times the least horizontal dimension.
2. A single row of deep foundation elements without lateral bracing is permitted for one- and two-family dwellings and lightweight construction not exceeding two stories above grade plane or 35 feet (10 668 mm) in building height, provided the centers of the elements are located within the width of the supported wall.

1810.2.3 Settlement. The settlement of a single deep foundation element or group thereof shall be estimated based on approved methods of analysis. The predicted settlement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

1810.2.4 Lateral loads. The moments, shears and lateral deflections used for design of deep foundation elements shall be established considering the nonlinear interaction of the shaft and soil, as determined by a registered design professional. Where the ratio of the depth of embedment of the element to its least horizontal dimension is less than or equal to six, it shall be permitted to assume the element is rigid.

1810.2.4.1 Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, deep foundation elements on Site Class E or F sites, as determined in Section 1613.3.2, shall be designed and constructed to withstand maximum imposed curvatures from earthquake ground motions and structure response. Curvatures shall include free-field soil strains modified for soil-foundation-structure interaction coupled with foundation element deformations associated with earthquake loads imparted to the foundation by the structure.

Exception: Deep foundation elements that satisfy the following additional detailing requirements shall be deemed to comply with the curvature capacity requirements of this section.

1. Precast prestressed concrete piles detailed in accordance with Section 1810.3.8.3.3.
2. Cast-in-place deep foundation elements with a minimum longitudinal reinforcement ratio of 0.005 extending the full length of the element and detailed in accordance with Sections 21.6.4.2, 21.6.4.3 and 21.6.4.4 of ACI 318 as required by Section 1810.3.9.4.2.2.

1810.2.5 Group effects. The analysis shall include group effects on lateral behavior where the center-to-center spacing of deep foundation elements in the direction of lateral force is less than eight times the least horizontal dimension of an element. The analysis shall include group effects on axial behavior where the center-to-center spacing of deep foundation elements is less than three times the least horizontal dimension of an element.

1810.3 Design and detailing. Deep foundations shall be designed and detailed in accordance with Sections 1810.3.1 through 1810.3.12.

1810.3.1 Design conditions. Design of deep foundations shall include the design conditions specified in Sections 1810.3.1.1 through 1810.3.1.6, as applicable.

1810.3.1.1 Design methods for concrete elements. Where concrete deep foundations are laterally supported in accordance with Section 1810.2.1 for the entire height and applied forces cause bending moments no greater than those resulting from accidental eccentricities, structural design of the element using the load

combinations of Section 1605.3 and the allowable stresses specified in this chapter shall be permitted. Otherwise, the structural design of concrete deep foundation elements shall use the load combinations of Section 1605.2 and approved strength design methods.

1810.3.1.2 Composite elements. Where a single deep foundation element comprises two or more sections of different materials or different types spliced together, each section of the composite assembly shall satisfy the applicable requirements of this code, and the maximum allowable load in each section shall be limited by the structural capacity of that section.

1810.3.1.3 Mislocation. The foundation or superstructure shall be designed to resist the effects of the mislocation of any deep foundation element by no less than 3 inches (76 mm). To resist the effects of mislocation, compressive overload of deep foundation elements to 110 percent of the allowable design load shall be permitted.

1810.3.1.4 Driven piles. Driven piles shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by handling, driving and service loads.

1810.3.1.5 Helical piles. Helical piles shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by installation into the ground and service loads.

1810.3.1.5.1 Helical piles seismic requirements.
[OSHPD 2] For structures assigned to Seismic Design Category D, E or F, capacities of helical piles shall be determined in accordance with Section 1810.3.3 by at least two project specific pre-production tests for each soil profile, size and depth of helical pile. At least two percent of all production piles shall be proof tested to design ultimate strength determined by using load combinations in Section 1605.2.1.

Helical piles shall satisfy corrosion resistance requirements of ICC-ES AC 358. In addition, all helical pile materials that are subject to corrosion shall include at least $\frac{1}{16}$ " corrosion allowance.

Helical piles shall not be considered as carrying any horizontal loads.

1810.3.1.6 Casings. Temporary and permanent casings shall be of steel and shall be sufficiently strong to resist collapse and sufficiently water tight to exclude any foreign materials during the placing of concrete. Where a permanent casing is considered reinforcing steel, the steel shall be protected under the conditions specified in Section 1810.3.2.5. Horizontal joints in the casing shall be spliced in accordance with Section 1810.3.6.

1810.3.2 Materials. The materials used in deep foundation elements shall satisfy the requirements of Sections 1810.3.2.1 through 1810.3.2.8, as applicable.

1810.3.2.1 Concrete. Where concrete is cast in a steel pipe or where an enlarged base is formed by compacting concrete, the maximum size for coarse aggregate

shall be $\frac{3}{4}$ inch (19.1 mm). Concrete to be compacted shall have a zero slump.

1810.3.2.1.1 Seismic hooks. For structures assigned to Seismic Design Category C, D, E or F, the ends of hoops, spirals and ties used in concrete deep foundation elements shall be terminated with seismic hooks, as defined in ACI 318, and shall be turned into the confined concrete core.

1810.3.2.1.2 ACI 318 Equation (10-5). here this chapter requires detailing of concrete deep foundation elements in accordance with Section 21.6.4.4 of ACI 318, compliance with Equation (10-5) of ACI 318 shall not be required.

1810.3.2.2 Prestressing steel. Prestressing steel shall conform to ASTM A 416.

1810.3.2.3 Structural steel. Structural steel piles, steel pipe and fully welded steel piles fabricated from plates shall conform to ASTM A 36, ASTM A 252, ASTM A 283, ASTM A 572, ASTM A 588, ASTM A 690, ASTM A 913 or ASTM A 992.

1810.3.2.4 Timber. Timber deep foundation elements shall be designed as piles or poles in accordance with AF&PA NDS. Round timber elements shall conform to ASTM D 25. Sawn timber elements shall conform to DOC PS-20.

1810.3.2.4.1 Preservative treatment. Timber deep foundation elements used to support permanent

structures shall be treated in accordance with this section unless it is established that the tops of the untreated timber elements will be below the lowest ground-water level assumed to exist during the life of the structure. Preservative and minimum final retention shall be in accordance with AWPA U1 (Commodity Specification E, Use Category 4C) for round timber elements and A PA U1 (Commodity Specification A, Use Category 4B) for sawn timber elements. Preservative-treated timber elements shall be subject to a quality control program administered by an approved agency. Element cutoffs shall be treated in accordance with AWPA M4.

1810.3.2.5 Protection of materials. here boring records or site conditions indicate possible deleterious action on the materials used in deep foundation elements because of soil constituents, changing water levels or other factors, the elements shall be adequately protected by materials, methods or processes approved by the building official. Protective materials shall be applied to the elements so as not to be rendered ineffective by installation. The effectiveness of such protective measures for the particular purpose shall have been thoroughly established by satisfactory service records or other evidence.

1810.3.2.6 Allowable stresses. The allowable stresses for materials used in deep foundation elements shall not exceed those specified in Table 1810.3.2.6.

TABLE 1810.3.2.6
ALLOWABLE STRESSES FOR MATERIALS USED IN DEEP FOUNDATION ELEMENTS

| MATERIAL TYPE AND CONDITION | MAXIMUM ALLOWABLE STRESS ^a |
|--|---------------------------------------|
| 1. Concrete or grout in compression ^b | |
| Cast-in-place with a permanent casing in accordance with Section 1810.3.2.7 | $0.4 f'_c$ |
| Cast-in-place in a pipe, tube, other permanent casing or rock | $0.33 f'_c$ |
| Cast-in-place without a permanent casing | $0.3 f'_c$ |
| Precast nonprestressed | $0.33 f'_c$ |
| Precast prestressed | $0.33 f'_c - 0.27 f_{pc}$ |
| 2. Nonprestressed reinforcement in compression | $0.4 f_y \leq 30,000$ psi |
| 3. Structural steel in compression | |
| Cores within concrete-filled pipes or tubes | $0.5 F_y \leq 32,000$ psi |
| Pipes, tubes or H-piles, where justified in accordance with Section 1810.3.2.8 | $0.5 F_y \leq 32,000$ psi |
| Pipes or tubes for micropiles | $0.4 F_y \leq 32,000$ psi |
| Other pipes, tubes or H-piles | $0.35 F_y \leq 16,000$ psi |
| Helical piles | $0.6 F_y \leq 0.5 F_u$ |
| 4. Nonprestressed reinforcement in tension | |
| Within micropiles | $0.6 f_y$ |
| Other conditions | $0.5 f_y \leq 24,000$ psi |
| 5. Structural steel in tension | |
| Pipes, tubes or H-piles, where justified in accordance with Section 1810.3.2.8 | $0.5 F_y \leq 32,000$ psi |
| Other pipes, tubes or H-piles | $0.35 F_y \leq 16,000$ psi |
| Helical piles | $0.6 F_y \leq 0.5 F_u$ |
| 6. Timber | In accordance with the AF&PA NDS |

a. f'_c is the specified compressive strength of the concrete or grout; f_{pc} is the compressive stress on the gross concrete section due to effective prestress forces only; f_y is the specified yield strength of reinforcement; F_y is the specified minimum yield stress of structural steel; F_u is the specified minimum tensile stress of structural steel.

b. The stresses specified apply to the gross cross sectional area within the concrete surface. Where a temporary or permanent casing is used, the inside face of the casing shall be considered the concrete surface.

1810.3.2.7 Increased allowable compressive stress for cased cast-in-place elements. The allowable compressive stress in the concrete shall be permitted to be increased as specified in Table 1810.3.2.6 for those portions of permanently cased cast-in-place elements that satisfy all of the following conditions:

1. The design shall not use the casing to resist any portion of the axial load imposed.
2. The casing shall have a sealed tip and be mandrel driven.
3. The thickness of the casing shall not be less than manufacturer's standard gage No.14 (0.068 inch) (1.75 mm).
4. The casing shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete.
5. The ratio of steel yield strength (F_y) to specified compressive strength (f'_c) shall not be less than six.
6. The nominal diameter of the element shall not be greater than 16 inches (406 mm).

1810.3.2.8 Justification of higher allowable stresses.

Use of allowable stresses greater than those specified in Section 1810.3.2.6 shall be permitted where supporting data justifying such higher stresses is filed with the building official. Such substantiating data shall include:

1. A geotechnical investigation in accordance with Section 1803; and
2. Load tests in accordance with Section 1810.3.3.1.2, regardless of the load supported by the element.

The design and installation of the deep foundation elements shall be under the direct supervision of a registered design professional knowledgeable in the field of soil mechanics and deep foundations who shall submit a report to the building official stating that the elements as installed satisfy the design criteria.

1810.3.3 Determination of allowable loads. The allowable axial and lateral loads on deep foundation elements shall be determined by an approved formula, load tests or method of analysis.

1810.3.3.1 Allowable axial load. The allowable axial load on a deep foundation element shall be determined in accordance with Sections 1810.3.3.1.1 through 1810.3.3.1.9.

1810.3.3.1.1 Driving criteria. The allowable compressive load on any driven deep foundation element where determined by the application of an approved driving formula shall not exceed 40 tons (356 kN). For allowable loads above 40 tons (356 kN), the wave equation method of analysis shall be used to estimate driveability for both driving stresses and net displacement per blow at the ultimate load. Allowable loads shall be verified by load tests in accordance with Section 1810.3.3.1.2. The formula

or wave equation load shall be determined for gravity-drop or power-actuated hammers and the hammer energy used shall be the maximum consistent with the size, strength and weight of the driven elements. The use of a follower is permitted only with the approval of the building official. The introduction of fresh hammer cushion or pile cushion material just prior to final penetration is not permitted.

1810.3.3.1.2 Load tests. Where design compressive loads are greater than those determined using the allowable stresses specified in Section 1810.3.2.6, where the design load for any deep foundation element is in doubt, or where cast-in-place deep foundation elements have an enlarged base formed either by compacting concrete or by driving a precast base, control test elements shall be tested in accordance with ASTM D 1143 or ASTM D 4945. At least one element shall be load tested in each area of uniform subsoil conditions. Where required by the building official, additional elements shall be load tested where necessary to establish the safe design capacity. The resulting allowable loads shall not be more than one-half of the ultimate axial load capacity of the test element as assessed by one of the published methods listed in Section 1810.3.3.1.3 with consideration for the test type, duration and subsoil. The ultimate axial load capacity shall be determined by a registered design professional with consideration given to tolerable total and differential settlements at design load in accordance with Section 1810.2.3. In subsequent installation of the balance of deep foundation elements, all elements shall be deemed to have a supporting capacity equal to that of the control element where such elements are of the same type, size and relative length as the test element; are installed using the same or comparable methods and equipment as the test element; are installed in similar subsoil conditions as the test element; and, for driven elements, where the rate of penetration (e.g., net displacement per blow) of such elements is equal to or less than that of the test element driven with the same hammer through a comparable driving distance.

1810.3.3.1.3 Load test evaluation methods. It shall be permitted to evaluate load tests of deep foundation elements using any of the following methods:

1. Davisson Offset Limit.
2. Brinch-Hansen 90% Criterion.
3. Butler-Hoy Criterion.
4. Other methods approved by the building official.

1810.3.3.1.4 Allowable frictional resistance. The assumed frictional resistance developed by any uncased cast-in-place deep foundation element shall not exceed one-sixth of the bearing value of the soil material at minimum depth as set forth in Table 1806.2, up to a maximum of 500 psf (24 kPa), unless a greater value is allowed by the building official on

the basis of a geotechnical investigation as specified in Section 1803 or a greater value is substantiated by a load test in accordance with Section 1810.3.3.1.2. Frictional resistance and bearing resistance shall not be assumed to act simultaneously unless determined by a geotechnical investigation in accordance with Section 1803.

1810.3.3.1.5 Uplift capacity of a single deep foundation element. Where required by the design, the uplift capacity of a single deep foundation element shall be determined by an approved method of analysis based on a minimum factor of safety of three or by load tests conducted in accordance with ASTM D 3689. The maximum allowable uplift load shall not exceed the ultimate load capacity as determined in Section 1810.3.3.1.2, using the results of load tests conducted in accordance with ASTM D 3689, divided by a factor of safety of two.

Exception: Where uplift is due to wind or seismic loading, the minimum factor of safety shall be two where capacity is determined by an analysis and one and one-half where capacity is determined by load tests.

1810.3.3.1.6 Uplift capacity of grouped deep foundation elements. For grouped deep foundation elements subjected to uplift, the allowable working uplift load for the group shall be calculated by an approved method of analysis where the deep foundation elements in the group are placed at a center-to-center spacing of at least 2.5 times the least horizontal dimension of the largest single element, the allowable working uplift load for the group is permitted to be calculated as the lesser of:

1. The proposed individual uplift working load times the number of elements in the group.
2. Two-thirds of the effective weight of the group and the soil contained within a block defined by the perimeter of the group and the length of the element, plus two-thirds of the ultimate shear resistance along the soil block.

1810.3.3.1.7 Load-bearing capacity. Deep foundation elements shall develop ultimate load capacities of at least twice the design working loads in the designated load-bearing layers. Analysis shall show that no soil layer underlying the designated load-bearing layers causes the load-bearing capacity safety factor to be less than two.

1810.3.3.1.8 Bent deep foundation elements. The load-bearing capacity of deep foundation elements discovered to have a sharp or sweeping bend shall be determined by an approved method of analysis or by load testing a representative element.

1810.3.3.1.9 Helical piles. The allowable axial design load, P_a , of helical piles shall be determined as follows:

$$P_a = 0.5 P_u \quad (\text{Equation 18-4})$$

where P_u is the least value of:

1. Sum of the areas of the helical bearing plates times the ultimate bearing capacity of the soil or rock comprising the bearing stratum.
2. Ultimate capacity determined from well-documented correlations with installation torque.
3. Ultimate capacity determined from load tests.
4. Ultimate axial capacity of pile shaft.
5. Ultimate axial capacity of pile shaft couplings.
6. Sum of the ultimate axial capacity of helical bearing plates affixed to pile.

1810.3.3.2 Allowable lateral load. Where required by the design, the lateral load capacity of a single deep foundation element or a group thereof shall be determined by an approved method of analysis or by lateral load tests to at least twice the proposed design working load. The resulting allowable load shall not be more than one-half of the load that produces a gross lateral movement of 1 inch (25 mm) at the lower of the top of foundation element and the ground surface, unless it can be shown that the predicted lateral movement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

1810.3.4 Subsiding soils. Where deep foundation elements are installed through subsiding fills or other subsiding strata and derive support from underlying firmer materials, consideration shall be given to the downward frictional forces that may be imposed on the elements by the subsiding upper strata.

Where the influence of subsiding fills is considered as imposing loads on the element, the allowable stresses specified in this chapter shall be permitted to be increased where satisfactory substantiating data are submitted.

1810.3.5 Dimensions of deep foundation elements. The dimensions of deep foundation elements shall be in accordance with Sections 1810.3.5.1 through 1810.3.5.3, as applicable.

1810.3.5.1 Precast. The minimum lateral dimension of precast concrete deep foundation elements shall be 8 inches (203 mm). Corners of square elements shall be chamfered.

1810.3.5.2 Cast-in-place or grouted-in-place. Cast-in-place and grouted-in-place deep foundation elements shall satisfy the requirements of this section.

1810.3.5.2.1 Cased. Cast-in-place deep foundation elements with a permanent casing shall have a nominal outside diameter of not less than 8 inches (203 mm).

1810.3.5.2.2 Uncased. Cast-in-place deep foundation elements without a permanent casing shall have a diameter of not less than 12 inches (305 mm). The element length shall not exceed 30 times the average diameter.

Exception: The length of the element is permitted to exceed 30 times the diameter, provided the design and installation of the deep foundations are under the direct supervision of a registered design professional knowledgeable in the field of soil mechanics and deep foundations. The registered design professional shall submit a report to the building official stating that the elements were installed in compliance with the approved construction documents.

1810.3.5.2.3 Micropiles. Micropiles shall have an outside diameter of 12 inches (305 mm) or less. The minimum diameter set forth elsewhere in Section 1810.3.5 shall not apply to micropiles.

1810.3.5.3 Steel. Steel deep foundation elements shall satisfy the requirements of this section.

1810.3.5.3.1 H-piles. Sections of H-piles shall comply with the following:

1. The flange projections shall not exceed 14 times the minimum thickness of metal in either the flange or the web and the flange widths shall not be less than 80 percent of the depth of the section.
2. The nominal depth in the direction of the web shall not be less than 8 inches (203 mm).
3. Flanges and web shall have a minimum nominal thickness of $\frac{3}{8}$ inch (9.5 mm).

1810.3.5.3.2 Steel pipes and tubes. Steel pipes and tubes used as deep foundation elements shall have a nominal outside diameter of not less than 8 inches (203 mm). Where steel pipes or tubes are driven open ended, they shall have a minimum of 0.34 square inch (219 mm^2) of steel in cross section to resist each 1,000 foot-pounds (1356 Nm) of pile hammer energy, or shall have the equivalent strength for steels having a yield strength greater than 35,000 psi (241 MPa) or the wave equation analysis shall be permitted to be used to assess compression stresses induced by driving to evaluate if the pile section is appropriate for the selected hammer. Where a pipe or tube with wall thickness less than 0.179 inch (4.6 mm) is driven open ended, a suitable cutting shoe shall be provided. Concrete-filled steel pipes or tubes in structures assigned to Seismic Design Category C, D, E or F shall have a wall thickness of not less than $\frac{3}{16}$ inch (5 mm). The pipe or tube casing for socketed drilled shafts shall have a nominal outside diameter of not less than 18

inches (457 mm), a wall thickness of not less than $\frac{3}{8}$ inch (9.5 mm) and a suitable steel driving shoe welded to the bottom; the diameter of the rock socket shall be approximately equal to the inside diameter of the casing.

Exceptions:

1. There is no minimum diameter for steel pipes or tubes used in micropiles.
2. For mandrel-driven pipes or tubes, the minimum wall thickness shall be $\frac{1}{10}$ inch (2.5 mm).

1810.3.5.3.3 Helical piles. Dimensions of the central shaft and the number, size and thickness of helical bearing plates shall be sufficient to support the design loads.

1810.3.6 Splices. Splices shall be constructed so as to provide and maintain true alignment and position of the component parts of the deep foundation element during installation and subsequent thereto and shall be designed to resist the axial and shear forces and moments occurring at the location of the splice during driving and for design load combinations. Where deep foundation elements of the same type are being spliced, splices shall develop not less than 50 percent of the bending strength of the weaker section. Where deep foundation elements of different materials or different types are being spliced, splices shall develop the full compressive strength and not less than 50 percent of the tension and bending strength of the weaker section. Where structural steel cores are to be spliced, the ends shall be milled or ground to provide full contact and shall be full-depth welded.

Splices occurring in the upper 10 feet (3048 mm) of the embedded portion of an element shall be designed to resist at allowable stresses the moment and shear that would result from an assumed eccentricity of the axial load of 3 inches (76 mm), or the element shall be braced in accordance with Section 1810.2.2 to other deep foundation elements that do not have splices in the upper 10 feet (3048 mm) of embedment.

1810.3.6.1 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F splices of deep foundation elements shall develop the lesser of the following:

1. The nominal strength of the deep foundation element; and
2. The axial and shear forces and moments from the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

1810.3.7 Top of element detailing at cutoffs. Where a minimum length for reinforcement or the extent of closely spaced confinement reinforcement is specified at the top of a deep foundation element, provisions shall be made so that those specified lengths or extents are maintained after cutoff.

1810.3.8 Precast concrete piles. Precast concrete piles shall be designed and detailed in accordance with Sections 1810.3.8.1 through 1810.3.8.3.

1810.3.8.1 Reinforcement. Longitudinal steel shall be arranged in a symmetrical pattern and be laterally tied with steel ties or wire spiral spaced center to center as follows:

1. At not more than 1 inch (25 mm) for the first five ties or spirals at each end; then
2. At not more than 4 inches (102 mm), for the remainder of the first 2 feet (610 mm) from each end; and then
3. At not more than 6 inches (152 mm) elsewhere.

The size of ties and spirals shall be as follows:

1. For piles having a least horizontal dimension of 16 inches (406 mm) or less, wire shall not be smaller than 0.22 inch (5.6 mm) (No. 5 gage).
2. For piles having a least horizontal dimension of more than 16 inches (406 mm) and less than 20 inches (508 mm), wire shall not be smaller than 0.238 inch (6 mm) (No. 4 gage).
3. For piles having a least horizontal dimension of 20 inches (508 mm) and larger, wire shall not be smaller than $\frac{1}{4}$ inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).

1810.3.8.2 Precast non prestressed piles. Precast non prestressed concrete piles shall comply with the requirements of Sections 1810.3.8.2.1 through 1810.3.8.2.3.

1810.3.8.2.1 Minimum reinforcement. Longitudinal reinforcement shall consist of at least four bars with a minimum longitudinal reinforcement ratio of 0.008.

1810.3.8.2.2 Seismic reinforcement in Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, precast non prestressed piles shall be reinforced as specified in this section. The minimum longitudinal reinforcement ratio shall be 0.01 throughout the length. Transverse reinforcement shall consist of closed ties or spirals with a minimum $\frac{3}{8}$ inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of eight times the diameter of the smallest longitudinal bar or 6 inches (152 mm) within a distance of three times the least pile dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 6 inches (152 mm) throughout the remainder of the pile.

1810.3.8.2.3 Additional seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, transverse reinforcement shall be in accordance with Section 1810.3.9.4.2.

1810.3.8.3 Precast prestressed piles. Precast prestressed concrete piles shall comply with the requirements of Sections 1810.3.8.3.1 through 1810.3.8.3.3.

1810.3.8.3.1 Effective prestress. The effective prestress in the pile shall not be less than 400 psi (2.76 MPa) for piles up to 30 feet (9144 mm) in length, 550 psi (3.79 MPa) for piles up to 50 feet (15 240 mm) in length and 700 psi (4.83 MPa) for piles greater than 50 feet (15 240 mm) in length.

Effective prestress shall be based on an assumed loss of 30,000 psi (207 MPa) in the prestressing steel. The tensile stress in the prestressing steel shall not exceed the values specified in ACI 318.

1810.3.8.3.2 Seismic reinforcement in Seismic Design Category C. For structures assigned to Seismic Design Category C, precast prestressed piles shall have transverse reinforcement in accordance with this section. The volumetric ratio of spiral reinforcement shall not be less than the amount required by the following formula for the upper 20 feet (6096 mm) of the pile.

$$\rho_s = 0.12f'_c / f_{yh} \quad (\text{Equation 18-5})$$

where:

f'_c = Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement \leq 85,000 psi (586 MPa).

ρ_s = Spiral reinforcement index (vol. spiral/vol. core).

At least one-half the volumetric ratio required by Equation 18-5 shall be provided below the upper 20 feet (6096 mm) of the pile.

1810.3.8.3.3 Seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, precast prestressed piles shall have transverse reinforcement in accordance with the following:

1. Requirements in ACI 318, Chapter 21, need not apply, unless specifically referenced.
2. Where the total pile length in the soil is 35 feet (10 668 mm) or less, the lateral transverse reinforcement in the ductile region shall occur through the length of the pile. Where the pile length exceeds 35 feet (10 668 mm), the ductile pile region shall be taken as the greater of 35 feet (10 668 mm) or the distance from the underside of the pile cap to the point of zero curvature plus three times the least pile dimension.
3. In the ductile region, the center-to-center spacing of the spirals or hoop reinforcement shall not exceed one-fifth of the least pile dimension, six times the diameter of the longitudinal strand or 8 inches (203 mm), whichever is smallest.

4. Circular spiral reinforcement shall be spliced by lapping one full turn and bending the end of each spiral to a 90-degree hook or by use of a mechanical or welded splice complying with Section 12.14.3 of ACI 318.
5. Where the transverse reinforcement consists of circular spirals, the volumetric ratio of spiral transverse reinforcement in the ductile region shall comply with the following:

$$\rho_s = 0.25(f'_c/f_{yh})(A_g/A_{ch} - 1.0) \\ [0.5 + 1.4P/(f'_c A_g)] \quad (\text{Equation 18-6})$$

but not less than

$$\rho_s = 0.12(f'_c/f_{yh}) \\ [0.5 + 1.4P/(f'_c A_g)]^3 0.12f'_c/f_{yh} \quad (\text{Equation 18-7})$$

and need not exceed:

$$\rho_s = 0.021 \quad (\text{Equation 18-8})$$

where:

A_g = Pile cross-sectional area, square inches (mm^2).

A_{ch} = Core area defined by spiral outside diameter, square inches (mm^2).

f'_c = Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement \leq 85,000 psi (586 MPa).

P = Axial load on pile, pounds (kN), as determined from Equations 16-5 and 16-7.

ρ_s = Volumetric ratio (vol. spiral/vol. core).

This required amount of spiral reinforcement is permitted to be obtained by providing an inner and outer spiral.

6. Where transverse reinforcement consists of rectangular hoops and cross ties, the total cross-sectional area of lateral transverse reinforcement in the ductile region with spacing, s , and perpendicular dimension, h_c , shall conform to:

$$A_{sh} = 0.3s h_c (f'_c/f_{yh})(A_g/A_{ch} - 1.0) \\ [0.5 + 1.4P/(f'_c A_g)] \quad (\text{Equation 18-9})$$

but not less than:

$$A_{sh} = 0.12s h_c (f'_c/f_{yh}) [0.5 + 1.4P/(f'_c A_g)] \quad (\text{Equation 18-10})$$

where:

f_{yh} = yield strength of transverse reinforcement \leq 70,000 psi (483 MPa).

h_c = Cross-sectional dimension of pile core measured center to center of hoop reinforcement, inch (mm).

s = Spacing of transverse reinforcement measured along length of pile, inch (mm).

A_{sh} = Cross-sectional area of transverse reinforcement, square inches (mm^2).

f'_c = Specified compressive strength of concrete, psi (MPa).

The hoops and cross ties shall be equivalent to deformed bars not less than No. 3 in size. Rectangular hoop ends shall terminate at a corner with seismic hooks.

Outside of the length of the pile requiring transverse confinement reinforcing, the spiral or hoop reinforcing with a volumetric ratio not less than one-half of that required for transverse confinement reinforcing shall be provided.

1810.3.9 Cast-in-place deep foundations. Cast-in-place deep foundation elements shall be designed and detailed in accordance with Sections 1810.3.9.1 through 1810.3.9.6.

1810.3.9.1 Design cracking moment. The design cracking moment (ϕM_n) for a cast-in-place deep foundation element not enclosed by a structural steel pipe or tube shall be determined using the following equation:

$$\phi M_n = 3\sqrt{f'_c S_m} \quad (\text{Equation 18-11})$$

For SI: $\phi M_n = 0.25\sqrt{f'_c S_m}$

where:

f'_c = Specified compressive strength of concrete or grout, psi (MPa).

S_m = Elastic section modulus, neglecting reinforcement and casing, cubic inches (mm^3).

1810.3.9.2 Required reinforcement. Where subject to uplift or where the required moment strength determined using the load combinations of Section 1605.2 exceeds the design cracking moment determined in accordance with Section 1810.3.9.1, cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.

1810.3.9.3 Placement of reinforcement. Reinforcement where required shall be assembled and tied together and shall be placed in the deep foundation element as a unit before the reinforced portion of the element is filled with concrete.

Exceptions:

1. Steel dowels embedded 5 feet (1524 mm) or less shall be permitted to be placed after concreting, while the concrete is still in a semifluid state.
2. For deep foundation elements installed with a hollow-stem auger, tied reinforcement shall be placed after elements are concreted, while the concrete is still in a semifluid state. Longitudi-

nal reinforcement without lateral ties shall be placed either through the hollow stem of the auger prior to concreting or after concreting, while the concrete is still in a semifluid state.

3. For Group R-3 and U occupancies not exceeding two stories of light-frame construction, reinforcement is permitted to be placed after concreting, while the concrete is still in a semifluid state, and the concrete cover requirement is permitted to be reduced to 2 inches (51 mm), provided the construction method can be demonstrated to the satisfaction of the building official.

1810.3.9.4 Seismic reinforcement. Where a structure is assigned to Seismic Design Category C, reinforcement shall be provided in accordance with Section 1810.3.9.4.1. Where a structure is assigned to Seismic Design Category D, E or F, reinforcement shall be provided in accordance with Section 1810.3.9.4.2.

Exceptions:

1. Isolated deep foundation elements supporting posts of Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where detailed so the element is not subject to lateral loads and the soil provides adequate lateral support in accordance with Section 1810.2.1.
2. Isolated deep foundation elements supporting posts and bracing from decks and patios appurtenant to Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where the lateral load, E , to the top of the element does not exceed 200 pounds (890 N) and the soil provides adequate lateral support in accordance with Section 1810.2.1.
3. Deep foundation elements supporting the concrete foundation wall of Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than two No. 4 bars, without ties or spirals, where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations with overstrength factor in Section 12.4.3.2 or 12.14.3.2 of ASCE 7 and the soil provides adequate lateral support in accordance with Section 1810.2.1.
4. Closed ties or spirals where required by Section 1810.3.9.4.2 shall be permitted to be limited to the top 3 feet (914 mm) of deep

foundation elements 10 feet (3048 mm) or less in depth supporting Group R-3 and U occupancies of Seismic Design Category D, not exceeding two stories of light-frame construction.

1810.3.9.4.1 Seismic reinforcement in Seismic Design Category C. For structures assigned to Seismic Design Category C, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.

A minimum of four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.0025, shall be provided throughout the minimum reinforced length of the element as defined below starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-third of the element length;
2. A distance of 10 feet (3048 mm);
3. Three times the least element dimension; and
4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605.2.

Transverse reinforcement shall consist of closed ties or spirals with a minimum $\frac{3}{8}$ inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of 6 inches (152 mm) or 8-longitudinal-bar diameters, within a distance of three times the least element dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 16 longitudinal bar diameters throughout the remainder of the reinforced length.

Exceptions:

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.
2. A spiral-welded metal casing of a thickness not less than manufacturer's standard gage No.14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

1810.3.9.4.2 Seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, cast-in-place deep foundation elements shall be rein-

forced as specified in this section. Reinforcement shall be provided where required by analysis.

A minimum of four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.005, shall be provided throughout the minimum reinforced length of the element as defined below starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-half of the element length;
2. A distance of 10 feet (3048 mm);
3. Three times the least element dimension; and
4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605.2.

Transverse reinforcement shall consist of closed ties or spirals no smaller than No. 3 bars for elements with a least dimension up to 20 inches (508 mm), and No. 4 bars for larger elements. Throughout the remainder of the reinforced length outside the regions with transverse confinement reinforcement, as specified in Section 1810.3.9.4.2.1 or 1810.3.9.4.2.2, the spacing of transverse reinforcement shall not exceed the least of the following:

1. 12 longitudinal bar diameters;
2. One-half the least dimension of the element; and
3. 12 inches (305 mm).

Exceptions:

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.
2. A spiral-welded metal casing of a thickness not less than manufacturer's standard gage No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

1810.3.9.4.2.1 Site Classes A through D. For Site Class A, B, C or D sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 21.6.4.2, 21.6.4.3 and 21.6.4.4 of ACI 318 within three times the least element dimension of the bottom of the pile cap. A transverse spiral reinforcement ratio of not less than one-half of that required in Section 21.6.4.4(a) of ACI 318 shall be permitted.

1810.3.9.4.2.2 Site Classes E and F. For Site Class E or F sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 21.6.4.2, 21.6.4.3 and 21.6.4.4 of ACI 318 within seven times the least element dimension of the pile cap and within seven times the least element dimension of the interfaces of strata that are hard or stiff and strata that are liquefiable or are composed of soft- to medium-stiff clay.

1810.3.9.5 Bellied drilled shafts. Where drilled shafts are bellied at the bottom, the edge thickness of the bell shall not be less than that required for the edge of footings. Where the sides of the bell slope at an angle less than 60 degrees (1 rad) from the horizontal, the effects of vertical shear shall be considered.

1810.3.9.6 Socketed drilled shafts. Socketed drilled shafts shall have a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock, both filled with concrete. Socketed drilled shafts shall have reinforcement or a structural steel core for the length as indicated by an approved method of analysis.

The depth of the rock socket shall be sufficient to develop the full load-bearing capacity of the element with a minimum safety factor of two, but the depth shall not be less than the outside diameter of the pipe or tube casing. The design of the rock socket is permitted to be predicated on the sum of the allowable load-bearing pressure on the bottom of the socket plus bond along the sides of the socket.

Where a structural steel core is used, the gross cross-sectional area of the core shall not exceed 25 percent of the gross area of the drilled shaft.

1810.3.10 Micropiles. Micropiles shall be designed and detailed in accordance with Sections 1810.3.10.1 through 1810.3.10.4.

1810.3.10.1 Construction. Micropiles shall develop their load-carrying capacity by means of a bond zone in soil, bedrock or a combination of soil and bedrock. Micropiles shall be grouted and have either a steel pipe or tube or steel reinforcement at every section along the length. It shall be permitted to transition from deformed reinforcing bars to steel pipe or tube reinforcement by extending the bars into the pipe or tube section by at least their development length in tension in accordance with ACI 318.

1810.3.10.2 Materials. Reinforcement shall consist of deformed reinforcing bars in accordance with ASTM A 615 Grade 60 or 75 or ASTM A 722 Grade 150.

The steel pipe or tube shall have a minimum wall thickness of $\frac{3}{16}$ inch (4.8 mm). Splices shall comply with Section 1810.3.6. The steel pipe or tube shall have a minimum yield strength of 45,000 psi (310 MPa) and a minimum elongation of 15 percent as shown by mill certifications or two coupon test samples per 40,000 pounds (18 160 kg) of pipe or tube.

1810.3.10.3 Reinforcement. For micropiles or portions thereof grouted inside a temporary or permanent casing or inside a hole drilled into bedrock or a hole drilled with grout, the steel pipe or tube or steel reinforcement shall be designed to carry at least 40 percent of the design compression load. Micropiles or portions thereof grouted in an open hole in soil without temporary or permanent casing and without suitable means of verifying the hole diameter during grouting shall be designed to carry the entire compression load in the reinforcing steel. Where a steel pipe or tube is used for reinforcement, the portion of the grout enclosed within the pipe is permitted to be included in the determination of the allowable stress in the grout.

1810.3.10.4 Seismic reinforcement. For structures assigned to Seismic Design Category C, a permanent steel casing shall be provided from the top of the micro-pile down to the point of zero curvature. For structures assigned to Seismic Design Category D, E or F, the micropile shall be considered as an alternative system in accordance with Section 104.11, *Chapter 1, Division II*. The alternative system design, supporting documentation and test data shall be submitted to the building official for review and approval.

[HCD 1 & HCD 2] For structures assigned to Seismic Design Category D, E or F, the micropile shall be considered as an alternative system in accordance with Section 1.8.7, Chapter 1, Division 1. The alternative system design, supporting documentation and test data shall be submitted to the building official for review and approval.

1810.3.10.4.1 Seismic requirements. [OSHPD 2]
For structures assigned to Seismic Design Category D, E or F, a permanent steel casing having a minimum thickness of $\frac{3}{8}$ inch shall be provided from the top of the micropile down to a minimum of 120 percent of the point of zero curvature. Capacity of micropiles shall be determined in accordance with Section 1810.3.3 by at least two project specific pre-production tests for each soil profile, size and depth of micropile. At least two percent of all production piles shall be proof tested to design ultimate strength determined by using load combinations in Section 1605.2.1.

Steel casing length in soil shall be considered as unbonded and shall not be considered as contributing to friction. Casing shall provide confinement at least equivalent to hoop reinforcing required by ACI 318 Section 21.12.4.

Reinforcement shall have Class 1 corrosion protection in accordance with PTI Recommendations for Prestressed Rock and Soil Anchors. Steel casing design shall include at least $\frac{1}{16}$ -inch corrosion allowance.

Micropiles shall not be considered as carrying any horizontal loads.

1810.3.11 Pile caps. Pile caps shall be of reinforced concrete, and shall include all elements to which vertical deep

foundation elements are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical load. The tops of vertical deep foundation elements shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend at least 4 inches (102 mm) beyond the edges of the elements. The tops of elements shall be cut or chipped back to sound material before capping.

1810.3.11.1 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, concrete deep foundation elements shall be connected to the pile cap by embedding the element reinforcement or field-placed dowels anchored in the element into the pile cap for a distance equal to their development length in accordance with ACI 318. It shall be permitted to connect precast prestressed piles to the pile cap by developing the element prestressing strands into the pile cap provided the connection is ductile. For deformed bars, the development length is the full development length for compression, or tension in the case of uplift, without reduction for excess reinforcement in accordance with Section 12.2.5 of ACI 318. Alternative measures for laterally confining concrete and maintaining toughness and ductile-like behavior at the top of the element shall be permitted provided the design is such that any hinging occurs in the confined region.

The minimum transverse steel ratio for confinement shall not be less than one-half of that required for columns.

For resistance to uplift forces, anchorage of steel pipes, tubes or H-piles to the pile cap shall be made by means other than concrete bond to the bare steel section. Concrete-filled steel pipes or tubes shall have reinforcement of not less than 0.01 times the cross-sectional area of the concrete fill developed into the cap and extending into the fill a length equal to two times the required cap embedment, but not less than the development length in tension of the reinforcement.

1810.3.11.2 Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, deep foundation element resistance to uplift forces or rotational restraint shall be provided by anchorage into the pile cap, designed considering the combined effect of axial forces due to uplift and bending moments due to fixity to the pile cap. Anchorage shall develop a minimum of 25 percent of the strength of the element in tension. Anchorage into the pile cap shall comply with the following:

1. In the case of uplift, the anchorage shall be capable of developing the least of the following:
 - 1.1. The nominal tensile strength of the longitudinal reinforcement in a concrete element;
 - 1.2. The nominal tensile strength of a steel element; and

1.3. The frictional force developed between the element and the soil multiplied by 1.3.

Exception: The anchorage is permitted to be designed to resist the axial tension force resulting from the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

2. In the case of rotational restraint, the anchorage shall be designed to resist the axial and shear forces, and moments resulting from the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7; or shall be capable of developing the full axial, bending and shear nominal strength of the element.

Where the vertical lateral force-resisting elements are columns, the pile cap flexural strengths shall exceed the column flexural strength. The connection between batter piles and pile caps shall be designed to resist the nominal strength of the pile acting as a short column. Batter piles and their connection shall be designed to resist forces and moments that result from the application of seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

1810.3.12 Grade beams. For structures assigned to Seismic Design Category D, E or F, grade beams shall comply with the provisions in Section 21.12.3 of ACI 318 for grade beams, except where they are designed to resist the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

1810.3.13 Seismic ties. For structures assigned to Seismic Design Category C, D, E or F, individual deep foundations shall be interconnected by ties. Unless it can be demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils or very dense granular soils, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger pile cap or column design gravity load times the seismic coefficient, S_{DS} , divided by 10, and 25 percent of the smaller pile or column design gravity load.

Exception: In Group R-3 and U occupancies of light-frame construction, deep foundation elements supporting foundation walls, isolated interior posts detailed so the element is not subject to lateral loads or exterior decks and patios are not subject to interconnection where the soils are of adequate stiffness, subject to the approval of the building official.

1810.4 Installation. Deep foundations shall be installed in accordance with Section 1810.4. Where a single deep foundation element comprises two or more sections of different materials or different types spliced together, each section shall satisfy the applicable conditions of installation.

1810.4.1 Structural integrity. Deep foundation elements shall be installed in such a manner and sequence as to prevent distortion or damage that may adversely affect the structural integrity of adjacent structures or of foundation elements being installed or already in place and as to avoid compacting the surrounding soil to the extent that other foundation elements cannot be installed properly.

1810.4.1.1 Compressive strength of precast concrete piles. A precast concrete pile shall not be driven before the concrete has attained a compressive strength of at least 75 percent of the specified compressive strength (f'_{c}), but not less than the strength sufficient to withstand handling and driving forces.

1810.4.1.2 Casing. Where cast-in-place deep foundation elements are formed through unstable soils and concrete is placed in an open-drilled hole, a casing shall be inserted in the hole prior to placing the concrete. Where the casing is withdrawn during concreting, the level of concrete shall be maintained above the bottom of the casing at a sufficient height to offset any hydrostatic or lateral soil pressure. Driven casings shall be mandrel driven their full length in contact with the surrounding soil.

1810.4.1.3 Driving near uncased concrete. Deep foundation elements shall not be driven within six element diameters center to center in granular soils or within one-half the element length in cohesive soils of an uncased element filled with concrete less than 48 hours old unless approved by the building official. If the concrete surface in any completed element rises or drops, the element shall be replaced. Driven uncased deep foundation elements shall not be installed in soils that could cause heave.

1810.4.1.4 Driving near cased concrete. Deep foundation elements shall not be driven within four and one-half average diameters of a cased element filled with concrete less than 24 hours old unless approved by the building official. Concrete shall not be placed in casings within heave range of driving.

1810.4.1.5 Defective timber piles. Any substantial sudden increase in rate of penetration of a timber pile shall be investigated for possible damage. If the sudden increase in rate of penetration cannot be correlated to soil strata, the pile shall be removed for inspection or rejected.

1810.4.2 Identification. Deep foundation materials shall be identified for conformity to the specified grade with this identity maintained continuously from the point of manufacture to the point of installation or shall be tested by an approved agency to determine conformity to the specified grade. The approved agency shall furnish an affidavit of compliance to the building official.

1810.4.3 Location plan. A plan showing the location and designation of deep foundation elements by an identification system shall be filed with the building official prior to installation of such elements. Detailed records for elements shall bear an identification corresponding to that shown on the plan.

1810.4.4 Preexcavation. The use of jetting, augering or other methods of preexcavation shall be subject to the approval of the building official. Where permitted, preexcavation shall be carried out in the same manner as used for deep foundation elements subject to load tests and in such a manner that will not impair the carrying capacity of the elements already in place or damage adjacent structures. Element tips shall be driven below the preexcavated depth until the required resistance or penetration is obtained.

1810.4.5 Vibratory driving. Vibratory drivers shall only be used to install deep foundation elements where the element load capacity is verified by load tests in accordance with Section 1810.3.3.1.2. The installation of production elements shall be controlled according to power consumption, rate of penetration or other approved means that ensure element capacities equal or exceed those of the test elements.

1810.4.6 Heaved elements. Deep foundation elements that have heaved during the driving of adjacent elements shall be redriven as necessary to develop the required capacity and penetration, or the capacity of the element shall be verified by load tests in accordance with Section 1810.3.3.1.2.

1810.4.7 Enlarged base cast-in-place elements. Enlarged bases for cast-in-place deep foundation elements formed by compacting concrete or by driving a precast base shall be formed in or driven into granular soils. Such elements shall be constructed in the same manner as successful prototype test elements driven for the project. Shafts extending through peat or other organic soil shall be encased in a permanent steel casing. Where a cased shaft is used, the shaft shall be adequately reinforced to resist column action or the annular space around the shaft shall be filled sufficiently to reestablish lateral support by the soil. Where heave occurs, the element shall be replaced unless it is demonstrated that the element is undamaged and capable of carrying twice its design load.

1810.4.8 Hollow-stem augered, cast-in-place elements. Where concrete or grout is placed by pumping through a hollow-stem auger, the auger shall be permitted to rotate in a clockwise direction during withdrawal. As the auger is withdrawn at a steady rate or in increments not to exceed 1 foot (305 mm), concreting or grouting pumping pressures shall be measured and maintained high enough at all times to offset hydrostatic and lateral earth pressures. Concrete or grout volumes shall be measured to ensure that the volume of concrete or grout placed in each element is equal to or greater than the theoretical volume of the hole created by the auger. Where the installation process of any element is interrupted or a loss of concreting or grouting pressure occurs, the element shall be redrilled to 5 feet (1524 mm) below the elevation of the tip of the auger when the installation was interrupted or concrete or grout pressure was lost and reformed. Augered cast-in-place elements shall not be installed within six diameters center to center of an element filled with concrete or grout less than

12 hours old, unless approved by the building official. If the concrete or grout level in any completed element drops due to installation of an adjacent element, the element shall be replaced.

1810.4.9 Socketed drilled shafts. The rock socket and pipe or tube casing of socketed drilled shafts shall be thoroughly cleaned of foreign materials before filling with concrete. Steel cores shall be bedded in cement grout at the base of the rock socket.

1810.4.10 Micropiles. Micropile deep foundation elements shall be permitted to be formed in holes advanced by rotary or percussive drilling methods, with or without casing. The elements shall be grouted with a fluid cement grout. The grout shall be pumped through a tremie pipe extending to the bottom of the element until grout of suitable quality returns at the top of the element. The following requirements apply to specific installation methods:

1. For micropiles grouted inside a temporary casing, the reinforcing bars shall be inserted prior to withdrawal of the casing. The casing shall be withdrawn in a controlled manner with the grout level maintained at the top of the element to ensure that the grout completely fills the drill hole. During withdrawal of the casing, the grout level inside the casing shall be monitored to verify that the flow of grout inside the casing is not obstructed.
2. For a micropile or portion thereof grouted in an open drill hole in soil without temporary casing, the minimum design diameter of the drill hole shall be verified by a suitable device during grouting.
3. For micropiles designed for end bearing, a suitable means shall be employed to verify that the bearing surface is properly cleaned prior to grouting.
4. Subsequent micropiles shall not be drilled near elements that have been grouted until the grout has had sufficient time to harden.
5. Micropiles shall be grouted as soon as possible after drilling is completed.
6. For micropiles designed with a full-length casing, the casing shall be pulled back to the top of the bond zone and reinserted or some other suitable means employed to assure grout coverage outside the casing.

1810.4.11 Helical piles. Helical piles shall be installed to specified embedment depth and torsional resistance criteria as determined by a registered design professional. The torque applied during installation shall not exceed the maximum allowable installation torque of the helical pile.

1810.4.12 Special inspection. Special inspections in accordance with Sections 1705.7 and 1705.8 shall be provided for driven and cast-in-place deep foundation elements, respectively. Special inspections in accordance with Section 1705.9 shall be provided for helical piles.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 18A – SOILS AND FOUNDATIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | X | X | X | | | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

CHAPTER 18A

SOILS AND FOUNDATIONS

SECTION 1801A GENERAL

1801A.1 Scope. The provisions of this chapter shall apply to building and foundation systems.

Refer to Appendix J, Grading, for requirements governing grading, excavation and earthwork construction, including fills and embankments.

1801A.1.1 Application. The scope of application of Chapter 18A is as follows:

1. *Structures regulated by the Division of the State Architect—Structural Safety, which include those applications listed in Section 1.9.2.1 (DSA-SS), and 1.9.2.2 (DSA-SS/CC). These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings*
2. *Applications listed in Section 1.10.1 and 1.10.4 regulated by the Office of Statewide Health Planning and Development (OSHPD). These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 18 and any applicable amendments therein.

1801A.1.2 Amendments in this chapter. DSA-SS and DSA-SS/CC adopt this chapter and all amendments.

Exception: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect-Structural Safety:
[DSA-SS] For applications listed in Section 1.9.2.1.
[DSA-SS/CC] For applications listed in Section 1.9.2.2.*
2. *Office of Statewide Health Planning and Development:
[OSHPD 1] - For applications listed in Section 1.10.1.
[OSHPD 4] - For applications listed in Section 1.10.4.*

1801A.1.3 Reference to other chapters.

1801A.1.3.1 [DSA-SS/CC] Where reference within this chapter is made to sections in Chapters 16A, 19A, 21A, 22A, and 34A, the provisions in Chapters

16, 19, 21, 22, and 34 respectively shall apply instead.

1801A.2 Design basis. Allowable bearing pressures, allowable stresses and design formulas provided in this chapter shall be used with the allowable stress design load combinations specified in Section 1605A.3. The quality and design of materials used structurally in excavations and foundations shall comply with the requirements specified in Chapters 16A, 19A, 21A, 22A, and 23 of this code. Excavations and fills shall also comply with Chapter 33.

SECTION 1802A DEFINITIONS

1802A.1 Definitions. The following words and terms are defined in Chapter 2;

DEEP FOUNDATION.

DRILLED SHAFT.

Socketed drilled shaft.

HELICAL PILE.

MICROPILE.

SHALLOW FOUNDATION.

SECTION 1803A GEOTECHNICAL INVESTIGATIONS

1803A.1 General. Geotechnical investigations shall be conducted in accordance with Section 1803A.2 and reported in accordance with Section 1803A.7. The classification and investigation of the soil shall be made under the responsible charge of a California registered geotechnical engineer. All recommendations contained in geotechnical and geohazard reports shall be subject to the approval of the enforcement agency. All reports shall be prepared and signed by a registered geotechnical engineer, a certified engineering geologist, and a registered geophysicist, where applicable

1803A.2 Investigations required. Geotechnical investigations shall be conducted in accordance with Sections 1803A.3 through 1803A.6.

Exceptions:

1. *Geotechnical reports are not required for one-story, wood-frame and light-steel-frame buildings of Type II or Type V construction and 4,000 square feet (371 m^2) or less in floor area, not located within Earthquake Fault Zones or Seismic Hazard Zones as shown in the most recently published maps from the California Geological Survey (CGS) or in seismic hazard zones as defined in the Safety Element of the local General Plan. Allowable foundation and lateral soil pressure values may be determined from Table 1806A.2.*

2. A previous report for a specific site may be resubmitted, provided that a reevaluation is made and the report is found to be currently appropriate.

1803A.3 Basis of investigation. Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility, liquefaction and expansiveness.

1803A.3.1 Scope of investigation. The scope of the geotechnical investigation including the number and types of borings or soundings, the equipment used to drill or sample, the in-situ testing equipment and the laboratory testing program shall be determined by a registered design professional.

There shall not be less than one boring or exploration shaft for each 5,000 square feet (465 m²) of building area at the foundation level with a minimum of two provided for any one building. A boring may be considered to reflect subsurface conditions relevant to more than one building, subject to the approval of the enforcement agency.

Borings shall be of sufficient size to permit visual examination of the soil in place or, in lieu thereof, cores shall be taken.

Borings shall be of sufficient depth and size to adequately characterize sub-surface conditions.

1803A.4 Qualified representative. The investigation procedure and apparatus shall be in accordance with generally accepted engineering practice. The registered design professional shall have a fully qualified representative on site during all boring or sampling operations.

1803A.5 Investigated conditions. Geotechnical investigations shall be conducted as indicated in Sections 1803A.5.1 through 1803A.5.12.

1803A.5.1 Classification. Soil materials shall be classified in accordance with ASTM D 2487.

1803A.5.2 Questionable soil. Where the classification, strength or compressibility of the soil is in doubt or where a load-bearing value superior to that specified in this code is claimed, the building official shall be permitted to require that a geotechnical investigation be conducted.

1803A.5.3 Expansive soil. In areas likely to have expansive soil, the building official shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D 4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75 µm), determined in accordance with ASTM D 422.

3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.

4. Expansion index greater than 20, determined in accordance with ASTM D 4829.

1803A.5.4 Ground-water table. A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet (1524 mm) below the elevation of the lowest floor level where such floor is located below the finished ground level adjacent to the foundation.

1803A.5.5 Deep foundations. Where deep foundations will be used, a geotechnical investigation shall be conducted and shall include all of the following, unless sufficient data upon which to base the design and installation is otherwise available:

1. Recommended deep foundation types and installed capacities.
2. Recommended center-to-center spacing of deep foundation elements.
3. Driving criteria.
4. Installation procedures.
5. Field inspection and reporting procedures (to include procedures for verification of the installed bearing capacity where required).
6. Load test requirements.
7. Suitability of deep foundation materials for the intended environment.
8. Designation of bearing stratum or strata.
9. Reductions for group action, where necessary.

1803A.5.6 Rock strata. Where subsurface explorations at the project site indicate variations or doubtful characteristics in the structure of the rock upon which foundations are to be constructed, a sufficient number of borings shall be made to a depth of not less than 10 feet (3048 mm) below the level of the foundations to provide assurance of the soundness of the foundation bed and its load-bearing capacity.

1803A.5.7 Excavation near foundations. Where excavation will remove lateral support from any foundation, an investigation shall be conducted to assess the potential consequences and address mitigation measures.

1803A.5.8 Compacted fill material. Where shallow foundations will bear on compacted fill material more than 12 inches (305 mm) in depth, a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of compacted fill material.
2. Specifications for material to be used as compacted fill.
3. Test methods to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill.

4. Maximum allowable thickness of each lift of compacted fill material.
5. Field test method for determining the in-place dry density of the compacted fill.
6. Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with Item 3.
7. Number and frequency of field tests required to determine compliance with Item 6.

1803A.5.9 Controlled low-strength material (CLSM).

Where shallow foundations will bear on controlled low-strength material (CLSM), a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of the CLSM.
2. Specifications for the CLSM.
3. Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.
4. Test methods for determining the acceptance of the CLSM in the field.
5. Number and frequency of field tests required to determine compliance with Item 4.

1803A.5.10 Alternate setback and clearance. Where setbacks or clearances other than those required in Section 1808A.7 are desired, the building official shall be permitted to require a geotechnical investigation by a registered design professional to demonstrate that the intent of Section 1808A.7 would be satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.

1803A.5.11 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, the geotechnical investigation shall be conducted, and shall include an evaluation of all of the following potential geologic and seismic hazards:

1. Slope instability.
2. Liquefaction.
3. Total and differential settlement.
4. Surface displacement due to faulting or seismically induced lateral spreading or lateral flow.

1803A.5.12 Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, the geotechnical investigation required by Section 1803.5.11 shall also include all of the following as applicable:

1. The determination of dynamic seismic lateral earth pressures on foundation walls and retaining walls supporting more than 6 feet (1.83 m) of backfill height due to design earthquake ground motions.
2. The potential for liquefaction and soil strength loss evaluated for site peak ground acceleration, earthquake magnitude, and source characteristics consist-

ent with the maximum considered earthquake ground motions. Peak ground acceleration shall be determined based on:

- 2.1 A site-specific study in accordance with Section 21.5 of ASCE 7; or
- 2.2 In accordance with Section 11.8.3 of ASCE 7.
3. An assessment of potential consequences of liquefaction and soil strength loss, including, but not limited to:
 - 3.1. Estimation of total and differential settlement;
 - 3.2. Lateral soil movement;
 - 3.3. Lateral soil loads on foundations;
 - 3.4. Reduction in foundation soil-bearing capacity and lateral soil reaction;
 - 3.5. Soil downdrag and reduction in axial and lateral soil reaction for pile foundations;
 - 3.6. Increases in soil lateral pressures on retaining walls; and
 - 3.7. Flotation of buried structures.
4. Discussion of mitigation measures such as, but not limited to:
 - 4.1. Selection of appropriate foundation type and depths;
 - 4.2. Selection of appropriate structural systems to accommodate anticipated displacements and forces;
 - 4.3. Ground stabilization; or
 - 4.4. Any combination of these measures and how they shall be considered in the design of the structure.

1803A.6 Geohazard reports. Geohazard reports shall be required for all proposed construction.

Exceptions:

1. Reports are not required for one-story, wood-frame and light-steel-frame buildings of Type II or Type V construction and 4,000 square feet (371 m^2) or less in floor area, not located within Earthquake Fault Zones or Seismic Hazard Zones as shown in the most recently published maps from the California Geological Survey (CGS) or in seismic hazard zones as defined in the Safety Element of the local General Plan; nonstructural, associated structural or voluntary structural alterations, and incidental structural additions or alterations, and structural repairs for other than earthquake damage.
2. A previous report for a specific site may be resubmitted, provided that a reevaluation is made and the report is found to be currently appropriate.

The purpose of the geohazard report shall be to identify geologic and seismic conditions that may require project mitigations. The reports shall contain data which provide an

assessment of the nature of the site and potential for earthquake damage based on appropriate investigations of the regional and site geology, project foundation conditions and the potential seismic shaking at the site. The report shall be prepared by a California-certified engineering geologist in consultation with a California-registered geotechnical engineer.

The preparation of the geohazard report shall consider the most recent CGS Note 48: Checklist for the Review of Engineering Geology and Seismology Reports for California Public School, Hospitals, and Essential Services Buildings. In addition, the most recent version of CGS Special Publication 42, Fault Rupture Hazard Zones in California, shall be considered for project sites proposed within an Alquist-Priolo Earthquake Fault Zone. The most recent version of CGS Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California, shall be considered for project sites proposed within a Seismic Hazard Zone. All conclusions shall be fully supported by satisfactory data and analysis.

In addition to requirements in Sections 1803A.5.11 and 1803A.5.12, the report shall include, but shall not be limited to, the following:

1. Site geology.
2. Evaluation of the known active and potentially active faults, both regional and local.
3. Ground-motion parameters, as required by Sections 1613A and 1616A, and ASCE 7.

The three Next Generation Attenuation (NGA) relations used for the 2008 USGS seismic hazards maps for Western United States (WUS) shall be utilized to determine the site-specific ground motion. When supported by data and analysis, other NGA relations, that were not used for the 2008 USGS maps, shall be permitted as additions or substitutions. No fewer than three NGA relations shall be utilized.

1803A.7 Geotechnical reporting. Where geotechnical investigations are required, a written report of the investigations shall be submitted to the building official by the owner or authorized agent at the time of permit application. *The geotechnical report shall provide completed evaluations of the foundation conditions of the site and the potential geologic/seismic hazards affecting the site. The geotechnical report shall include, but shall not be limited to, site-specific evaluations of design criteria related to the nature and extent of foundation materials, groundwater conditions, liquefaction potential, settlement potential and slope stability. The report shall contain the results of the analyses of problem areas identified in the geohazard report. The geotechnical report shall incorporate estimates of the characteristics of site ground motion provided in the geohazard report.* This geotechnical report shall include, but need not be limited to, the following information:

1. A plot showing the location of the soil investigations.
2. A complete record of the soil boring and penetration test logs and soil samples.
3. A record of the soil profile.

4. Elevation of the water table, if encountered. *Historic high ground water elevations shall be addressed in the report to adequately evaluate liquefaction and settlement potential.*
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and varying soil strength; and the effects of adjacent loads.
6. Expected total and differential settlement.
7. Deep foundation information in accordance with Section 1803A.5.5.
8. Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. Compacted fill material properties and testing in accordance with Section 1803A.5.8.
10. Controlled low-strength material properties and testing in accordance with Section 1803A.5.9.
11. *The report shall consider the effects of stepped footings addressed in Section 1809A.3.*
12. *The report shall consider the effects of seismic hazards in accordance with Section 1803A.6 and shall incorporate the associated geohazard report.*

1803A.8 Geotechnical peer review. [DSA-SS and DSA-SS/CC] When alternate foundations designs or ground improvements are employed or where slope stabilization is required, a qualified peer review by a California-licensed geotechnical engineer, in accordance with Section 3422, may be required by the enforcement agency. In Section 3422, where reference is made to structural or seismic-resisting system, it shall be replaced with geotechnical, foundation, or ground improvement, as appropriate.

SECTION 1804A EXCAVATION, GRADING AND FILL

1804A.1 Excavation near foundations. Excavation for any purpose shall not remove lateral support from any foundation without first underpinning or protecting the foundation against settlement or lateral translation.

1804A.2 Placement of backfill. The excavation outside the foundation shall be backfilled with soil that is free of organic material, construction debris, cobbles and boulders or with a controlled low-strength material (CLSM). The backfill shall be placed in lifts and compacted in a manner that does not damage the foundation or the waterproofing or dampproofing material.

Exception: CLSM need not be compacted.

1804A.3 Site grading. The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than one unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. If physical obstructions or lot lines prohibit 10 feet (3048 mm) of

horizontal distance, a 5-percent slope shall be provided to an approved alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped a minimum of 2 percent where located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped a minimum of 2 percent away from the building.

Exception: Where climatic or soil conditions warrant, the slope of the ground away from the building foundation shall be permitted to be reduced to not less than one unit vertical in 48 units horizontal (2-percent slope).

The procedure used to establish the final ground level adjacent to the foundation shall account for additional settlement of the backfill.

1804A.4 Grading and fill in flood hazard areas. In flood hazard areas established in Section 1612A.3, grading and/or fill shall not be approved:

1. Unless such fill is placed, compacted and sloped to minimize shifting, slumping and erosion during the rise and fall of flood water and, as applicable, wave action.
2. In floodways, unless it has been demonstrated through hydrologic and hydraulic analyses performed by a registered design professional in accordance with standard engineering practice that the proposed grading or fill, or both, will not result in any increase in flood levels during the occurrence of the design flood.
3. In flood hazard areas subject to high-velocity wave action, unless such fill is conducted and/or placed to avoid diversion of water and waves toward any building or structure.
4. Where design flood elevations are specified but floodways have not been designated, unless it has been demonstrated that the cumulative effect of the proposed flood hazard area encroachment, when combined with all other existing and anticipated flood hazard area encroachment, will not increase the design flood elevation more than 1 foot (305 mm) at any point.

1804A.5 Compacted fill material. Where shallow foundations will bear on compacted fill material, the compacted fill shall comply with the provisions of an approved geotechnical report, as set forth in Section 1803A.

Exception: Compacted fill material 12 inches (305 mm) in depth or less need not comply with an approved report, provided the in-place dry density is not less than 90 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D 1557. The compaction shall be verified by special inspection in accordance with Section 1704A.7.

1804A.6 Controlled low-strength material (CLSM). Where shallow foundations will bear on controlled low-strength material (CLSM), the CLSM shall comply with the provisions of an approved geotechnical report, as set forth in Section 1803A.

SECTION 1805A DAMPROOFING AND WATERPROOFING

1805A.1 General. Walls or portions thereof that retain earth and enclose interior spaces and floors below grade shall be waterproofed and dampproofed in accordance with this section, with the exception of those spaces containing groups other than residential and institutional where such omission is not detrimental to the building or occupancy.

Ventilation for crawl spaces shall comply with Section 1203.4.

1805A.1.1 Story above grade plane. Where a basement is considered a story above grade plane and the finished ground level adjacent to the basement wall is below the basement floor elevation for 25 percent or more of the perimeter, the floor and walls shall be dampproofed in accordance with Section 1805A.2 and a foundation drain shall be installed in accordance with Section 1805A.4.2. The foundation drain shall be installed around the portion of the perimeter where the basement floor is below ground level. The provisions of Sections 1803A.5.4, 1805A.3 and 1805A.4.1 shall not apply in this case.

1805A.1.2 Under-floor space. The finished ground level of an under-floor space such as a crawl space shall not be located below the bottom of the footings. Where there is evidence that the ground-water table rises to within 6 inches (152 mm) of the ground level at the outside building perimeter, or that the surface water does not readily drain from the building site, the ground level of the under-floor space shall be as high as the outside finished ground level, unless an approved drainage system is provided. The provisions of Sections 1803A.5.4, 1805A.2, 1805A.3 and 1805A.4 shall not apply in this case.

1805A.1.2.1 Flood hazard areas. For buildings and structures in flood hazard areas as established in Section 1612A.3, the finished ground level of an under-floor space such as a crawl space shall be equal to or higher than the outside finished ground level on at least one side.

Exception: Under-floor spaces of Group R-3 buildings that meet the requirements of FEMA/FIA-TB-11.

1805A.1.3 Ground-water control. Where the ground-water table is lowered and maintained at an elevation not less than 6 inches (152 mm) below the bottom of the lowest floor, the floor and walls shall be dampproofed in accordance with Section 1805A.2. The design of the system to lower the ground-water table shall be based on accepted principles of engineering that shall consider, but not necessarily be limited to, permeability of the soil, rate at which water enters the drainage system, rated capacity of pumps, head against which pumps are to operate and the rated capacity of the disposal area of the system.

1805A.2 Dampproofing. Where hydrostatic pressure will not occur, as determined by Section 1803A.5.4, floors and walls shall be dampproofed in accordance with this section.

1805A.2.1 Floors. Dampproofing materials for floors shall be installed between the floor and the base course required by Section 1805A.4.1, except where a separate floor is provided above a concrete slab.

Where installed beneath the slab, dampproofing shall consist of not less than 6-mil (0.006 inch; 0.152 mm) polyethylene with joints lapped not less than 6 inches (152 mm), or other approved methods or materials. Where permitted to be installed on top of the slab, dampproofing shall consist of mopped-on bitumen, not less than 4-mil (0.004 inch; 0.102 mm) polyethylene, or other approved methods or materials. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1805A.2.2 Walls. Dampproofing materials for walls shall be installed on the exterior surface of the wall, and shall extend from the top of the footing to above ground level.

Dampproofing shall consist of a bituminous material, 3 pounds per square yard (16 N/m^2) of acrylic modified cement, $\frac{1}{8}$ inch (3.2 mm) coat of surface-bonding mortar complying with ASTM C 887, any of the materials permitted for waterproofing by Section 1805A.3.2 or other approved methods or materials.

1805A.2.2.1 Surface preparation of walls. Prior to application of dampproofing materials on concrete walls, holes and recesses resulting from the removal of form ties shall be sealed with a bituminous material or other approved methods or materials. Unit masonry walls shall be parged on the exterior surface below ground level with not less than $\frac{3}{8}$ inch (9.5 mm) of portland cement mortar. The parging shall be coved at the footing.

Exception: Parging of unit masonry walls is not required where a material is approved for direct application to the masonry.

1805A.3 Waterproofing. Where the ground-water investigation required by Section 1803A.5.4 indicates that a hydrostatic pressure condition exists, and the design does not include a ground-water control system as described in Section 1805A.1.3, walls and floors shall be waterproofed in accordance with this section.

1805A.3.1 Floors. Floors required to be waterproofed shall be of concrete and designed and constructed to withstand the hydrostatic pressures to which the floors will be subjected.

Waterproofing shall be accomplished by placing a membrane of rubberized asphalt, butyl rubber, fully adhered/fully bonded HDPE or polyolefin composite membrane or not less than 6-mil [0.006 inch (0.152 mm)] polyvinyl chloride with joints lapped not less than 6 inches (152 mm) or other approved materials under the slab. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1805A.3.2 Walls. Walls required to be waterproofed shall be of concrete or masonry and shall be designed and con-

structed to withstand the hydrostatic pressures and other lateral loads to which the walls will be subjected.

Waterproofing shall be applied from the bottom of the wall to not less than 12 inches (305 mm) above the maximum elevation of the ground-water table. The remainder of the wall shall be dampproofed in accordance with Section 1805A.2.2. Waterproofing shall consist of two-ply hot-mopped felts, not less than 6-mil (0.006 inch; 0.152 mm) polyvinyl chloride, 40-mil (0.040 inch; 1.02 mm) polymer-modified asphalt, 6-mil (0.006 inch; 0.152 mm) polyethylene or other approved methods or materials capable of bridging nonstructural cracks. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1805A.3.2.1 Surface preparation of walls. Prior to the application of waterproofing materials on concrete or masonry walls, the walls shall be prepared in accordance with Section 1805A.2.2.1.

1805A.3.3 Joints and penetrations. Joints in walls and floors, joints between the wall and floor and penetrations of the wall and floor shall be made water-tight utilizing approved methods and materials.

1805A.4 Subsoil drainage system. Where a hydrostatic pressure condition does not exist, dampproofing shall be provided and a base shall be installed under the floor and a drain installed around the foundation perimeter. A subsoil drainage system designed and constructed in accordance with Section 1805A.1.3 shall be deemed adequate for lowering the ground-water table.

1805A.4.1 Floor base course. Floors of basements, except as provided for in Section 1805A.1.1, shall be placed over a floor base course not less than 4 inches (102 mm) in thickness that consists of gravel or crushed stone containing not more than 10 percent of material that passes through a No. 4 (4.75 mm) sieve.

Exception: Where a site is located in well-drained gravel or sand/gravel mixture soils, a floor base course is not required.

1805A.4.2 Foundation drain. A drain shall be placed around the perimeter of a foundation that consists of gravel or crushed stone containing not more than 10-percent material that passes through a No. 4 (4.75 mm) sieve. The drain shall extend a minimum of 12 inches (305 mm) beyond the outside edge of the footing. The thickness shall be such that the bottom of the drain is not higher than the bottom of the base under the floor, and that the top of the drain is not less than 6 inches (152 mm) above the top of the footing. The top of the drain shall be covered with an approved filter membrane material. Where a drain tile or perforated pipe is used, the invert of the pipe or tile shall not be higher than the floor elevation. The top of joints or the top of perforations shall be protected with an approved filter membrane material. The pipe or tile shall be placed on not less than 2 inches (51 mm) of gravel or crushed stone complying with Section 1805A.4.1, and shall be covered with not less than 6 inches (152 mm) of the same material.

1805A.4.3 Drainage discharge. The floor base and foundation perimeter drain shall discharge by gravity or mechanical means into an approved drainage system that complies with the *California Plumbing Code*.

Exception: Where a site is located in well-drained gravel or sand/gravel mixture soils, a dedicated drainage system is not required.

SECTION 1806A

PRESUMPTIVE LOAD-BEARING VALUES OF SOILS

1806A.1 Load combinations. The presumptive load-bearing values provided in Table 1806A.2 shall be used with the allowable stress design load combinations specified in Section 1605A.3. The values of vertical foundation pressure and lateral bearing pressure given in Table 1806A.2 shall be permitted to be increased by one-third where used with the alternative basic load combinations of Section 1605A.3.2 that include wind or earthquake loads.

1806A.2 Presumptive load-bearing values. The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806A.2 unless data to substantiate the use of higher values are submitted and approved. Where the building official has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803A.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions. Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the building official deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

1806A.3 Lateral load resistance. Where the presumptive values of Table 1806A.2 are used to determine resistance to lateral loads, the calculations shall be in accordance with Sections 1806A.3.1 through 1806A.3.4.

1806A.3.1 Combined resistance. The total resistance to lateral loads shall be permitted to be determined by combining the values derived from the lateral bearing pressure and the lateral sliding resistance specified in Table 1806A.2.

1806A.3.2 Lateral sliding resistance limit. For clay, sandy clay, silty clay, clayey silt, silt and sandy silt, in no case shall the lateral sliding resistance exceed one-half the dead load.

1806A.3.3 Increase for depth. The lateral bearing pressures specified in Table 1806A.2 shall be permitted to be increased by the tabular value for each additional foot (305 mm) of depth to a maximum of 15 times the tabular value.

1806A.3.4 Increase for poles. Isolated poles for uses such as flagpoles or signs and poles used to support buildings that are not adversely affected by a $\frac{1}{2}$ inch (12.7 mm) motion at the ground surface due to short-term lateral loads shall be permitted to be designed using lateral bearing pressures equal to two times the tabular values.

SECTION 1807A

FOUNDATION WALLS, RETAINING WALLS AND EMBEDDED POSTS AND POLES

1807A.1 Foundation walls. Foundation walls shall be designed and constructed in accordance with Sections 1807A.1.1 through 1807A.1.6. Foundation walls shall be supported by foundations designed in accordance with Section 1808A.

1807A.1.1 Design lateral soil loads. Foundation walls shall be designed for the lateral soil loads *determined by a geotechnical investigation, in accordance with Section 1803A*.

1807A.1.2 Unbalanced backfill height. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab on grade is provided and is in contact with the interior surface of the foundation wall, the unbalanced backfill

TABLE 1806A.2
PRESUMPTIVE LOAD-BEARING VALUES

| CLASS OF MATERIALS | VERTICAL FOUNDATION PRESSURE (psf) | LATERAL BEARING PRESSURE (psf/ft below natural grade) | LATERAL SLIDING RESISTANCE | |
|--|------------------------------------|---|--------------------------------------|-----------------------------|
| | | | Coefficient of friction ^a | Cohesion (psf) ^b |
| 1. Crystalline bedrock | 12,000 | 1,200 | 0.70 | — |
| 2. Sedimentary and foliated rock | 4,000 | 400 | 0.35 | — |
| 3. Sandy gravel and/or gravel (GW and GP) | 3,000 | 200 | 0.35 | — |
| 4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC) | 2,000 | 150 | 0.25 | — |
| 5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH) | 1,500 | 100 | — | 130 |

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Cohesion value to be multiplied by the contact area, as limited by Section 1806A.3.2.

height shall be permitted to be measured from the exterior finish ground level to the top of the interior concrete slab.

1807A.1.3 Rubble stone foundation walls. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.*

1807A.1.4 Permanent wood foundation systems. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.*

1807A.1.5 Concrete and masonry foundation walls.

Concrete and masonry foundation walls shall be designed in accordance with Chapter 19A or 21A, as applicable.

1807A.2 Retaining walls. Retaining walls shall be designed in accordance with Sections 1807A.2.1 through 1807A.2.3. *Freestanding cantilever walls shall be designed in accordance with Section 1807A.2.4.*

1807A.2.1 General. Retaining walls shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Where a keyway is extended below the wall base with the intent to engage passive pressure and enhance sliding stability, lateral soil pressures on both sides of the keyway shall be considered in the sliding analysis.

1807A.2.2 Design lateral soil loads. Retaining walls shall be designed for the lateral soil loads *determined by a geotechnical investigation in accordance with Section 1803A and shall not be less than eighty percent of the lateral soil loads determined in accordance with Section 1610A.*

1807A.2.3 Safety factor. Retaining walls shall be designed to resist the lateral action of soil to produce sliding and overturning with a minimum safety factor of 1.5 in each case. The load combinations of Section 1605A shall not apply to this requirement. Instead, design shall be based on 0.7 times nominal earthquake loads, 1.0 times other nominal loads, and investigation with one or more of the variable loads set to zero. The safety factor against lateral sliding shall be taken as the available soil resistance at the base of the retaining wall foundation divided by the net lateral force applied to the retaining wall.

Exception: Where earthquake loads are included, the minimum safety factor for retaining wall sliding and overturning shall be 1.1.

1807A.2.4 Freestanding cantilever walls. *A stability check against the possibility of overturning shall be performed for isolated spread footings which support free-standing cantilever walls. The stability check shall be made by dividing R_p used for the wall by 2.0. The allowable soil pressure may be doubled for this evaluation.*

Exception: *For overturning about the principal axis of rectangular footings with symmetrical vertical loading and the design lateral force applied, a triangular or trapezoidal soil pressure distribution which covers the full width of the footing will meet the stability requirement.*

1807A.3 Embedded posts and poles. Designs to resist both axial and lateral loads employing posts or poles as columns embedded in earth or in concrete footings in earth shall be in accordance with Sections 1807A.3.1 through 1807A.3.3.

1807A.3.1 Limitations. The design procedures outlined in this section are subject to the following limitations:

1. The frictional resistance for structural walls and slabs on silts and clays shall be limited to one-half of the normal force imposed on the soil by the weight of the footing or slab.
2. Posts embedded in earth shall not be used to provide lateral support for structural or nonstructural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

Wood poles shall be treated in accordance with AWPA U1 for sawn timber posts (Commodity Specification A, Use Category 4B) and for round timber posts (Commodity Specification B, Use Category 4B).

1807A.3.2 Design criteria. The depth to resist lateral loads shall be determined using the design criteria established in Sections 1807A.3.2.1 through 1807A.3.2.3, or by other methods approved by the building official.

1807A.3.2.1 Nonconstrained. The following formula shall be used in determining the depth of embedment required to resist lateral loads where no lateral constraint is provided at the ground surface, such as by a rigid floor or rigid ground surface pavement, and where no lateral constraint is provided above the ground surface, such as by a structural diaphragm.

$$d = 0.5A\{1 + [1 + (4.36h/A)]^{1/2}\} \quad (\text{Equation 18A-1})$$

where:

$$A = 2.34P/(S_1 b)$$

b = Diameter of round post or footing or diagonal dimension of square post or footing, feet (m).

d = Depth of embedment in earth in feet (m) but not over 12 feet (3658 mm) for purpose of computing lateral pressure.

h = Distance in feet (m) from ground surface to point of application of " P ".

P = Applied lateral force in pounds (kN).

S_1 = Allowable lateral soil-bearing pressure as set forth in Section 1806A.2 based on a depth of one-third the depth of embedment in pounds per square foot (psf) (kPa).

1807A.3.2.2 Constrained. The following formula shall be used to determine the depth of embedment required to resist lateral loads where lateral constraint is provided at the ground surface, such as by a rigid floor or pavement.

$$d = \sqrt{\frac{4.25Ph}{S_3 b}} \quad (\text{Equation 18A-2})$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3 b}} \quad (\text{Equation 18A-3})$$

where:

M_g = Moment in the post at grade, in foot-pounds (kN-m).

S_3 = Allowable lateral soil-bearing pressure as set forth in Section 1806A.2 based on a depth equal to the depth of embedment in pounds per square foot (kPa).

1807A.3.2.3 Vertical load. The resistance to vertical loads shall be determined using the vertical foundation pressure set forth in Table 1806A.2.

1807A.3.3 Backfill. The backfill in the annular space around columns not embedded in poured footings shall be by one of the following methods:

1. Backfill shall be of concrete with a specified compressive strength of not less than 2,000 psi (13.8 MPa). The hole shall not be less than 4 inches (102 mm) larger than the diameter of the column at its bottom or 4 inches (102 mm) larger than the diagonal dimension of a square or rectangular column.
2. Backfill shall be of clean sand. The sand shall be thoroughly compacted by tamping in layers not more than 8 inches (203 mm) in depth.
3. Backfill shall be of controlled low-strength material (CLSM).

SECTION 1808A FOUNDATIONS

1808A.1 General. Foundations shall be designed and constructed in accordance with Sections 1808A.2 through 1808A.9. Shallow foundations shall also satisfy the requirements of Section 1809A. Deep foundations shall also satisfy the requirements of Section 1810A.

1808A.2 Design for capacity and settlement. Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that differential settlement is minimized. Foundations in areas with expansive soils shall be designed in accordance with the provisions of Section 1808A.6.

The enforcing agency may require an analysis of foundation elements to determine subgrade deformations in order to evaluate their effect on the superstructure, including story drift.

1808A.3 Design loads. Foundations shall be designed for the most unfavorable effects due to the combinations of loads specified in Section 1605A.2 or 1605A.3. The dead load is permitted to include the weight of foundations and overlying fill. Reduced live loads, as specified in Sections 1607A.9 and 1607A.11, shall be permitted to be used in the design of foundations.

1808A.3.1 Seismic overturning. Where foundations are proportioned using the load combinations of Section 1605.2 or 1605A.3.1, and the computation of seismic overturning effects is by equivalent lateral force analysis or modal analysis, the proportioning shall be in accordance with Section 12.13.4 of ASCE 7.

1808A.4 Vibratory loads. Where machinery operations or other vibrations are transmitted through the foundation, consideration shall be given in the foundation design to prevent detrimental disturbances of the soil.

1808A.5 Shifting or moving soils. Where it is known that the shallow subsoils are of a shifting or moving character, foundations shall be carried to a sufficient depth to ensure stability.

1808A.6 Design for expansive soils. Foundations for buildings and structures founded on expansive soils shall be designed in accordance with Section 1808A.6.1 or 1808A.6.2.

Exception: Foundation design need not comply with Section 1808A.6.1 or 1808A.6.2 where one of the following conditions is satisfied:

1. The soil is removed in accordance with Section 1808A.6.3; or
2. The building official approves stabilization of the soil in accordance with Section 1808A.6.4.

1808A.6.1 Foundations. Foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

1808A.6.2 Slab-on-ground foundations. Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive soils shall be determined in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* or *PTI Standard Requirements for Analysis of Shallow Concrete Foundations on Expansive Soils*. Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *PTI Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils*. It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

1808A.6.3 Removal of expansive soil. Where expansive soil is removed in lieu of designing foundations in accordance with Section 1808A.6.1 or 1808A.6.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive soils and shall comply with Section 1804A.5 or 1804A.6.

Exception: Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

1808A.6.4 Stabilization. Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 1808A.6.1 or 1808A.6.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

1808A.7 Foundations on or adjacent to slopes. The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall comply with Sections 1808A.7.1 through 1808A.7.5.

1808A.7.1 Building clearance from ascending slopes. In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in Section 1808A.7.5 and Figure 1808A.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

1808A.7.2 Foundation setback from descending slope surface. Foundations on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the foundation without detrimental

settlement. Except as provided for in Section 1808A.7.5 and Figure 1808A.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

1808A.7.3 Pools. The setback between pools regulated by this code and slopes shall be equal to one-half the building footing setback distance required by this section. That portion of the pool wall within a horizontal distance of 7 feet (2134 mm) from the top of the slope shall be capable of supporting the water in the pool without soil support.

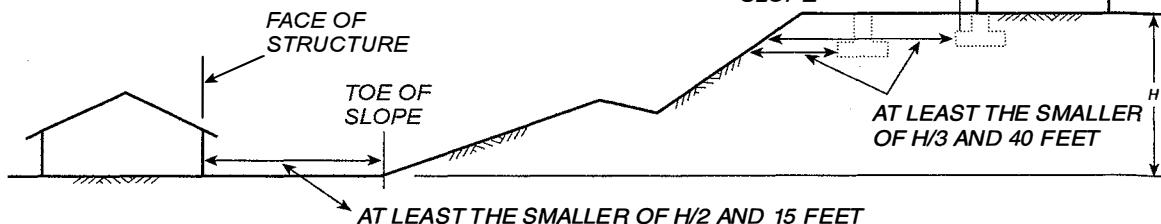
1808A.7.4 Foundation elevation. On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the building official, provided it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

1808A.7.5 Alternate setback and clearance. Alternate setbacks and clearances are permitted, subject to the approval of the building official. The building official shall be permitted to require a geotechnical investigation as set forth in Section 1803A.5.10.

1808A.8 Concrete foundations. The design, materials and construction of concrete foundations shall comply with Sections 1808A.8.1 through 1808A.8.6 and the provisions of Chapter 19A.

1808A.8.1 Concrete or grout strength and mix proportioning. Concrete or grout in foundations shall have a specified compressive strength (f'_c) not less than the largest applicable value indicated in Table 1808A.8.1.

Where concrete is placed through a funnel hopper at the top of a deep foundation element, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 8 inches (204 mm). Where



For SI: 1 foot = 304.8 mm.

**FIGURE 1808A.7.1
FOUNDATION CLEARANCES FROM SLOPES**

concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.

1808A.8.2 Concrete cover. The concrete cover provided for prestressed and nonprestressed reinforcement in foundations shall be no less than the largest applicable value specified in Table 1808A.8.2. Longitudinal bars spaced less than $1\frac{1}{2}$ inches (38 mm) clear distance apart shall be considered bundled bars for which the concrete cover provided shall also be no less than that required by Section 7.7.4 of ACI 318. Concrete cover shall be measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. Where concrete is placed in a temporary or permanent casing or a mandrel, the inside face of the casing or mandrel shall be considered the concrete surface.

1808A.8.3 Placement of concrete. Concrete shall be placed in such a manner as to ensure the exclusion of any foreign matter and to secure a full-size foundation. Concrete shall not be placed through water unless a tremie or other method approved by the building official is used. Where placed under or in the presence of water, the concrete shall be deposited by approved means to ensure minimum segregation of the mix and negligible turbulence of the water. Where depositing concrete from the top of a deep foundation element, the concrete shall be chuted

directly into smooth-sided pipes or tubes or placed in a rapid and continuous operation through a funnel hopper centered at the top of the element.

1808A.8.4 Protection of concrete. Concrete foundations shall be protected from freezing during depositing and for a period of not less than five days thereafter. Water shall not be allowed to flow through the deposited concrete.

1808A.8.5 Forming of concrete. Concrete foundations are permitted to be cast against the earth where, in the opinion of the building official, soil conditions do not require formwork. Where formwork is required, it shall be in accordance with Chapter 6 of ACI 318.

1808A.8.6 Seismic requirements. See Section 1908A for additional requirements for foundations of structures assigned to Seismic Design Category D, E or F.

For structures assigned to Seismic Design Category D, E or F, provisions of ACI 318, Sections 21.12.1 through 21.12.4, shall apply where not in conflict with the provisions of Sections 1808A through 1810A.

1808A.9 Vertical masonry foundation elements. Vertical masonry foundation elements that are not foundation piers as defined in Section 2102.1 shall be designed as piers, walls or columns, as applicable, in accordance with TMS 402/ACI 530/ASCE 5.

TABLE 1808A.8.1
MINIMUM SPECIFIED COMPRESSIVE STRENGTH f'_c OF CONCRETE OR GROUT

| FOUNDATION ELEMENT OR CONDITION | SPECIFIED COMPRESSIVE STRENGTH, f'_c |
|---|--|
| 1. Foundations for structures assigned to Seismic Design Category D, E or F | 3,000 psi |
| 2. Precast nonprestressed driven piles | 4,000 psi |
| 3. Socketed drilled shafts | 4,000 psi |
| 4. Micropiles | 4,000 psi |
| 5. Precast prestressed driven piles | 5,000 psi |

For SI: 1 pound per square inch = 0.00689 MPa.

TABLE 1808A.8.2
MINIMUM CONCRETE COVER

| FOUNDATION ELEMENT OR CONDITION | MINIMUM COVER |
|---|---|
| 1. Shallow foundations | In accordance with Section 7.7 of ACI 318 |
| 2. Precast nonprestressed deep foundation elements Exposed to seawater Not manufactured under plant conditions Manufactured under plant control conditions | 3 inches 2 inches In accordance with Section 7.7.3 of ACI 318 |
| 3. Precast prestressed deep foundation elements Exposed to seawater Other | 2.5 inches In accordance with Section 7.7.3 of ACI 318 |
| 4. Cast-in-place deep foundation elements not enclosed by a steel pipe, tube or permanent casing | 2.5 inches |
| 5. Cast-in-place deep foundation elements enclosed by a steel pipe, tube or permanent casing | 1 inch |
| 6. Structural steel core within a steel pipe, tube or permanent casing | 2 inches |
| 7. Cast-in-place drilled shafts enclosed by a stable rock socket | 1.5 inches |

For SI: 1 inch = 25.4 mm.

SECTION 1809A SHALLOW FOUNDATIONS

1809A.1 General. Shallow foundations shall be designed and constructed in accordance with Sections 1809A.2 through 1809A.13.

1809A.2 Supporting soils. Shallow foundations shall be built on undisturbed soil, compacted fill material or controlled low-strength material (CLSM). Compacted fill material shall be placed in accordance with Section 1804A.5. CLSM shall be placed in accordance with Section 1804A.6.

1809A.3 Stepped footings. The top surface of footings shall be level. The bottom surface of footings shall be permitted to have a slope not exceeding one unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footing or where the surface of the ground slopes more than one unit vertical in 10 units horizontal (10-percent slope).

Individual steps in continuous footings shall not exceed 18 inches (457 mm) in height and the slope of a series of such steps shall not exceed 1 unit vertical to 2 units horizontal (50 percent slope) unless otherwise recommended by a geotechnical report. The steps shall be detailed on the drawings. The local effects due to the discontinuity of the steps shall be considered in the design of the foundation.

1809A.4 Depth and width of footings. The minimum depth of footings below the undisturbed ground surface shall be 12 inches (305 mm). Where applicable, the requirements of Section 1809A.5 shall also be satisfied. The minimum width of footings shall be 12 inches (305 mm).

1809A.5 Frost protection. Except where otherwise protected from frost, foundations and other permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:

1. Extending below the frost line of the locality;
2. Constructing in accordance with ASCE 32; or
3. Erecting on solid rock.

Exception: Free-standing buildings meeting all of the following conditions shall not be required to be protected:

1. Assigned to Risk Category I, in accordance with Section 1604A.5;
2. Area of 600 square feet (56 m^2) or less for light-frame construction or 400 square feet (37 m^2) or less for other than light-frame construction; and
3. Eave height of 10 feet (3048 mm) or less.

Shallow foundations shall not bear on frozen soil unless such frozen condition is of a permanent character.

1809A.6 Location of footings. Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an approved manner or a greater slope has been properly established by engineering analysis.

1809A.7 Prescriptive footings for light-frame construction. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1809A.8 Plain concrete footings. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1809A.9 Masonry-unit footings. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1809A.10 Reserved.

1809A.11 Steel grillage footings. Grillage footings of structural steel shapes shall be separated with approved steel spacers and be entirely encased in concrete with at least 6 inches (152 mm) on the bottom and at least 4 inches (102 mm) at all other points. The spaces between the shapes shall be completely filled with concrete or cement grout.

1809A.12 Timber footings. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1809A.13 Footing seismic ties. Where a structure is assigned to Seismic Design Category D, E or F, individual spread footings founded on soil defined in Section 1613A.5.2 as Site Class E or F shall be interconnected by ties. Unless it is demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger footing design gravity load times the seismic coefficient, S_{DS} , divided by 10 and 25 percent of the smaller footing design gravity load.

1809A.14 Pipes and trenches. Unless otherwise recommended by the soils report, open or backfilled trenches parallel with a footing shall not be below a plane having a downward slope of 1 unit vertical to 2 units horizontal (50 percent slope) from a line 9 inches (229 mm) above the bottom edge of the footing, and not closer than 18 inches (457 mm) from the face of such footing.

Where pipes cross under footings, the footings shall be specially designed. Pipe sleeves shall be provided where pipes cross through footings or footing walls and sleeve clearances shall provide for possible footing settlement, but not less than 1 inch (25 mm) all around pipe.

Exception: Alternate trench locations and pipe clearances shall be permitted when approved by registered design professional in responsible charge and the enforcement agent.

1809A.15 Grade beams: [DSA-SS, DSA-SS/CC] For structures assigned to Seismic Design Category D, E or F, grade beams in shallow foundations shall comply with Section 1810A.3.12.

SECTION 1810A DEEP FOUNDATIONS

1810A.1 General. Deep foundations shall be analyzed, designed, detailed and installed in accordance with Sections 1810A.1 through 1810A.4.

1810A.1.1 Geotechnical investigation. Deep foundations shall be designed and installed on the basis of a geotechnical investigation as set forth in Section 1803A.

1810A.1.2 Use of existing deep foundation elements. Deep foundation elements left in place where a structure has been demolished shall not be used for the support of new construction unless satisfactory evidence is submitted to the building official, which indicates that the elements are sound and meet the requirements of this code. Such elements shall be load tested or redriven to verify their capacities. The design load applied to such elements shall be the lowest allowable load as determined by tests or redriving data.

1810A.1.3 Deep foundation elements classified as columns. Deep foundation elements standing unbraced in air, water or fluid soils shall be classified as columns and designed as such in accordance with the provisions of this code from their top down to the point where adequate lateral support is provided in accordance with Section 1810A.2.1.

Exception: Where the unsupported height to least horizontal dimension of a cast-in-place deep foundation element does not exceed three, it shall be permitted to design and construct such an element as a pedestal in accordance with ACI 318.

1810A.1.4 Special types of deep foundations. The use of types of deep foundation elements not specifically mentioned herein is permitted, subject to the approval of the building official, upon the submission of acceptable test data, calculations and other information relating to the structural properties and load capacity of such elements. The allowable stresses for materials shall not in any case exceed the limitations specified herein.

1810A.2 Analysis. The analysis of deep foundations for design shall be in accordance with Sections 1810A.2.1 through 1810A.2.5.

1810A.2.1 Lateral support. Any soil other than fluid soil shall be deemed to afford sufficient lateral support to prevent buckling of deep foundation elements and to permit the design of the elements in accordance with accepted engineering practice and the applicable provisions of this code.

Where deep foundation elements stand unbraced in air, water or fluid soils, it shall be permitted to consider them laterally supported at a point 5 feet (1524 mm) into stiff soil or 10 feet (3048 mm) into soft soil unless otherwise approved by the building official on the basis of a geotechnical investigation by a registered design professional.

1810A.2.2 Stability. Deep foundation elements shall be braced to provide lateral stability in all directions. Three or more elements connected by a rigid cap shall be considered braced, provided that the elements are located in radial directions from the centroid of the group not less than 60 degrees (1 rad) apart. A two-element group in a rigid cap shall be considered to be braced along the axis connecting the two elements. Methods used to brace deep foundation elements shall be subject to the approval of the building official.

Deep foundation elements supporting walls shall be placed alternately in lines spaced at least 1 foot (305 mm)

apart and located symmetrically under the center of gravity of the wall load carried, unless effective measures are taken to provide for eccentricity and lateral forces, or the foundation elements are adequately braced to provide for lateral stability.

Exceptions:

1. Isolated cast-in-place deep foundation elements without lateral bracing shall be permitted where the least horizontal dimension is no less than 2 feet (610 mm), adequate lateral support in accordance with Section 1810A.2.1 is provided for the entire height and the height does not exceed 12 times the least horizontal dimension.
2. A single row of deep foundation elements without lateral bracing is permitted for one- and two-family dwellings and lightweight construction not exceeding two stories above grade plane or 35 feet (10 668 mm) in building height, provided the centers of the elements are located within the width of the supported wall.

1810A.2.3 Settlement. The settlement of a single deep foundation element or group thereof shall be estimated based on approved methods of analysis. The predicted settlement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

1810A.2.4 Lateral loads. The moments, shears and lateral deflections used for design of deep foundation elements shall be established considering the nonlinear interaction of the shaft and soil, as determined by a registered design professional. Where the ratio of the depth of embedment of the element to its least horizontal dimension is less than or equal to six, it shall be permitted to assume the element is rigid.

1810A.2.4.1 Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, deep foundation elements on Site Class E or F sites, as determined in Section 1613A.5.2, shall be designed and constructed to withstand maximum imposed curvatures from earthquake ground motions and structure response. Curvatures shall include free-field soil strains modified for soil-foundation-structure interaction coupled with foundation element deformations associated with earthquake loads imparted to the foundation by the structure.

Exception: Deep foundation elements that satisfy the following additional detailing requirements shall be deemed to comply with the curvature capacity requirements of this section.

1. Precast prestressed concrete piles detailed in accordance with Section 1810A.3.8.3.3.
2. Cast-in-place deep foundation elements with a minimum longitudinal reinforcement ratio of 0.005 extending the full length of the element and detailed in accordance with Sections 21.6.4.2, 21.6.4.3 and 21.6.4.4 of ACI 318 as required by Section 1810A.3.9.4.2.2.

1810A.2.5 Group effects. The analysis shall include group effects on lateral behavior where the center-to-center spacing of deep foundation elements in the direction of lateral force is less than eight times the least horizontal dimension of an element. The analysis shall include group effects on axial behavior where the center-to-center spacing of deep foundation elements is less than three times the least horizontal dimension of an element.

1810A.3 Design and detailing. Deep foundations shall be designed and detailed in accordance with Sections 1810A.3.1 through 1810A.3.12.

1810A.3.1 Design conditions. Design of deep foundations shall include the design conditions specified in Sections 1810A.3.1.1 through 1810A.3.1.6, as applicable.

1810A.3.1.1 Design methods for concrete elements. Where concrete deep foundations are laterally supported in accordance with Section 1810A.2.1 for the entire height and applied forces cause bending moments no greater than those resulting from accidental eccentricities, structural design of the element using the load combinations of Section 1605A.3 and the allowable stresses specified in this chapter shall be permitted. Otherwise, the structural design of concrete deep foundation elements shall use the load combinations of Section 1605A.2 and approved strength design methods.

1810A.3.1.2 Composite elements. Where a single deep foundation element comprises two or more sections of different materials or different types spliced together, each section of the composite assembly shall satisfy the applicable requirements of this code, and the maximum allowable load in each section shall be limited by the structural capacity of that section.

1810A.3.1.3 Mislocation. The foundation or superstructure shall be designed to resist the effects of the mislocation of any deep foundation element by no less than 3 inches (76 mm). To resist the effects of mislocation, compressive overload of deep foundation elements to 110 percent of the allowable design load shall be permitted.

1810A.3.1.4 Driven piles. Driven piles shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by handling, driving and service loads.

1810A.3.1.5 Helical piles. Helical piles shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by installation into the ground and service loads.

1810A.3.1.5.1 Helical piles seismic requirements.
For structures assigned to Seismic Design Category D, E or F, capacities of helical piles shall be determined in accordance with Section 1810A.3.3 by at least two project specific preproduction tests for each soil profile, size and depth of helical pile. At least two percent of all production piles shall be proof tested to the load determined in accordance with Section 1615A.1.10.

Helical piles shall satisfy corrosion resistance requirements of ICC-ES AC 358. In addition, all helical pile materials that are subject to corrosion shall include at least $\frac{1}{16}$ " corrosion allowance.

Helical piles shall not be considered as carrying any horizontal loads.

1810A.3.1.6 Casings. Temporary and permanent casings shall be of steel and shall be sufficiently strong to resist collapse and sufficiently water tight to exclude any foreign materials during the placing of concrete. Where a permanent casing is considered reinforcing steel, the steel shall be protected under the conditions specified in Section 1810A.3.2.5. Horizontal joints in the casing shall be spliced in accordance with Section 1810A.3.6.

1810A.3.2 Materials. The materials used in deep foundation elements shall satisfy the requirements of Sections 1810A.3.2.1 through 1810A.3.2.8, as applicable.

1810A.3.2.1 Concrete. Where concrete is cast in a steel pipe or where an enlarged base is formed by compacting concrete, the maximum size for coarse aggregate shall be $\frac{3}{4}$ inch (19.1 mm). Concrete to be compacted shall have a zero slump.

1810A.3.2.1.1 Seismic hooks. For structures assigned to Seismic Design Category C, D, E or F, the ends of hoops, spirals and ties used in concrete deep foundation elements shall be terminated with seismic hooks, as defined in ACI 318, and shall be turned into the confined concrete core.

1810A.3.2.2 Prestressing steel. Prestressing steel shall conform to ASTM A 416.

1810A.3.2.3 Structural steel. Structural steel piles, steel pipe and fully welded steel piles fabricated from plates shall conform to ASTM A 36, ASTM A 252, ASTM A 283, ASTM A 572, ASTM A 588, ASTM A 690, ASTM A 913 or ASTM A 992.

1810A.3.2.4 Timber. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1810A.3.2.5 Protection of materials. Where boring records or site conditions indicate possible deleterious action on the materials used in deep foundation elements because of soil constituents, changing water levels or other factors, the elements shall be adequately protected by materials, methods or processes approved by the building official. Protective materials shall be applied to the elements so as not to be rendered ineffective by installation. The effectiveness of such protective measures for the particular purpose shall have been thoroughly established by satisfactory service records or other evidence.

1810A.3.2.6 Allowable stresses. The allowable stresses for materials used in deep foundation elements shall not exceed those specified in Table 1810A.3.2.6.

1810A.3.2.7 Increased allowable compressive stress for cased cast-in-place elements. The allowable compressive stress in the concrete shall be permitted to be

increased as specified in Table 1810A.3.2.6 for those portions of permanently cased cast-in-place elements that satisfy all of the following conditions:

1. The design shall not use the casing to resist any portion of the axial load imposed.
2. The casing shall have a sealed tip and be mandrel driven.
3. The thickness of the casing shall not be less than manufacturer's standard gage No. 14 (0.068 inch) (1.75 mm).
4. The casing shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete.
5. The ratio of steel yield strength (F_y) to specified compressive strength (f'_c) shall not be less than six.
6. The nominal diameter of the element shall not be greater than 16 inches (406 mm).

1810A.3.2.8 Justification of higher allowable stresses. Use of allowable stresses greater than those specified in Section 1810A.3.2.6 shall be permitted where supporting data justifying such higher stresses is filed with the building official. Such substantiating data shall include:

1. A geotechnical investigation in accordance with Section 1803A; and

**TABLE 1810A.3.2.6
ALLOWABLE STRESSES FOR MATERIALS USED IN DEEP FOUNDATION ELEMENTS**

| MATERIAL TYPE AND CONDITION | MAXIMUM ALLOWABLE STRESS ^a |
|---|---|
| 1. Concrete or grout in compression ^b <ul style="list-style-type: none"> Cast-in-place with a permanent casing in accordance with Section 1810A.3.2.7 Cast-in-place in a pipe, tube, other permanent casing or rock Cast-in-place without a permanent casing Precast nonprestressed Precast prestressed | $0.4 f'_c$ $0.33 f'_c$ $0.3 f'_c$ $0.33 f'_c$ $0.33 f'_c \quad 0.27 f_{pc}$ |
| 2. Nonprestressed reinforcement in compression | $0.4 f_y \leq 30,000$ psi |
| 3. Structural steel in compression <ul style="list-style-type: none"> Cores within concrete-filled pipes or tubes Pipes, tubes or H-piles, where justified in accordance with Section 1810A.3.2.8 Pipes or tubes for micropiles Other pipes, tubes or H-piles Helical piles | $0.5 F_y \leq 32,000$ psi $0.5 F_y \leq 32,000$ psi $0.4 F_y \leq 32,000$ psi $0.35 F_y \leq 16,000$ psi $0.6 F_y \leq 0.5 F_u$ |
| 4. Nonprestressed reinforcement in tension <ul style="list-style-type: none"> Within micropiles Other conditions | $0.6 f_y$ $0.5 f_y \leq 24,000$ psi |
| 5. Structural steel in tension <ul style="list-style-type: none"> Pipes, tubes or H-piles, where justified in accordance with Section 1810A.3.2.8 Other pipes, tubes or H-piles Helical piles | $0.5 F_y \leq 32,000$ psi $0.35 F_y \leq 16,000$ psi $0.6 F_y \leq 0.5 F_u$ |
| 6. Timber | In accordance with the AF&PA NDS |

a. f'_c is the specified compressive strength of the concrete or grout; f_{pc} is the compressive stress on the gross concrete section due to effective prestress forces only; f_y is the specified yield strength of reinforcement; F_y is the specified minimum yield stress of structural steel; F_u is the specified minimum tensile stress of structural steel.

b. The stresses specified apply to the gross cross sectional area within the concrete surface. Where a temporary or permanent casing is used, the inside face of the casing shall be considered the concrete surface.

ity-drop or power-actuated hammers and the hammer energy used shall be the maximum consistent with the size, strength and weight of the driven elements. The use of a follower is permitted only with the approval of the building official. The introduction of fresh hammer cushion or pile cushion material just prior to final penetration is not permitted.

1810A.3.3.1.2 Load tests. Where design compressive loads are greater than those determined using the allowable stresses specified in Section 1810A.3.2.6, where the design load for any deep foundation element is in doubt, or where cast-in-place deep foundation elements have an enlarged base formed either by compacting concrete or by driving a precast base, control test elements shall be tested in accordance with ASTM D 1143 *including Procedure G: Cyclic Loading Test* or ASTM D 4945. At least one element shall be load tested in each area of uniform subsoil conditions. Where required by the building official, additional elements shall be load tested where necessary to establish the safe design capacity. The resulting allowable loads shall not be more than one-half of the ultimate axial load capacity of the test element as assessed by one of the published methods listed in Section 1810A.3.3.1.3 with consideration for the test type, duration and subsoil. The ultimate axial load capacity shall be determined by a registered design professional with consideration given to tolerable total and differential settlements at design load in accordance with Section 1810A.2.3. In subsequent installation of the balance of deep foundation elements, all elements shall be deemed to have a supporting capacity equal to that of the control element where such elements are of the same type, size and relative length as the test element; are installed using the same or comparable methods and equipment as the test element; are installed in similar subsoil conditions as the test element; and, for driven elements, where the rate of penetration (e.g., net displacement per blow) of such elements is equal to or less than that of the test element driven with the same hammer through a comparable driving distance.

1810A.3.3.1.3 Load test evaluation methods. It shall be permitted to evaluate load tests of deep foundation elements using any of the following methods:

1. Davisson Offset Limit.
2. Brinch-Hansen 90% Criterion.
3. Butler-Hoy Criterion.
4. Other methods approved by the building official.

1810A.3.3.1.4 Allowable frictional resistance. The assumed frictional resistance developed by any uncased cast-in-place deep foundation element shall not exceed one-sixth of the bearing value of the soil

material at minimum depth as set forth in Table 1806A.2, up to a maximum of 500 psf (24 kPa), unless a greater value is allowed by the building official on the basis of a geotechnical investigation as specified in Section 1803A or a greater value is substantiated by a load test in accordance with Section 1810A.3.3.1.2. Frictional resistance and bearing resistance shall not be assumed to act simultaneously unless determined by a geotechnical investigation in accordance with Section 1803A.

1810A.3.3.1.5 Uplift capacity of a single deep foundation element. Where required by the design, the uplift capacity of a single deep foundation element shall be determined by an approved method of analysis based on a minimum factor of safety of three or by load tests conducted in accordance with ASTM D 3689. The maximum allowable uplift load shall not exceed the ultimate load capacity as determined in Section 1810A.3.3.1.2, using the results of load tests conducted in accordance with ASTM D 3689 *including the cyclic loading procedure*, divided by a factor of safety of two.

Exception: Where uplift is due to wind or seismic loading, the minimum factor of safety shall be two where capacity is determined by an analysis and one and one-half where capacity is determined by load tests.

1810A.3.3.1.6 Uplift capacity of grouped deep foundation elements. For grouped deep foundation elements subjected to uplift, the allowable working uplift load for the group shall be calculated by an approved method of analysis. Where the deep foundation elements in the group are placed at a center-to-center spacing of at least 2.5 times the least horizontal dimension of the largest single element, the allowable working uplift load for the group is permitted to be calculated as the lesser of:

1. The proposed individual uplift working load times the number of elements in the group.
2. Two-thirds of the effective weight of the group and the soil contained within a block defined by the perimeter of the group and the length of the element, plus two-thirds of the ultimate shear resistance along the soil block.

1810A.3.3.1.7 Load-bearing capacity. Deep foundation elements shall develop ultimate load capacities of at least twice the design working loads in the designated load-bearing layers. Analysis shall show that no soil layer underlying the designated load-bearing layers causes the load-bearing capacity safety factor to be less than two.

1810A.3.3.1.8 Bent deep foundation elements. The load-bearing capacity of deep foundation elements discovered to have a sharp or sweeping bend shall be determined by an approved method of analysis or by load testing a representative element.

1810A.3.3.1.9 Helical piles. The allowable axial design load, P_a , of helical piles shall be determined as follows:

$$P_a = 0.5 P_u \quad (\text{Equation 18A-4})$$

where P_u is the least value of:

1. Sum of the areas of the helical bearing plates times the ultimate bearing capacity of the soil or rock comprising the bearing stratum.
2. Ultimate capacity determined from well-documented correlations with installation torque.
3. Ultimate capacity determined from load tests.
4. Ultimate axial capacity of pile shaft.
5. Ultimate axial capacity of pile shaft couplings.
6. Sum of the ultimate axial capacity of helical bearing plates affixed to pile.

1810A.3.3.2 Allowable lateral load. Where required by the design, the lateral load capacity of a single deep foundation element or a group thereof shall be determined by an approved method of analysis or by lateral load tests *in accordance with ASTM D 3966, including the cyclic loading procedure*, to at least twice the proposed design working load. The resulting allowable load shall not be more than one-half of the load that produces a gross lateral movement of 1 inch (25 mm) at the lower of the top of foundation element and the ground surface, unless it can be shown that the predicted lateral movement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

1810A.3.4 Subsiding soils. Where deep foundation elements are installed through subsiding fills or other subsiding strata and derive support from underlying firmer materials, consideration shall be given to the downward frictional forces that may be imposed on the elements by the subsiding upper strata.

Where the influence of subsiding fills is considered as imposing loads on the element, the allowable stresses specified in this chapter shall be permitted to be increased where satisfactory substantiating data are submitted.

1810A.3.5 Dimensions of deep foundation elements. The dimensions of deep foundation elements shall be in accordance with Sections 1810A.3.5.1 through 1810A.3.5.3, as applicable.

1810A.3.5.1 Precast. The minimum lateral dimension of precast concrete deep foundation elements shall be 8 inches (203 mm). Corners of square elements shall be chamfered.

1810A.3.5.2 Cast-in-place or grouted-in-place. Cast-in-place and grouted-in-place deep foundation elements shall satisfy the requirements of this section.

1810A.3.5.2.1 Cased. Cast-in-place deep foundation elements with a permanent casing shall have a nominal outside diameter of not less than 8 inches (203 mm).

1810A.3.5.2.2 Uncased. Cast-in-place deep foundation elements without a permanent casing shall have a diameter of not less than 12 inches (305 mm). The element length shall not exceed 30 times the average diameter.

Exception: The length of the element is permitted to exceed 30 times the diameter, provided the design and installation of the deep foundations are under the direct supervision of a registered design professional knowledgeable in the field of soil mechanics and deep foundations. The registered design professional shall submit a report to the building official stating that the elements were installed in compliance with the approved construction documents.

1810A.3.5.2.3 Micropiles. Micropiles shall have an outside diameter of 12 inches (305 mm) or less. The minimum diameter set forth elsewhere in Section 1810A.3.5 shall not apply to micropiles.

1810A.3.5.3 Steel. Steel deep foundation elements shall satisfy the requirements of this section.

1810A.3.5.3.1 H-piles. Sections of H-piles shall comply with the following:

1. The flange projections shall not exceed 14 times the minimum thickness of metal in either the flange or the web and the flange widths shall not be less than 80 percent of the depth of the section.
2. The nominal depth in the direction of the web shall not be less than 8 inches (203 mm).
3. Flanges and web shall have a minimum nominal thickness of $\frac{3}{8}$ inch (9.5 mm).

1810A.3.5.3.2 Steel pipes and tubes. Steel pipes and tubes used as deep foundation elements shall have a nominal outside diameter of not less than 8 inches (203 mm). Where steel pipes or tubes are driven open ended, they shall have a minimum of 0.34 square inch (219 mm²) of steel in cross section to resist each 1,000 foot-pounds (1356 Nm) of pile hammer energy, or shall have the equivalent strength for steels having a yield strength greater than 35,000 psi (241 MPa) or the wave equation analysis shall be permitted to be used to assess compression stresses induced by driving to evaluate if the pile section is appropriate for the selected hammer. Where a pipe or tube with wall thickness less than 0.179 inch (4.6 mm) is driven open ended, a suitable cutting shoe shall be provided. Concrete-filled steel pipes or tubes in structures assigned to Seismic Design Category C, D, E or F shall have a wall thickness of not less than $\frac{3}{16}$ inch (5 mm). The pipe or tube casing for socketed drilled shafts shall have a nominal outside diameter of not less than 18 inches (457 mm), a wall thickness of not less than $\frac{3}{8}$ inch (9.5 mm) and a suitable steel driving shoe welded to the bottom; the diameter of the rock

socket shall be approximately equal to the inside diameter of the casing.

Exceptions:

1. There is no minimum diameter for steel pipes or tubes used in micropiles.
2. For mandrel-driven pipes or tubes, the minimum wall thickness shall be $\frac{1}{10}$ inch (2.5 mm).

1810A.3.5.3.3 Helical piles. Dimensions of the central shaft and the number, size and thickness of helical bearing plates shall be sufficient to support the design loads.

1810A.3.6 Splices. Splices shall be constructed so as to provide and maintain true alignment and position of the component parts of the deep foundation element during installation and subsequent thereto and shall be designed to resist the axial and shear forces and moments occurring at the location of the splice during driving and for design load combinations. Where deep foundation elements of the same type are being spliced, splices shall develop not less than 50 percent of the bending strength of the weaker section. Where deep foundation elements of different materials or different types are being spliced, splices shall develop the full compressive strength and not less than 50 percent of the tension and bending strength of the weaker section. Where structural steel cores are to be spliced, the ends shall be milled or ground to provide full contact and shall be full-depth welded.

Splices occurring in the upper 10 feet (3048 mm) of the embedded portion of an element shall be designed to resist at allowable stresses the moment and shear that would result from an assumed eccentricity of the axial load of 3 inches (76 mm), or the element shall be braced in accordance with Section 1810A.2.2 to other deep foundation elements that do not have splices in the upper 10 feet (3048 mm) of embedment.

1810A.3.6.1 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F splices of deep foundation elements shall develop the lesser of the following:

1. The nominal strength of the deep foundation element; and
2. The axial and shear forces and moments from the load effects including overstrength factor in Section 12.4.3.2 of ASCE 7.

1810A.3.7 Top of element detailing at cutoffs. Where a minimum length for reinforcement or the extent of closely spaced confinement reinforcement is specified at the top of a deep foundation element, provisions shall be made so that those specified lengths or extents are maintained after cutoff.

1810A.3.8 Precast concrete piles. Precast concrete piles shall be designed and detailed in accordance with Sections 1810A.3.8.1 through 1810A.3.8.3.

1810A.3.8.1 Reinforcement. Longitudinal steel shall be arranged in a symmetrical pattern and be laterally

tied with steel ties or wire spiral spaced center to center as follows:

1. At not more than 1 inch (25 mm) for the first five ties or spirals at each end; then
2. At not more than 4 inches (102 mm), for the remainder of the first 2 feet (610 mm) from each end; and then
3. At not more than 6 inches (152 mm) elsewhere.

The size of ties and spirals shall be as follows:

1. For piles having a least horizontal dimension of 16 inches (406 mm) or less, wire shall not be smaller than 0.22 inch (5.6 mm) (No. 5 gage).
2. For piles having a least horizontal dimension of more than 16 inches (406 mm) and less than 20 inches (508 mm), wire shall not be smaller than 0.238 inch (6 mm) (No. 4 gage).
3. For piles having a least horizontal dimension of 20 inches (508 mm) and larger, wire shall not be smaller than $\frac{1}{4}$ inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).

1810A.3.8.2 Precast nonprestressed piles. Precast nonprestressed concrete piles shall comply with the requirements of Sections 1810A.3.8.2.1 through 1810A.3.8.2.3.

1810A.3.8.2.1 Minimum reinforcement. Longitudinal reinforcement shall consist of at least four bars with a minimum longitudinal reinforcement ratio of 0.008.

1810A.3.8.2.2 Seismic reinforcement in Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, precast nonprestressed piles shall be reinforced as specified in this section. The minimum longitudinal reinforcement ratio shall be 0.01 throughout the length. Transverse reinforcement shall consist of closed ties or spirals with a minimum $\frac{3}{8}$ inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of eight times the diameter of the smallest longitudinal bar or 6 inches (152 mm) within a distance of three times the least pile dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 6 inches (152 mm) throughout the remainder of the pile.

1810A.3.8.2.3 Additional seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, transverse reinforcement shall be in accordance with Section 1810A.3.9.4.2.

1810A.3.8.3 Precast prestressed piles. Precast prestressed concrete piles shall comply with the requirements of Sections 1810A.3.8.3.1 through 1810A.3.8.3.3.

1810A.3.8.3.1 Effective prestress. The effective prestress in the pile shall not be less than 400 psi (2.76 MPa) for piles up to 30 feet (9144 mm) in

length, 550 psi (3.79 MPa) for piles up to 50 feet (15 240 mm) in length and 700 psi (4.83 MPa) for piles greater than 50 feet (15 240 mm) in length.

Effective prestress shall be based on an assumed loss of 30,000 psi (207 MPa) in the prestressing steel. The tensile stress in the prestressing steel shall not exceed the values specified in ACI 318.

1810A.3.8.3.2 Seismic reinforcement in Seismic Design Category C. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1810A.3.8.3.3 Seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, *in accordance with Section 1613A*, precast prestressed piles shall have transverse reinforcement in accordance with the following:

1. Requirements in ACI 318, Chapter 21, need not apply, unless specifically referenced.
2. Where the total pile length in the soil is 35 feet (10 668 mm) or less, the lateral transverse reinforcement in the ductile region shall occur through the length of the pile. Where the pile length exceeds 35 feet (10 668 mm), the ductile pile region shall be taken as the greater of 35 feet (10 668 mm) or the distance from the underside of the pile cap to the point of zero curvature plus three times the least pile dimension.
3. In the ductile region, the center-to-center spacing of the spirals or hoop reinforcement shall not exceed one-fifth of the least pile dimension, six times the diameter of the longitudinal strand or 8 inches (203 mm), whichever is smallest.
4. Circular spiral reinforcement shall be spliced by lapping one full turn and bending the end of each spiral to a 90-degree hook or by use of a mechanical or welded splice complying with Section 12.14.3 of ACI 318.
5. Where the transverse reinforcement consists of circular spirals, the volumetric ratio of spiral transverse reinforcement in the ductile region shall comply with the following:

$$\rho_s = 0.25(f'_c/f_{yh})(A_g/A_{ch} - 1.0) \\ [0.5 + 1.4P/(f'_c A_g)] \quad (\text{Equation 18A-6})$$

but not less than

$$\rho_s = 0.12(f'_c/f_{yh}) \\ [0.5 + 1.4P/(f'_c A_g)]^3 0.12f'_c/f_{yh} \quad (\text{Equation 18A-7})$$

and need not exceed:

$$\rho_s = 0.021 \quad (\text{Equation 18A-8})$$

where:

A_g = Pile cross-sectional area, square inches (mm^2).

A_{ch} = Core area defined by spiral outside diameter, square inches (mm^2).

f'_c = Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement \leq 85,000 psi (586 MPa).

P = Axial load on pile, pounds (kN), as determined from Equations 16-5 and 16-7.

p_s = Volumetric ratio (vol. spiral/vol. core).

6. Where transverse reinforcement consists of rectangular hoops and cross ties, the total cross-sectional area of lateral transverse reinforcement in the ductile region with spacing, s , and perpendicular dimension, h_c , shall conform to:

$$A_{sh} = 0.3s h_c (f'_c/f_{yh})(A_g/A_{ch} - 1.0) \\ [0.5 + 1.4P/(f'_c A_g)] \quad (\text{Equation 18-9})$$

but not less than:

$$A_{sh} = 0.12s h_c (f'_c/f_{yh}) [0.5 + 1.4P/(f'_c A_g)] \quad (\text{Equation 18-10})$$

where:

f_{yh} = yield strength of transverse reinforcement \leq 70,000 psi (483 MPa).

h_c = Cross-sectional dimension of pile core measured center to center of hoop reinforcement, inch (mm).

s = Spacing of transverse reinforcement measured along length of pile, inch (mm).

A_{sh} = Cross-sectional area of transverse reinforcement, square inches (mm^2).

f'_c = Specified compressive strength of concrete, psi (MPa).

The hoops and cross ties shall be equivalent to deformed bars not less than No. 3 in size. Rectangular hoop ends shall terminate at a corner with seismic hooks.

Outside of the length of the pile requiring transverse confinement reinforcing, the spiral or hoop reinforcing with a volumetric ratio not less than one-half of that required for transverse confinement reinforcing shall be provided.

- 1810A.3.9 Cast-in-place deep foundations.** Cast-in-place deep foundation elements shall be designed and detailed in accordance with Sections 1810A.3.9.1 through 1810A.3.9.6.

1810A.3.9.1 Design cracking moment. The design cracking moment (ϕM_n) for a cast-in-place deep foundation element not enclosed by a structural steel pipe or tube shall be determined using the following equation:

$$\phi M_n = 3 \sqrt{f'_c} S_m \quad (\text{Equation 18A-11})$$

where:

f'_c = Specified compressive strength of concrete or grout, psi (MPa)

S_m = Elastic section modulus, neglecting reinforcement and casing, cubic inches (mm^3)

1810A.3.9.2 Required reinforcement. Where subject to uplift or where the required moment strength determined using the load combinations of Section 1605A.2 exceeds the design cracking moment determined in accordance with Section 1810A.3.9.1, cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.

1810A.3.9.3 Placement of reinforcement. Reinforcement where required shall be assembled and tied together and shall be placed in the deep foundation element as a unit before the reinforced portion of the element is filled with concrete.

Exceptions:

1. Steel dowels embedded 5 feet (1524 mm) or less shall be permitted to be placed after concreting, while the concrete is still in a semifluid state.
2. For deep foundation elements installed with a hollow-stem auger, tied reinforcement shall be placed after elements are concreted, while the concrete is still in a semifluid state. Longitudinal reinforcement without lateral ties shall be placed either through the hollow stem of the auger prior to concreting or after concreting, while the concrete is still in a semifluid state.
3. For Group R-3 and U occupancies not exceeding two stories of light-frame construction, reinforcement is permitted to be placed after concreting, while the concrete is still in a semifluid state, and the concrete cover requirement is permitted to be reduced to 2 inches (51 mm), provided the construction method can be demonstrated to the satisfaction of the building official.

1810A.3.9.4 Seismic reinforcement. Where a structure is assigned to Seismic Design Category C, reinforcement shall be provided in accordance with Section 1810A.3.9.4.1. Where a structure is assigned to Seismic Design Category D, E or F, reinforcement shall be provided in accordance with Section 1810A.3.9.4.2.

Exceptions:

1. Isolated deep foundation elements supporting posts of Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as

required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where detailed so the element is not subject to lateral loads and the soil provides adequate lateral support in accordance with Section 1810A.2.1.

2. Isolated deep foundation elements supporting posts and bracing from decks and patios appurtenant to Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where the lateral load, E , to the top of the element does not exceed 200 pounds (890 N) and the soil provides adequate lateral support in accordance with Section 1810A.2.1.
3. Deep foundation elements supporting the concrete foundation wall of Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than two No. 4 bars, without ties or spirals, where the design cracking moment determined in accordance with Section 1810A.3.9.1 exceeds the required moment strength determined using the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7 and the soil provides adequate lateral support in accordance with Section 1810A.2.1.
4. Closed ties or spirals where required by Section 1810A.3.9.4.2 shall be permitted to be limited to the top 3 feet (914 mm) of deep foundation elements 10 feet (3048 mm) or less in depth supporting Group R-3 and U occupancies of Seismic Design Category D, not exceeding two stories of light-frame construction.

1810A.3.9.4.1 Seismic reinforcement in Seismic Design Category C. For structures assigned to Seismic Design Category C in accordance with Section 1613A, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.

A minimum of four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.0025, shall be provided for throughout the minimum reinforced length of the element as defined below starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-third of the element length;
2. A distance of 10 feet (3048 mm);
3. Three times the least element dimension; and
4. The distance from the top of the element to the point where the design cracking moment

determined in accordance with Section 1810A.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605A.2.

Transverse reinforcement shall consist of closed ties or spirals with a minimum $\frac{3}{8}$ inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of 6 inches (152 mm) or 8-longitudinal-bar diameters, within a distance of three times the least element dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 16 longitudinal bar diameters throughout the remainder of the reinforced length.

Exceptions:

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.
2. A spiral-welded metal casing of a thickness not less than manufacturer's standard gage No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

1810A.3.9.4.2 Seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.

A minimum of four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.005, shall be provided throughout the minimum reinforced length of the element as defined below starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-half of the element length;
2. A distance of 10 feet (3048 mm);
3. Three times the least element dimension; and
4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810A.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605A.2.

Transverse reinforcement shall consist of closed ties or spirals no smaller than No. 3 bars for elements with a least dimension up to 20 inches (508 mm), and No. 4 bars for larger elements. Throughout the remainder of the reinforced length outside the regions with transverse confinement reinforce-

ment, as specified in Section 1810A.3.9.4.2.1 or 1810A.3.9.4.2.2, the spacing of transverse reinforcement shall not exceed the least of the following:

1. 12 longitudinal bar diameters;
2. One-half the least dimension of the element; and
3. 12 inches (305 mm).

Exceptions:

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.
2. A spiral-welded metal casing of a thickness not less than manufacturer's standard gage No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

1810A.3.9.4.2.1 Site Classes A through D. For Site Class A, B, C or D sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 21.6.4.2, 21.6.4.3 and 21.6.4.4 of ACI 318 within three times the least element dimension *at the bottom of the pile cap*. A transverse spiral reinforcement ratio of not less than one-half of that required in Section 21.6.4.4(a) of ACI 318 shall be permitted *for concrete deep foundation elements*.

1810A.3.9.4.2.2 Site Classes E and F. For Site Class E or F sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 21.6.4.2, 21.6.4.3 and 21.6.4.4 of ACI 318 within seven times the least element dimension *at the bottom of the pile cap* and within seven times the least element dimension *at the interfaces of strata that are hard or stiff and strata that are liquefiable or are composed of soft- to medium-stiff clay*.

1810A.3.9.5 Belled drilled shafts. Where drilled shafts are belled at the bottom, the edge thickness of the bell shall not be less than that required for the edge of footings. Where the sides of the bell slope at an angle less than 60 degrees (1 rad) from the horizontal, the effects of vertical shear shall be considered.

1810A.3.9.6 Socketed drilled shafts. Socketed drilled shafts shall have a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock, both filled with concrete. Socketed drilled shafts shall have reinforcement or a structural steel core for the length as indicated by an approved method of analysis.

The depth of the rock socket shall be sufficient to develop the full load-bearing capacity of the element

with a minimum safety factor of two, but the depth shall not be less than the outside diameter of the pipe or tube casing. The design of the rock socket is permitted to be predicated on the sum of the allowable load-bearing pressure on the bottom of the socket plus bond along the sides of the socket.

Where a structural steel core is used, the gross cross-sectional area of the core shall not exceed 25 percent of the gross area of the drilled shaft.

1810A.3.10 Micropiles. Micropiles shall be designed and detailed in accordance with Sections 1810A.3.10.1 through 1810A.3.10.4.

1810A.3.10.1 Construction. Micropiles shall develop their load-carrying capacity by means of a bond zone in soil, bedrock or a combination of soil and bedrock. Micropiles shall be grouted and have either a steel pipe or tube or steel reinforcement at every section along the length. It shall be permitted to transition from deformed reinforcing bars to steel pipe or tube reinforcement by extending the bars into the pipe or tube section by at least their development length in tension in accordance with ACI 318.

1810A.3.10.2 Materials. Reinforcement shall consist of deformed reinforcing bars in accordance with ASTM A 615 Grade 60 or 75 or ASTM A 722 Grade 150.

The steel pipe or tube shall have a minimum wall thickness of $\frac{3}{16}$ inch (4.8 mm). Splices shall comply with Section 1810A.3.6. The steel pipe or tube shall have a minimum yield strength of 45,000 psi (310 MPa) and a minimum elongation of 15 percent as shown by mill certifications or two coupon test samples per 40,000 pounds (18 160 kg) of pipe or tube.

1810A.3.10.3 Reinforcement. For micropiles or portions thereof grouted inside a temporary or permanent casing or inside a hole drilled into bedrock or a hole drilled with grout, the steel pipe or tube or steel reinforcement shall be designed to carry at least 40 percent of the design compression load. Micropiles or portions thereof grouted in an open hole in soil without temporary or permanent casing and without suitable means of verifying the hole diameter during grouting shall be designed to carry the entire compression load in the reinforcing steel. Where a steel pipe or tube is used for reinforcement, the portion of the grout enclosed within the pipe is permitted to be included in the determination of the allowable stress in the grout.

> **1810A.3.10.4 Seismic requirements.** For structures assigned to Seismic Design Category D, E or F, a permanent steel casing having a minimum thickness of $\frac{3}{8}$ " shall be provided from the top of the micropile down to a minimum of 120 percent of the point of zero curvature. Capacity of micropiles shall be determined in accordance with Section 1810A.3.3 by at least two project specific preproduction tests for each soil profile, size and depth of micropile. At least two percent of all production piles shall be proof tested to the load determined in accordance with Section 1615A.1.10.

Steel casing length in soil shall be considered as unbonded and shall not be considered as contributing to friction. Casing shall provide confinement at least equivalent to hoop reinforcing required by ACI 318 Section 21.12.4.

Reinforcement shall have Class 1 corrosion protection in accordance with PTI Recommendations for Prestressed Rock and Soil Anchors. Steel casing design shall include at least $\frac{1}{16}$ " corrosion allowance.

Micropiles shall not be considered as carrying any horizontal loads.

1810A.3.11 Pile caps. Pile caps shall be of reinforced concrete, and shall include all elements to which vertical deep foundation elements are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical load. The tops of vertical deep foundation elements shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend at least 4 inches (102 mm) beyond the edges of the elements. The tops of elements shall be cut or chipped back to sound material before capping.

1810A.3.11.1 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, concrete deep foundation elements shall be connected to the pile cap by embedding the element reinforcement or field-placed dowels anchored in the element into the pile cap for a distance equal to their development length in accordance with ACI 318. It shall be permitted to connect precast prestressed piles to the pile cap by developing the element prestressing strands into the pile cap provided the connection is ductile. For deformed bars, the development length is the full development length for compression, or tension in the case of uplift, without reduction for excess reinforcement in accordance with Section 12.2.5 of ACI 318. Alternative measures for laterally confining concrete and maintaining toughness and ductile-like behavior at the top of the element shall be permitted provided the design is such that any hinging occurs in the confined region.

The minimum transverse steel ratio for confinement shall not be less than one-half of that required for columns.

For resistance to uplift forces, anchorage of steel pipes, tubes or H-piles to the pile cap shall be made by means other than concrete bond to the bare steel section. Concrete-filled steel pipes or tubes shall have reinforcement of not less than 0.01 times the cross-sectional area of the concrete fill developed into the cap and extending into the fill a length equal to two times the required cap embedment, but not less than the development length in tension of the reinforcement.

1810A.3.11.2 Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, deep foundation element resistance to uplift forces or rotational restraint shall be provided by anchorage into the pile cap, designed considering the combined effect of axial forces due to uplift and bend-

ing moments due to fixity to the pile cap. Anchorage shall develop a minimum of 25 percent of the strength of the element in tension. Anchorage into the pile cap shall comply with the following:

1. In the case of uplift, the anchorage shall be capable of developing the least of the following:
 - 1.1. The nominal tensile strength of the longitudinal reinforcement in a concrete element;
 - 1.2. The nominal tensile strength of a steel element; and
 - 1.3. The frictional force developed between the element and the soil multiplied by 1.3.

Exception: The anchorage is permitted to be designed to resist the axial tension force resulting from the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

2. In the case of rotational restraint, the anchorage shall be designed to resist the axial and shear forces, and moments resulting from the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7; or shall be capable of developing the full axial, bending and shear nominal strength of the element.

Where the vertical lateral force-resisting elements are columns, the pile cap flexural strengths shall exceed the column flexural strength. The connection between batter piles and pile caps shall be designed to resist the nominal strength of the pile acting as a short column. Batter piles and their connection shall be designed to resist forces and moments that result from the application of seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

1810A.3.12 Grade beams. For structures assigned to Seismic Design Category D, E or F, grade beams shall comply with the provisions in Section 21.12.3 of ACI 318 for grade beams, except where they are designed to resist the seismic load effects including overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

1810A.3.13 Seismic ties. For structures assigned to Seismic Design Category C, D, E or F, individual deep foundations shall be interconnected by ties. Unless it can be demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils or very dense granular soils, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger pile cap or column design gravity load times the seismic coefficient, S_{DS} , divided by 10, and 25 percent of the smaller pile or column design gravity load.

Exception: In Group R-3 and U occupancies of light-frame construction, deep foundation elements support-

ing foundation walls, isolated interior posts detailed so the element is not subject to lateral loads or exterior decks and patios are not subject to interconnection where the soils are of adequate stiffness, subject to the approval of the building official.

1810A.4 Installation. Deep foundations shall be installed in accordance with Section 1810A.4. Where a single deep foundation element comprises two or more sections of different materials or different types spliced together, each section shall satisfy the applicable conditions of installation.

1810A.4.1 Structural integrity. Deep foundation elements shall be installed in such a manner and sequence as to prevent distortion or damage that may adversely affect the structural integrity of adjacent structures or of foundation elements being installed or already in place and as to avoid compacting the surrounding soil to the extent that other foundation elements cannot be installed properly.

1810A.4.1.1 Compressive strength of precast concrete piles. A precast concrete pile shall not be driven before the concrete has attained a compressive strength of at least 75 percent of the specified compressive strength (f'_c), but not less than the strength sufficient to withstand handling and driving forces.

1810A.4.1.2 Casing. Where cast-in-place deep foundation elements are formed through unstable soils and concrete is placed in an open-drilled hole, a casing shall be inserted in the hole prior to placing the concrete. Where the casing is withdrawn during concreting, the level of concrete shall be maintained above the bottom of the casing at a sufficient height to offset any hydrostatic or lateral soil pressure. Driven casings shall be mandrel driven their full length in contact with the surrounding soil.

1810A.4.1.3 Driving near uncased concrete. Deep foundation elements shall not be driven within six element diameters center to center in granular soils or within one-half the element length in cohesive soils of an uncased element filled with concrete less than 48 hours old unless approved by the building official. If the concrete surface in any completed element rises or drops, the element shall be replaced. Driven uncased deep foundation elements shall not be installed in soils that could cause heave.

1810A.4.1.4 Driving near cased concrete. Deep foundation elements shall not be driven within four and one-half average diameters of a cased element filled with concrete less than 24 hours old unless approved by the building official. Concrete shall not be placed in casings within heave range of driving.

1810A.4.1.5 Defective timber piles. Not permitted by DSA-SS, DSA-SS/CC or OSHPD.

1810A.4.2 Identification. Deep foundation materials shall be identified for conformity to the specified grade with this identity maintained continuously from the point of manufacture to the point of installation or shall be tested by an approved agency to determine conformity to the specified grade. The approved agency shall furnish an affidavit of compliance to the building official.

1810A.4.3 Location plan. A plan showing the location and designation of deep foundation elements by an identification system shall be filed with the building official prior to installation of such elements. Detailed records for elements shall bear an identification corresponding to that shown on the plan.

1810A.4.4 Preexcavation. The use of jetting, augering or other methods of preexcavation shall be subject to the approval of the building official. Where permitted, preexcavation shall be carried out in the same manner as used for deep foundation elements subject to load tests and in such a manner that will not impair the carrying capacity of the elements already in place or damage adjacent structures. Element tips shall be driven below the preexcavated depth until the required resistance or penetration is obtained.

1810A.4.5 Vibratory driving. Vibratory drivers shall only be used to install deep foundation elements where the element load capacity is verified by load tests in accordance with Section 1810A.3.3.1.2. The installation of production elements shall be controlled according to power consumption, rate of penetration or other approved means that ensure element capacities equal or exceed those of the test elements.

1810A.4.6 Heaved elements. Deep foundation elements that have heaved during the driving of adjacent elements shall be redriven as necessary to develop the required capacity and penetration, or the capacity of the element shall be verified by load tests in accordance with Section 1810A.3.3.1.2.

1810A.4.7 Enlarged base cast-in-place elements. Enlarged bases for cast-in-place deep foundation elements formed by compacting concrete or by driving a precast base shall be formed in or driven into granular soils. Such elements shall be constructed in the same manner as successful prototype test elements driven for the project. Shafts extending through peat or other organic soil shall be encased in a permanent steel casing. Where a cased shaft is used, the shaft shall be adequately reinforced to resist column action or the annular space around the shaft shall be filled sufficiently to reestablish lateral support by the soil. Where heave occurs, the element shall be replaced unless it is demonstrated that the element is undamaged and capable of carrying twice its design load.

1810A.4.8 Hollow-stem augered, cast-in-place elements. Where concrete or grout is placed by pumping through a hollow-stem auger, the auger shall be permitted to rotate in a clockwise direction during withdrawal. As the auger is withdrawn at a steady rate or in increments not to exceed 1 foot (305 mm), concreting or grouting pumping pressures shall be measured and maintained high enough at all times to offset hydrostatic and lateral earth pressures. Concrete or grout volumes shall be measured to ensure that the volume of concrete or grout placed in each element is equal to or greater than the theoretical volume of the hole created by the auger. Where the installation process of any element is interrupted or a loss of concreting or grouting pressure occurs, the element shall be

redrilled to 5 feet (1524 mm) below the elevation of the tip of the auger when the installation was interrupted or concrete or grout pressure was lost and reformed. Augered cast-in-place elements shall not be installed within six diameters center to center of an element filled with concrete or grout less than 12 hours old, unless approved by the building official. If the concrete or grout level in any completed element drops due to installation of an adjacent element, the element shall be replaced.

1810A.4.9 Socketed drilled shafts. The rock socket and pipe or tube casing of socketed drilled shafts shall be thoroughly cleaned of foreign materials before filling with concrete. Steel cores shall be bedded in cement grout at the base of the rock socket.

1810A.4.10 Micropiles. Micropile deep foundation elements shall be permitted to be formed in holes advanced by rotary or percussive drilling methods, with or without casing. The elements shall be grouted with a fluid cement grout. The grout shall be pumped through a tremie pipe extending to the bottom of the element until grout of suitable quality returns at the top of the element. The following requirements apply to specific installation methods:

1. For micropiles grouted inside a temporary casing, the reinforcing bars shall be inserted prior to withdrawal of the casing. The casing shall be withdrawn in a controlled manner with the grout level maintained at the top of the element to ensure that the grout completely fills the drill hole. During withdrawal of the casing, the grout level inside the casing shall be monitored to verify that the flow of grout inside the casing is not obstructed.
2. For a micropile or portion thereof grouted in an open drill hole in soil without temporary casing, the minimum design diameter of the drill hole shall be verified by a suitable device during grouting.
3. For micropiles designed for end bearing, a suitable means shall be employed to verify that the bearing surface is properly cleaned prior to grouting.
4. Subsequent micropiles shall not be drilled near elements that have been grouted until the grout has had sufficient time to harden.
5. Micropiles shall be grouted as soon as possible after drilling is completed.
6. For micropiles designed with a full-length casing, the casing shall be pulled back to the top of the bond zone and reinserted or some other suitable means employed to assure grout coverage outside the casing.

1810A.4.11 Helical piles. Helical piles shall be installed to specified embedment depth and torsional resistance criteria as determined by a registered design professional. The torque applied during installation shall not exceed the maximum allowable installation torque of the helical pile.

1810A.4.12 Special inspection. Special inspections in accordance with Sections 1704A.8 and 1704A.9 shall be provided for driven and cast-in-place deep foundation ele-

ments, respectively. Special inspections in accordance with Section 1704A.10 shall be provided for helical piles.

SECTION 1811A

PRESTRESSED ROCK AND SOIL FOUNDATION ANCHORS

1811A.1 General. The requirements of this section address the use of vertical rock and soil anchors in resisting seismic or wind overturning forces resulting in tension on shallow foundations.

1811A.2 Adoption. Except for the modifications as set forth in Sections 1811A.3 and 1811A.4, all prestressed rock and soil foundation anchors shall be designed in accordance with PTI Recommendations for Prestressed Rock and Soil Anchors.

1811A.3 Geotechnical requirements. Geotechnical report for the prestressed rock and soil foundation anchors shall address the following:

1. Minimum diameter and minimum spacing for the anchors including consideration of group effects.
2. Maximum unbonded length and minimum bonded length of the tendon.
3. Maximum recommended anchor tension capacity based upon the soil or rock strength/grout bond and anchor depth/spacing.
4. Allowable bond stress at the ground/grout interface and applicable factor of safety for ultimate bond stress.
5. Anchor axial tension stiffness recommendations at the anticipated anchor axial tension displacements, when required for structural analysis.
6. Minimum grout pressure for installation and post-grout pressure.
7. Class I Corrosion Protection is required for all permanent anchors. Geotechnical report shall specify the corrosion protection recommendations for temporary anchors.
8. Performance test shall be at a minimum of 1.6 times the design loads. There shall be a minimum of two preproduction test anchors. Preproduction test anchors shall be tested to ultimate load or 0.80 times the specified minimum tensile strength of the tendon. A creep test is required for all prestressed anchors with greater than 10 kips of lock-off prestressing load.
9. Lock-off prestressing load requirements.
10. Acceptable drilling methods.
11. Geotechnical observation and monitoring requirements.

1811A.4 Structural Requirements.

1. Tendons shall be thread-bar anchors conforming to ASTM A 722.
2. The anchors shall be placed vertical.

3. Design loads shall be based upon the load combinations in Section 1605A.3.1 and shall not exceed 60 percent of the specified minimum tensile strength of the tendons.

4. Ultimate load shall be based upon Section 1615A.1.10 and shall not exceed 80 percent of the specified minimum tensile strength of the tendons.
5. The anchor shall be designed to fail in grout bond to the soil or rock before pullout of the soil wedge by group effect.
6. Foundation design shall incorporate the effect of lock-off loads.
7. Design shall account for as-built locations of soil anchors considering all the acceptable construction tolerances.
8. Design shall account for both short and long term deformation.
9. Enforcement agency may require consideration of anchor deformation in evaluating deformation compatibility or building drift where it may be significant.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 19 – CONCRETE

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | X | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | X | | X | X | | | | | X | | X | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 1901.1.1 | | | | | | | | | | X | | | | | | | | | | |
| 1901.1.2 | | | | | | | | | | X | | | | | | | | | | |
| 1901.1.3 | | | | | | | | | | X | | | | | | | | | | |
| 1901.1.4 | | | | | | | | | | X | | | | | | | | | | |
| 1905.1.2 | X | | | | | | | | | | | | | | | | | | | |
| 1905.1.3 | X | | | | | | | | | | | | | | | | | | | |
| 1905.1.9 | X | | X | X | | | | | | | | | | | | | | | | |
| 1907.1.1 | | | X | X | | | | | | | | | | | | | | | | |
| 1908.1.1 | | | | | | | | | | | X | | | | | | | | | |
| 1909.1.1 | | | | | | | | | | | X | | | | | | | | | |
| 1909.1.2 | | | | | | | | | | | X | | | | | | | | | |
| 1909.2 & subsections | | | | | | | | | | | X | | | | | | | | | |
| 1913.1.1 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.1 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.2 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.3 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.4 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.5 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.6 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.7 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.8 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.9 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.10 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.11 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.11.1 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.11.2 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.11.3 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.11.4 | | | | | | | | | | | X | | | | | | | | | |
| 1913.2.11.5 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.1 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.2 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.3 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.4 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.5 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.6 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.7 | | | | | | | | | | | X | | | | | | | | | |
| 1913.3.8 | | | | | | | | | | | X | | | | | | | | | |

(continued)

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 19 – CONCRETE — continued

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.

See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | CSA | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|-----|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 1913.4.1 | | | | | | | X | | | | | | | | | | | | | |
| 1913.4.2 | | | | | | | X | | | | | | | | | | | | | |
| 1913.4.3 | | | | | | | X | | | | | | | | | | | | | |
| 1913.4.4 | | | | | | | X | | | | | | | | | | | | | |
| 1913.4.5 | | | | | | | X | | | | | | | | | | | | | |
| 1913.5 | | | | | | | X | | | | | | | | | | | | | |

CHAPTER 19

CONCRETE

Italics are used for text within Sections 1903 through 1905 of this code to indicate provisions that differ from ACI 318.

SECTION 1901 GENERAL

1901.1 Scope. The provisions of this chapter shall govern the materials, quality control, design and construction of concrete used in structures.

1901.1.1 Application. *The scope of application of Chapter 19 is as follows:*

Community college buildings regulated by the Division of the State Architect—Structural Safety/Community Colleges (DSA-SS/CC), as listed in Section 1.9.2.2.

1901.1.2 Amendments in this chapter. DSA-SS/CC adopts this chapter and all amendments.

Exceptions: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

Division of the State Architect—Structural Safety/Community Colleges:

[DSA-SS/CC] For applications listed in Section 1.9.2.2.

1901.1.3 Reference to other chapters. *[DSA-SS/CC]* Where reference within this chapter is made to sections in Chapters 17 and 18, the provisions in Chapters 17A, and 18A respectively shall apply instead.

1901.1.4 Amendments. *[DSA-SS/CC]* See Section 1913 for additional requirements applicable to community colleges.

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905 of this code. Except for the provisions of Sections 1904 and 1907, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical loads or lateral forces from other parts of the structure to the soil.

1901.3 Construction documents. The construction documents for structural concrete construction shall include:

1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. The specified strength or grade of reinforcement.
3. The size and location of structural elements, reinforcement and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. The magnitude and location of prestressing forces.
6. Anchorage length of reinforcement and location and length of lap splices.
7. Type and location of mechanical and welded splices of reinforcement.

8. Details and location of contraction or isolation joints specified for plain concrete.
9. Minimum concrete compressive strength at time of posttensioning.
10. Stressing sequence for post-tensioning tendons.
11. For structures assigned to *Seismic Design Category D, E or F*, a statement if slab on grade is designed as a structural diaphragm.

1901.4 Special inspection. The special inspection of concrete elements of buildings and structures and concreting operations shall be as required by Chapter 17.

SECTION 1902 DEFINITIONS

1902.1 General. The words and terms defined in ACI 318 shall, for the purposes of this chapter and as used elsewhere in this code for concrete construction, have the meanings shown in ACI 318 as modified by Section 1905.1.1.

SECTION 1903 SPECIFICATIONS FOR TESTS AND MATERIALS

1903.1 General. Materials used to produce concrete, concrete itself and testing thereof shall comply with the applicable standards listed in ACI 318. *Where required, special inspections and tests shall be in accordance with Chapter 17.*

1903.2 Glass fiber reinforced concrete. *Glass fiber reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL 128 standard.*

1903.3 Flat wall insulating concrete form (ICF) systems. *Insulating concrete form material used for forming flat concrete walls shall conform to ASTM E 2634.*

SECTION 1904 DURABILITY REQUIREMENTS

1904.1 Exposure categories and classes. Concrete shall be assigned to exposure classes in accordance with the durability requirements of ACI 318 based on:

1. Exposure to freezing and thawing in a moist condition or deicer chemicals;
2. Exposure to sulfates in water or soil;
3. Exposure to water where the concrete is intended to have low permeability; and
4. Exposure to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater or spray from these sources, where the concrete has steel reinforcement.

1904.2 Concrete properties. Concrete mixtures shall conform to the most restrictive maximum water-cementitious materials ratios, maximum cementitious admixtures, minimum air-entrainment and minimum specified concrete compressive strength requirements of ACI 318 based on the exposure classes assigned in Section 1904.1.

Exception: For occupancies and appurtenances thereto in Group R occupancies that are in buildings less than four stories above grade plane, normal-weight aggregate concrete is permitted to comply with the requirements of Table 1904.2 based on the weathering classification (freezing and thawing) determined from Figure 1904.2 in lieu of the durability requirements of ACI 318.

SECTION 1905 MODIFICATIONS TO ACI 318

1905.1 General. The text of ACI 318 shall be modified as indicated in Sections 1905.1.1 through 1905.1.10.

1905.1.1 ACI 318, Section 2.2. Modify existing definitions and add the following definitions to ACI 318, Section 2.2.

DESIGN DISPLACEMENT. Total lateral displacement expected for the design-basis earthquake, as specified by Section 12.8.6 of ASCE 7.

DETAILED PLAIN CONCRETE STRUCTURAL WALL. A wall complying with the requirements of Chapter 22, including 22.6.7.

ORDINARY PRECAST STRUCTURAL WALL. A precast wall complying with the requirements of Chapters 1 through 18.

ORDINARY REINFORCED CONCRETE STRUCTURAL WALL. A cast-in-place wall complying with the requirements of Chapters 1 through 18.

ORDINARY STRUCTURAL PLAIN CONCRETE WALL. A wall complying with the requirements of Chapter 22, excluding 22.6.7.

SPECIAL STRUCTURAL WALL. A cast-in-place or precast wall complying with the requirements of 21.1.3 through 21.1.7, 21.9 and 21.10, as applicable, in addition to the requirements for ordinary reinforced concrete structural walls or ordinary precast structural walls, as applicable. Where ASCE 7 refers to a "special reinforced concrete structural wall," it shall be deemed to mean a "special structural wall."

WALL PIER. A wall segment with a horizontal length-to-thickness ratio of at least 2.5, but not exceeding 6, whose clear height is at least two times its horizontal length.

1905.1.2 ACI 318, Section 21.1.1. Modify ACI 318 Sections 21.1.1.3 and 21.1.1.7 to read as follows:

21.1.1.3 - Structures assigned to Seismic Design Category A shall satisfy requirements of Chapters 1 to 19 and 22; Chapter 21 does not apply. Structures assigned to Seismic Design Category B, C, D, E or F also shall satisfy 21.1.1.4 through 21.1.1.8, as applicable. Except for structural elements of plain concrete complying with Section 1905.1.8 of the California Building Code, struc-

tural elements of plain concrete are prohibited in structures assigned to Seismic Design Category C, D, E or F.

21.1.1.7 - Structural systems designated as part of the seismic force-resisting system shall be restricted to those permitted by ASCE 7. Except for Seismic Design Category A, for which Chapter 21 does not apply, the following provisions shall be satisfied for each structural system designated as part of the seismic force-resisting system, regardless of the Seismic Design Category:

- (a) Ordinary moment frames shall satisfy 21.2.
- (b) Ordinary reinforced concrete structural walls and ordinary precast structural walls need not satisfy any provisions in Chapter 21.
- (c) Intermediate moment frames shall satisfy 21.3.
- (d) Intermediate precast structural walls shall satisfy 21.4.
- (e) Special moment frames shall satisfy 21.5 through 21.8.
- (f) Special structural walls shall satisfy 21.9.
- (g) Special structural walls constructed using precast concrete shall satisfy 21.10.

All special moment frames and special structural walls shall also satisfy 21.1.3 through 21.1.7.

1905.1.3 ACI 318, Section 21.4. Modify ACI 318, Section 21.4, by renumbering Section 21.4.3 to become 21.4.4 and adding new Sections 21.4.3, 21.4.5, 21.4.6 and 21.4.7 to read as follows:

21.4.3 - Connections that are designed to yield shall be capable of maintaining 80 percent of their design strength at the deformation induced by the design displacement or shall use Type 2 mechanical splices.

21.4.4 - Elements of the connection that are not designed to yield shall develop at least $1.5 S_y$.

21.4.5 - Wall piers in Seismic Design Category D, E or F shall comply with Section 1905.1.4 of the California Building Code.

21.4.6 - Wall piers not designed as part of a moment frame in buildings assigned to Seismic Design Category C shall have transverse reinforcement designed to resist the shear forces determined from 21.3.3. Spacing of transverse reinforcement shall not exceed 8 inches (203 mm). Transverse reinforcement shall be extended beyond the pier clear height for at least 12 inches (305 mm).

Exceptions:

1. Wall piers that satisfy 21.13.
2. Wall piers along a wall line within a story where other shear wall segments provide lateral support to the wall piers and such segments have a total stiffness of at least six times the sum of the stiffnesses of all the wall piers.

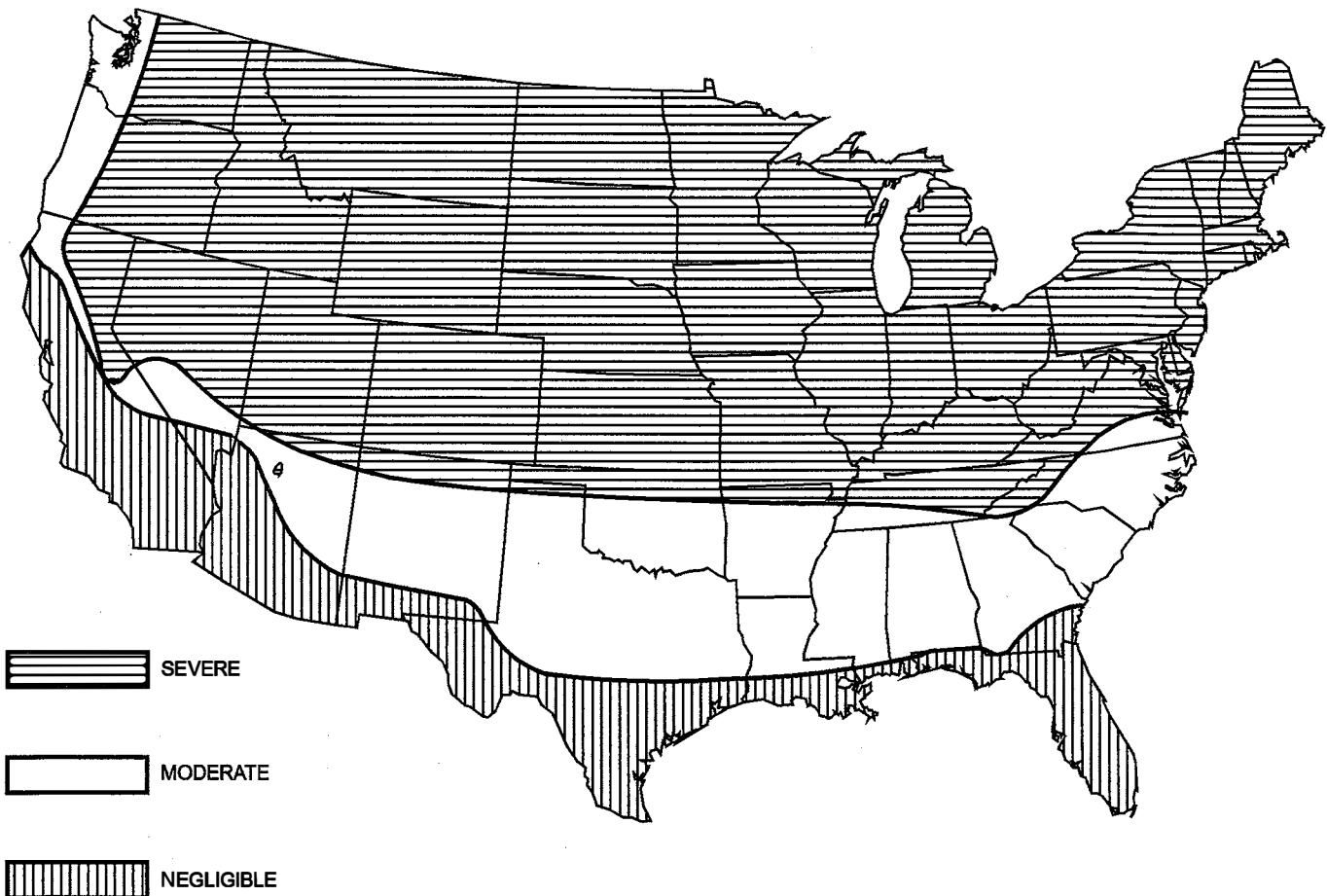
21.4.7 - Wall segments with a horizontal length-to-thickness ratio less than 2.5 shall be designed as columns.

**TABLE 1904.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c)**

| TYPE OR LOCATION OF CONCRETE CONSTRUCTION | MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c at 28 days, psi) | | |
|--|--|----------------------|----------------------|
| | Negligible exposure | Moderate exposure | Severe exposure |
| Basement walls ^c and foundations not exposed to the weather | 2,500 | 2,500 | 2,500 ^a |
| Basement slabs and interior slabs on grade, except garage floor slabs | 2,500 | 2,500 | 2,500 ^a |
| Basement walls ^c , foundation walls, exterior walls and other vertical concrete surfaces exposed to the weather | 2,500 | 3,000 ^b | 3,000 ^b |
| Driveways, curbs, walks, patios, porches, carport slabs, steps and other flatwork exposed to the weather, and garage floor slabs | 2,500 | 3,000 ^{b,d} | 3,500 ^{b,d} |

For SI: 1 pound per square inch = 0.00689 MPa.

- a. Concrete in these locations that can be subjected to freezing and thawing during construction shall be of air-entrained concrete in accordance with Section 1904.2.
- b. Concrete shall be air entrained in accordance with ACI 318.
- c. Structural plain concrete basement walls are exempt from the requirements for exposure conditions of Section 1904.2.
- d. For garage floor slabs where a steel trowel finish is used, the total air content required by ACI 318 is permitted to be reduced to not less than 3 percent, provided the minimum specified compressive strength of the concrete is increased to 4,000 psi.



**FIGURE 1904.2
WEATHERING PROBABILITY MAP FOR CONCRETE^{a, b, c}**

- a. Lines defining areas are approximate only. Local areas can be more or less severe than indicated by the region classification.
- b. A "severe" classification is where weather conditions encourage or require the use of deicing chemicals or where there is potential for a continuous presence of moisture during frequent cycles of freezing and thawing. A "moderate" classification is where weather conditions occasionally expose concrete in the presence of moisture to freezing and thawing, but where deicing chemicals are not generally used. A "negligible" classification is where weather conditions rarely expose concrete in the presence of moisture to freezing and thawing.
- c. Alaska and Hawaii are classified as severe and negligible, respectively.

1905.1.4 ACI 318, Section 21.9. Modify ACI 318, Section 21.9, by deleting Section 21.9.8 and replacing with the following:

21.9.8 - Wall piers and wall segments.

21.9.8.1 - Wall piers not designed as a part of a special moment frame shall have transverse reinforcement designed to satisfy the requirements in 21.9.8.2.

Exceptions:

1. Wall piers that satisfy 21.13.
2. Wall piers along a wall line within a story where other shear wall segments provide lateral support to the wall piers and such segments have a total stiffness of at least six times the sum of the stiffnesses of all the wall piers.

21.9.8.2 - Transverse reinforcement with seismic hooks at both ends shall be designed to resist the shear forces determined from 21.6.5.1. Spacing of transverse reinforcement shall not exceed 6 inches (152 mm). Transverse reinforcement shall be extended beyond the pier clear height for at least 12 inches (305 mm).

21.9.8.3 - Wall segments with a horizontal length-to-thickness ratio less than 2.5 shall be designed as columns.

1905.1.5 ACI 318, Section 21.10. Modify ACI 318, Section 21.10.2, to read as follows:

21.10.2 - Special structural walls constructed using precast concrete shall satisfy all the requirements of 21.9 for cast-in-place special structural walls in addition to Sections 21.4.2 through 21.4.4.

1905.1.6 ACI 318, Section 21.12.1.1. Modify ACI 318, Section 21.12.1.1, to read as follows:

21.12.1.1 - Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of Section 21.12 and other applicable provisions of ACI 318 unless modified by Chapter 18 of the *California Building Code*.

1905.1.7 ACI 318, Section 22.6. Modify ACI 318, Section 22.6, by adding new Section 22.6.7 to read as follows:

22.6.7 - Detailed plain concrete structural walls.

22.6.7.1 - Detailed plain concrete structural walls are walls conforming to the requirements of ordinary structural plain concrete walls and 22.6.7.2.

22.6.7.2 - Reinforcement shall be provided as follows:

- (a) Vertical reinforcement of at least 0.20 square inch (129 mm^2) in cross-sectional area shall be provided continuously from support to support at each corner, at each side of each opening and at the ends of walls. The continuous vertical bar required beside an opening is permitted

to substitute for one of the two No. 5 bars required by 22.6.6.5.

(b) Horizontal reinforcement at least 0.20 square inch (129 mm^2) in cross-sectional area shall be provided:

1. Continuously at structurally connected roof and floor levels and at the top of walls;
2. At the bottom of load-bearing walls or in the top of foundations where doveled to the wall; and
3. At a maximum spacing of 120 inches (3048 mm).

Reinforcement at the top and bottom of openings, where used in determining the maximum spacing specified in Item 3 above, shall be continuous in the wall.

1905.1.8 ACI 318, Section 22.10. Delete ACI 318, Section 22.10, and replace with the following:

22.10 - Plain concrete in structures assigned to Seismic Design Category C, D, E or F.

22.10.1 - Structures assigned to Seismic Design Category C, D, E or F shall not have elements of structural plain concrete, except as follows:

- (a) Structural plain concrete basement, foundation or other walls below the base are permitted in detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls. In dwellings assigned to Seismic Design Category D or E, the height of the wall shall not exceed 8 feet (2438 mm), the thickness shall not be less than $7\frac{1}{2}$ inches (190 mm), and the wall shall retain no more than 4 feet (1219 mm) of unbalanced fill. Walls shall have reinforcement in accordance with 22.6.6.5.
- (b) Isolated footings of plain concrete supporting pedestals or columns are permitted, provided the projection of the footing beyond the face of the supported member does not exceed the footing thickness.

Exception: In detached one- and two-family dwellings three stories or less in height, the projection of the footing beyond the face of the supported member is permitted to exceed the footing thickness.

- (c) Plain concrete footings supporting walls are permitted, provided the footings have at least two continuous longitudinal reinforcing bars. Bars shall not be smaller than No. 4 and shall have a total area of not less than 0.002 times the gross cross-sectional area of the footing. For footings that exceed 8 inches (203 mm) in

thickness, a minimum of one bar shall be provided at the top and bottom of the footing. Continuity of reinforcement shall be provided at corners and intersections.

Exceptions:

1. In Seismic Design Categories A, B and C, detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls, are permitted to have plain concrete footings without longitudinal reinforcement.
2. For foundation systems consisting of a plain concrete footing and a plain concrete stemwall, a minimum of one bar shall be provided at the top of the stemwall and at the bottom of the footing.
3. Where a slab on ground is cast monolithically with the footing, one No. 5 bar is permitted to be located at either the top of the slab or bottom of the footing.

1905.1.9 ACI 318, Section D.3.3. Modify ACI 318, Sections D.3.3.4.2, D.3.3.4.3(d) and D.3.3.5.2 to read as follows:

D.3.3.4.2 - Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with Section D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with Section D.3.3.4.4.

Exception: Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 and Section 1604.8.2 of this code shall be deemed to satisfy Section D.3.3.4.3(d).

D.3.3.4.3(d) - The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_0 . The anchor design tensile strength shall be calculated from Section D.3.3.4.4

D.3.3.5.2 - Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with Section D.3.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with Section D.6.

Exceptions:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill

plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane design shear strength in accordance with Sections D.6.2 and D.6.3 need not be computed and Section D.3.3.5.3 shall be deemed to be satisfied provided all of the following are met:

- 1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.
- 1.2. The maximum anchor nominal diameter is $5/8$ inches (16 mm).
- 1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).
- 1.4. Anchor bolts are located a minimum of $1\frac{3}{4}$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.
- 1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.
- 1.6. The sill plate is 2-inch or 3-inch nominal thickness.
2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of light-frame construction to foundations or foundation stem walls the in-plane design shear strength in accordance with Sections D.6.2 and D.6.3 need not be computed and Section D.3.3.5.3 shall be deemed to be satisfied provided all of the following are met:
 - 2.1. The maximum anchor nominal diameter is $5/8$ inches (16 mm).
 - 2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).
 - 2.3. Anchors are located a minimum of $1\frac{3}{4}$ inches (45 mm) from the edge of the concrete parallel to the length of the track.
 - 2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.
 - 2.5. The track is 33 to 68 mil designation thickness.

Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete shall be permitted to be determined in accordance with AISI S100 Section E3.3.1.

3. In light-frame construction, bearing or non-bearing walls, shear strength of concrete

anchors less than or equal to $\frac{5}{8}$ inch (16 mm) in diameter of sill plate or track to foundation or foundation stem wall need not satisfy Section D.3.3.5.3 (a) through (c) when the design strength of the anchors is determined in accordance with Section D.6.2.1(c).

SECTION 1906 STRUCTURAL PLAIN CONCRETE

1906.1 Scope. The design and construction of structural plain concrete, both cast-in-place and precast, shall comply with the minimum requirements of ACI 318, as modified in Section 1905.

Exception: For Group R-3 occupancies and buildings of other occupancies less than two stories above grade plane of light-frame construction, the required footing thickness of ACI 318 is permitted to be reduced to 6 inches (152 mm), provided that the footing does not extend more than 4 inches (102 mm) on either side of the supported wall.

SECTION 1907 MINIMUM SLAB PROVISIONS

1907.1 General. The thickness of concrete floor slabs supported directly on the ground shall not be less than $3\frac{1}{2}$ inches (89 mm). A 6-mil (0.006 inch; 0.15 mm) polyethylene vapor retarder with joints lapped not less than 6 inches (152 mm) shall be placed between the base course or subgrade and the concrete floor slab, or other approved equivalent methods or materials shall be used to retard vapor transmission through the floor slab.

Exception: A vapor retarder is not required:

1. For detached structures accessory to occupancies in Group R-3, such as garages, utility buildings or other unheated facilities.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m^2) and carports attached to occupancies in Group R-3.
3. For buildings of other occupancies where migration of moisture through the slab from below will not be detrimental to the intended occupancy of the building.
4. For driveways, walks, patios and other flatwork which will not be enclosed at a later date.
5. Where approved based on local site conditions.

1907.1.1 [HCD 1] Capillary break. When a vapor retarder is required, a capillary break shall be installed in accordance with the California Green Building Standards Code (CALGreen), Chapter 4, Division 4.5.

SECTION 1908 ANCHORAGE TO CONCRETE— ALLOWABLE STRESS DESIGN

1908.1 Scope. The provisions of this section shall govern the allowable stress design of headed bolts and headed stud anchors cast in normal-weight concrete for purposes of transmitting structural loads from one connected element to the other. These provisions do not apply to anchors installed in hardened concrete or where load combinations include earthquake loads or effects. The bearing area of headed anchors shall be not less than one and one-half times the shank area. Where strength design is used, or where load combinations include earthquake loads or effects, the design strength of anchors shall be determined in accordance with Section 1909. Bolts shall conform to ASTM A 307 or an approved equivalent.

1908.1.1 Power Actuated Fasteners. [OSHPD 2] Power actuated fasteners qualified in accordance with ICC-ES AC 70 shall be deemed to satisfy the requirements of this section.

Power actuated fasteners shall be permitted in seismic shear for components exempt from construction documents review by ASCE 7 Section 13.1.4 and for interior nonbearing nonshear wall partitions. Power actuated fastener shall not be used to anchor exterior cladding or curtain wall systems.

1908.2 Allowable service load. The allowable service load for headed anchors in shear or tension shall be as indicated in Table 1908.2. Where anchors are subject to combined shear and tension, the following relationship shall be satisfied:

$$(P_s / P_t)^{5/3} + (V_s / V_t)^{5/3} \leq 1 \quad (\text{Equation 19-1})$$

where:

P_s = Applied tension service load, pounds (N).

P_t = Allowable tension service load from Table 1908.2, pounds (N).

V_s = Applied shear service load, pounds (N).

V_t = Allowable shear service load from Table 1908.2, pounds (N).

1908.3 Required edge distance and spacing. The allowable service loads in tension and shear specified in Table 1908.2 are for the edge distance and spacing specified. The edge distance and spacing are permitted to be reduced to 50 percent of the values specified with an equal reduction in allowable service load. Where edge distance and spacing are reduced less than 50 percent, the allowable service load shall be determined by linear interpolation.

1908.4 Increase in allowable load. Increase of the values in Table 1908.2 by one-third is permitted where the provisions of Section 1605.3.2 permit an increase in allowable stress for wind loading.

1908.5 Increase for special inspection. Where special inspection is provided for the installation of anchors, a 100-percent increase in the allowable tension values of Table 1908.2 is permitted. No increase in shear value is permitted.

**TABLE 1908.2
ALLOWABLE SERVICE LOAD ON EMBEDDED BOLTS (pounds)**

| BOLT DIAMETER (inches) | MINIMUM EMBEDMENT (inches) | EDGE DISTANCE (inches) | SPACING (inches) | MINIMUM CONCRETE STRENGTH (psi) | | | | | |
|------------------------|----------------------------|------------------------|------------------|---------------------------------|-------|----------------|-------|----------------|-------|
| | | | | $f'_c = 2,500$ | | $f'_c = 3,000$ | | $f'_c = 4,000$ | |
| | | | | Tension | Shear | Tension | Shear | Tension | Shear |
| $\frac{1}{4}$ | $2\frac{1}{2}$ | $1\frac{1}{2}$ | 3 | 200 | 500 | 200 | 500 | 200 | 500 |
| $\frac{3}{8}$ | 3 | $2\frac{1}{4}$ | $4\frac{1}{2}$ | 500 | 1,100 | 500 | 1,100 | 500 | 1,100 |
| $\frac{1}{2}$ | 4 | 3 | 6 | 950 | 1,250 | 950 | 1,250 | 950 | 1,250 |
| | 4 | 5 | 6 | 1,450 | 1,600 | 1,500 | 1,650 | 1,550 | 1,750 |
| $\frac{5}{8}$ | $4\frac{1}{2}$ | $3\frac{3}{4}$ | $7\frac{1}{2}$ | 1,500 | 2,750 | 1,500 | 2,750 | 1,500 | 2,750 |
| | $4\frac{1}{2}$ | $6\frac{1}{4}$ | $7\frac{1}{2}$ | 2,125 | 2,950 | 2,200 | 3,000 | 2,400 | 3,050 |
| $\frac{3}{4}$ | 5 | $4\frac{1}{2}$ | 9 | 2,250 | 3,250 | 2,250 | 3,560 | 2,250 | 3,560 |
| | 5 | $7\frac{1}{2}$ | 9 | 2,825 | 4,275 | 2,950 | 4,300 | 3,200 | 4,400 |
| $\frac{7}{8}$ | 6 | $5\frac{1}{4}$ | $10\frac{1}{2}$ | 2,550 | 3,700 | 2,550 | 4,050 | 2,550 | 4,050 |
| 1 | 7 | 6 | 12 | 3,050 | 4,125 | 3,250 | 4,500 | 3,650 | 5,300 |
| $1\frac{1}{8}$ | 8 | $6\frac{3}{4}$ | $13\frac{1}{2}$ | 3,400 | 4,750 | 3,400 | 4,750 | 3,400 | 4,750 |
| $1\frac{1}{4}$ | 9 | $7\frac{1}{2}$ | 15 | 4,000 | 5,800 | 4,000 | 5,800 | 4,000 | 5,800 |

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa, 1 pound = 4.45 N.

SECTION 1909 ANCHORAGE TO CONCRETE— STRENGTH DESIGN

1909.1 Scope. The provisions of this section shall govern the strength design of anchors installed in concrete for purposes of transmitting structural loads from one connected element to the other. Headed bolts, headed studs and hooked (J- or L-) bolts cast in concrete and expansion anchors and undercut anchors installed in hardened concrete shall be designed in accordance with Appendix D of ACI 318 as modified by Sections 1905.1.9 and 1905.1.10, provided they are within the scope of Appendix D.

The strength design of anchors that are not within the scope of Appendix D of ACI 318, and as amended in Sections 1905.1.9 and 1905.1.10, shall be in accordance with an approved procedure.

1909.1.1 Mechanical anchors and specialty inserts. [OSHPD 2] Mechanical anchors qualified in accordance with ICC-ES AC 193 shall be deemed to satisfy the requirements of this section.

Specialty inserts, including cast-in-place specialty inserts, tested in accordance with ICC-ES AC 193 shall be deemed to satisfy the requirements of this section.

1909.1.2 Post-installed adhesive anchors. [OSHPD 2] Adhesive anchors qualified in accordance with ICC-ES AC 308 shall be deemed to satisfy the requirements of this section.

1909.2 Tests for Post-installed anchors in concrete. [OSHPD 2] When post-installed anchors are used in lieu of cast-in-place bolts, the installation verification test loads, frequency and acceptance criteria shall be in accordance with this section.

1909.2.1 General. Test loads or torques and acceptance criteria shall be shown on the construction documents.

If any anchor fails testing, all anchors of the same type shall be tested, which are installed by the same trade, not previously tested until twenty (20) consecutive anchors pass, then resume the initial test frequency.

1909.2.2 Test loads. Required test loads shall be determined by one of the following methods:

1. Twice the maximum allowable tension load or one and a quarter ($1\frac{1}{4}$) times the maximum design strength of anchors as provided in approved test report using criteria adopted in this code or determined in accordance with Appendix D of ACI 318.

Tension test load need not exceed 80 percent of the nominal yield strength of the anchor element ($= 0.8 A_{se} f_{ya}$).

2. The manufacturer's recommended installation torque based on approved test report using criteria adopted in this code.

1909.2.3 Test frequency. When post-installed anchors are used for sill plate bolting applications, 10 percent of the anchors shall be tested.

When post-installed anchors are used for other structural applications, all such anchors shall be tested.

When post-installed anchors are used for nonstructural applications such as equipment anchorage, 50 percent or alternate bolts in a group, including at least one-half the anchors in each group, shall be tested.

The testing of the post-installed anchors shall be done in the presence of the special inspector and a report of the test results shall be submitted to the enforcement agency.

Exceptions:

1. Undercut anchors that allow visual confirmation of full set shall not require testing.

2. Where the factored design tension on anchors is less than 100 lbs and those anchors are clearly noted on the approved construction documents, only 10 percent of those anchors shall be tested.
3. Where adhesive anchor systems are used to install reinforcing dowel bars in hardened concrete, only 25 percent of the dowels shall be tested if all of the following conditions are met:
 - a. The dowels are used exclusively to transmit shear forces across joints between existing and new concrete.
 - b. The number of dowels in any one member equals or exceeds twelve (12).
 - c. The dowels are uniformly distributed across seismic force resisting members (such as shear walls, collectors, and diaphragms).

Anchors to be tested shall be selected at random by the special inspector/inspector of record (IOR).

4. Testing of shear dowels across cold joints in slabs on grade, where the slab is not part of the lateral force-resisting system shall not be required.
5. Testing is not required for power actuated fasteners used to attach tracks of interior non-shear wall partitions for shear only, where there are at least three fasteners per segment of track.

1909.2.4 Test acceptance criteria. Acceptance criteria for post-installed anchors shall be based on approved test report using criteria adopted in this code. Field test shall satisfy following minimum requirements.

1. *Hydraulic ram method:*

Anchors tested with a hydraulic jack or spring loaded devices shall maintain the test load for a minimum of 15 seconds and shall exhibit no discernable movement during the tension test, e.g., as evidenced by loosening of the washer under the nut.

For adhesive anchors, where other than bond is being tested, the testing device shall not restrict the concrete shear cone type failure mechanism from occurring.

2. *Torque wrench method:*

Anchors tested with a calibrated torque wrench must attain the specified torque within $\frac{1}{2}$ turn of the nut.

Exceptions:

a. *Wedge or sleeve type:*

One-quarter ($\frac{1}{4}$) turn of the nut for a $\frac{3}{8}$ in. sleeve anchor only.

b. *Threaded Type:*

One-quarter ($\frac{1}{4}$) turn of the screw after initial seating of the screw head.

1909.2.5 Testing procedure. Test procedure shall be as permitted by approved test report using criteria adopted in this code. Torque controlled post-installed anchors shall be permitted to be tested using torque based on approved

test report using criteria adopted in this code. All other post-installed anchors shall be tension tested. Manufacturer's recommendation for testing may be approved by the enforcement agency based on approved test report using criteria adopted in this code.

SECTION 1910 SHOTCRETE

1910.1 General. Shotcrete is mortar or concrete that is pneumatically projected at high velocity onto a surface. Except as specified in this section, shotcrete shall conform to the requirements of this chapter for plain or reinforced concrete.

1910.2 Proportions and materials. Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in finished in-place hardened shotcrete meeting the strength requirements of this code.

1910.3 Aggregate. Coarse aggregate, if used, shall not exceed $\frac{3}{4}$ inch (19.1 mm).

1910.4 Reinforcement. Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1910.4.1 through 1910.4.4.

1910.4.1 Size. The maximum size of reinforcement shall be No. 5 bars unless it is demonstrated by preconstruction tests that adequate encasement of larger bars will be achieved.

1910.4.2 Clearance. When No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of $2\frac{1}{2}$ inches (64 mm). When bars larger than No. 5 are permitted, there shall be a minimum clearance between parallel bars equal to six diameters of the bars used. When two curtains of steel are provided, the curtain nearer the nozzle shall have a minimum spacing equal to 12 bar diameters and the remaining curtain shall have a minimum spacing of six bar diameters.

Exception: Subject to the approval of the building official, required clearances shall be reduced where it is demonstrated by preconstruction tests that adequate encasement of the bars used in the design will be achieved.

1910.4.3 Splices. Lap splices of reinforcing bars shall utilize the noncontact lap splice method with a minimum clearance of 2 inches (51 mm) between bars. The use of contact lap splices necessary for support of the reinforcing is permitted when approved by the building official, based on satisfactory preconstruction tests that show that adequate encasement of the bars will be achieved, and provided that the splice is oriented so that a plane through the center of the spliced bars is perpendicular to the surface of the shotcrete.

1910.4.4 Spirally tied columns. Shotcrete shall not be applied to spirally tied columns.

1910.5 Preconstruction tests. When required by the building official, a test panel shall be shot, cured, cored or sawn, examined and tested prior to commencement of the project. The sample panel shall be representative of the project and

simulate job conditions as closely as possible. The panel thickness and reinforcing shall reproduce the thickest and most congested area specified in the structural design. It shall be shot at the same angle, using the same nozzleman and with the same concrete mix design that will be used on the project. The equipment used in preconstruction testing shall be the same equipment used in the work requiring such testing, unless substitute equipment is approved by the building official.

1910.6 Rebound. Any rebound or accumulated loose aggregate shall be removed from the surfaces to be covered prior to placing the initial or any succeeding layers of shotcrete. Rebound shall not be used as aggregate.

1910.7 Joints. Except where permitted herein, unfinished work shall not be allowed to stand for more than 30 minutes unless edges are sloped to a thin edge. For structural elements that will be under compression and for construction joints shown on the approved construction documents, square joints are permitted. Before placing additional material adjacent to previously applied work, sloping and square edges shall be cleaned and wetted.

1910.8 Damage. In-place shotcrete that exhibits sags, sloughs, segregation, honeycombing, sand pockets or other obvious defects shall be removed and replaced. Shotcrete above sags and sloughs shall be removed and replaced while still plastic.

1910.9 Curing. During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.

1910.9.1 Initial curing. Shotcrete shall be kept continuously moist for 24 hours after shotcreting is complete or shall be sealed with an approved curing compound.

1910.9.2 Final curing. Final curing shall continue for seven days after shotcreting, or for three days if high-early-strength cement is used, or until the specified strength is obtained. Final curing shall consist of the initial curing process or the shotcrete shall be covered with an approved moisture-retaining cover.

1910.9.3 Natural curing. Natural curing shall not be used in lieu of that specified in this section unless the relative humidity remains at or above 85 percent, and is authorized by the registered design professional and approved by the building official.

1910.10 Strength tests. Strength tests for shotcrete shall be made by an approved agency on specimens that are representative of the work and which have been water soaked for at least 24 hours prior to testing. When the maximum-size aggregate is larger than $\frac{3}{8}$ inch (9.5 mm), specimens shall consist of not less than three 3-inch-diameter (76 mm) cores or 3-inch (76 mm) cubes. When the maximum-size aggregate is $\frac{3}{8}$ inch (9.5 mm) or smaller, specimens shall consist of not less than 2-inch-diameter (51 mm) cores or 2-inch (51 mm) cubes.

1910.10.1 Sampling. Specimens shall be taken from the in-place work or from test panels, and shall be taken at least once each shift, but not less than one for each 50 cubic yards (38.2 m^3) of shotcrete.

1910.10.2 Panel criteria. When the maximum-size aggregate is larger than $\frac{3}{8}$ inch (9.5 mm), the test panels shall have minimum dimensions of 18 inches by 18 inches (457 mm by 457 mm). When the maximum size aggregate is $\frac{3}{8}$ inch (9.5 mm) or smaller, the test panels shall have minimum dimensions of 12 inches by 12 inches (305 mm by 305 mm). Panels shall be shot in the same position as the work, during the course of the work and by the nozzlemen doing the work. The conditions under which the panels are cured shall be the same as the work.

1910.10.3 Acceptance criteria. The average compressive strength of three cores from the in-place work or a single test panel shall equal or exceed $0.85 f'_c$ with no single core less than $0.75 f'_c$. The average compressive strength of three cubes taken from the in-place work or a single test panel shall equal or exceed f'_c with no individual cube less than $0.88 f'_c$. To check accuracy, locations represented by erratic core or cube strengths shall be retested.

SECTION 1911 REINFORCED GYPSUM CONCRETE

1911.1 General. Reinforced gypsum concrete shall comply with the requirements of ASTM C 317 and ASTM C 956.

1911.2 Minimum thickness. The minimum thickness of reinforced gypsum concrete shall be 2 inches (51 mm) except the minimum required thickness shall be reduced to $1\frac{1}{2}$ inches (38 mm), provided the following conditions are satisfied:

1. The overall thickness, including the formboard, is not less than 2 inches (51 mm).
2. The clear span of the gypsum concrete between supports does not exceed 33 inches (838 mm).
3. Diaphragm action is not required.
4. The design live load does not exceed 40 pounds per square foot (psf) (1915 Pa).

SECTION 1912 CONCRETE-FILLED PIPE COLUMNS

1912.1 General. Concrete-filled pipe columns shall be manufactured from standard, extra-strong or double-extra-strong steel pipe or tubing that is filled with concrete so placed and manipulated as to secure maximum density and to ensure complete filling of the pipe without voids.

1912.2 Design. The safe supporting capacity of concrete-filled pipe columns shall be computed in accordance with the approved rules or as determined by a test.

1912.3 Connections. Caps, base plates and connections shall be of approved types and shall be positively attached to the shell and anchored to the concrete core. Welding of brackets without mechanical anchorage shall be prohibited. Where the pipe is slotted to accommodate webs of brackets or other connections, the integrity of the shell shall be restored by welding to ensure hooping action of the composite section.

1912.4 Reinforcement. To increase the safe load-supporting capacity of concrete-filled pipe columns, the steel reinforce-

ment shall be in the form of rods, structural shapes or pipe embedded in the concrete core with sufficient clearance to ensure the composite action of the section, but not nearer than 1 inch (25 mm) to the exterior steel shell. Structural shapes used as reinforcement shall be milled to ensure bearing on cap and base plates.

1912.5 Fire-resistance-rating protection. Pipe columns shall be of such size or so protected as to develop the required fire-resistance ratings specified in Table 601. Where an outer steel shell is used to enclose the fire protective covering, the shell shall not be included in the calculations for strength of the column section. The minimum diameter of pipe columns shall be 4 inches (102 mm) except that in structures of Type V construction not exceeding three stories above grade plane or 40 feet (12 192 mm) in building height, pipe columns used in basements and as secondary steel members shall have a minimum diameter of 3 inches (76 mm).

1912.6 Approvals. Details of column connections and splices shall be shop fabricated by approved methods and shall be approved only after tests in accordance with the approved rules. Shop-fabricated concrete-filled pipe columns shall be inspected by the building official or by an approved representative of the manufacturer at the plant.

SECTION 1913 ADDITIONAL REQUIREMENTS [DSA-SS/CC]

1913.1 General.

1913.1.1 Construction documents. Openings larger than 12 inches (305 mm) in any dimension shall be detailed on the structural drawings.

1913.2 Tests and materials. Where required, special inspections and tests shall be in accordance with Chapter 17A and this section.

1913.2.1 Glass fiber reinforced concrete. Glass fiber reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL 128 standard.

1913.2.2 Fly ash. Replace ACI 318 Section 3.2.2 as follows:

Fly ash or other pozzolan can be used as a partial substitute for ASTM C 150 portland cement, as follows:

1. Fly ash or other pozzolan shall conform to ASTM C 618 for Class N or Class F materials (Class C is not permitted), and
2. More than 15 percent by weight of fly ash or other pozzolans shall be permitted to be substituted for ASTM C 150 portland cement if the mix design is proportioned per ACI 318 Section 5.3. See Section 1904 for durability requirements.
3. More than 40 percent by weight of ground-granulated blast-furnace slag conforming to ASTM C 989 shall be permitted to be substituted for ASTM C 150 portland cement if the mix design is proportioned per ACI 318 Section 5.3. See Section 1904 for durability requirements.

1913.2.3 ACI 318, Section 3.3.2. Modify ACI 318 Section 3.3.2 by adding the following:

Aggregate size limitations waiver shall be approved by the enforcement agency.

Evidence that the aggregate used is not reactive in the presence of cement alkalis may be required by the enforcement agency. If new aggregate sources are to be used or if past experience indicates problems with existing aggregate sources, test the aggregate for potential reactivity according to ASTM C 289 to determine potential reactivity in the presence of cement.

If the results of the test are other than innocuous, selected concrete proportions using the aggregate (see Section 1905.2) shall be tested in accordance with ASTM C 1567. If the results of this test indicate an expansion greater than 0.10 percent at 16-days age, provide mitigation with one of the cementitious material systems noted below such that an expansion of less than 0.10 percent at 16-days age is obtained:

1. Low-alkali portland cement containing not more than 0.6 percent total alkali when calculated as sodium oxide, as determined by the method given in ASTM C 114.
2. Blended hydraulic cement, Type IS or IP, conforming to ASTM C 595, except that Type IS cement shall not contain less than 40 percent slag constituent.
3. Replacement of not less than 15 percent by weight of the portland cement used by a mineral admixture conforming to ASTM C 618 for Class N or F materials (Class C is not permitted).
4. Replacement of not less than 40 percent by weight of the portland cement used by a ground granulated blast-furnace slag conforming to ASTM C 989.

1913.2.4 Discontinuous steel fibers - Modify ACI 318 Section 3.5.1 by adding the following:

Discontinuous steel fibers shall not be permitted

1913.2.5 Cementitious material. The concrete supplier shall furnish to the enforcement agency certification that the cement proposed for use on the project has been manufactured and tested in compliance with the requirements of ASTM C 150 for portland cement and ASTM C 595 or ASTM C 1157 for blended hydraulic cement, whichever is applicable. When a mineral admixture or ground granulated blast-furnace slag is proposed for use, the concrete supplier shall furnish to the enforcement agency certification that they have been manufactured and tested in compliance with ASTM C 618 or ASTM C 989, whichever is applicable. The concrete producer shall provide copies of the cementitious material supplier's certificate of compliance that represents the materials used by date of shipment for concrete. Cementitious materials without certification of compliance shall not be used.

1913.2.6 Tests of reinforcing bars. Where samples are taken from bundles as delivered from the mill, with the bundles identified as to heat number and provided the mill analyses accompany the report, one tensile test and one

bend test shall be made from a specimen from each 10 tons (9080 kg) or fraction thereof of each size of reinforcing steel.

Where positive identification of the heat number cannot be made or where random samples are to be taken, one series of tests shall be made from each $2\frac{1}{2}$ tons (2270 kg) or fraction thereof of each size of reinforcing steel.

Tests of reinforcing bars may be waived by the structural engineer with the approval of the Building Official for one-story buildings provided certified mill test reports are provided for each shipment of such reinforcement.

1913.2.7 Tests for prestressing steel and anchorage. All wires or bars of each size from each mill heat and all strands from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each lot can be accurately identified at the job site. Each lot of tendon and anchorage assemblies and bar couplers to be installed shall be likewise identified.

The following samples of materials and tendons selected by the engineer or the designated testing laboratory from the prestressing steel at the plant or job site shall be furnished by the contractor and tested by an approved independent testing agency:

1. For wire, strand or bars, 7-foot-long (2134 mm) samples shall be taken of the coil of wire or strand reel or rods. A minimum of one random sample per 5,000 pounds (2270 kg) of each heat or lot used on the job shall be selected.
2. For prefabricated prestressing tendons other than bars, one completely fabricated tendon 10 feet (3048 mm) in length between grips with anchorage assembly at one end shall be furnished for each size and type of tendon and anchorage assembly.

Variations of the bearing plate size need not be considered.

The anchorages of unbonded tendons shall develop at least 95 percent of the minimum specified ultimate strength of the prestressing steel. The total elongation of the tendon under ultimate load shall not be less than 2 percent measured in a minimum gage length of 10 feet (3048 mm).

Anchorage of bonded tendons shall develop at least 90 percent of the minimum specified strength of the prestressing steel tested in an unbonded state. All couplings shall develop at least 95 percent of the minimum specified strength of the prestressing steel and shall not reduce the elongation at rupture below the requirements of the tendon itself.

3. If the prestressing tendon is a bar, one 7-foot (2134 mm) length complete with one end anchorage shall be furnished and, in addition, if couplers are to be used with the bar, two 4-foot (1219 mm) lengths of bar fabricated to fit and equipped with one coupler shall be furnished.

4. Mill tests of materials used for end anchorages shall be furnished. In addition, at least one Brinnell hardness test shall be made of each thickness of bearing plate.

1913.2.8 Composite construction cores. Cores of the completed composite concrete construction shall be taken to demonstrate the shear strength along the contact surfaces. The cores shall be tested when the cast-in-place concrete is approximately 28 days old and shall be tested by a shear loading parallel to the joint between the precast concrete and the cast-in-place concrete. The minimum unit shear strength of the contact surface area of the core shall not be less than 100 psi (689 kPa).

At least one core shall be taken from each building for each 5,000 square feet (465 m^2) of area of composite concrete construction and not less than three cores shall be taken from each project. The architect or structural engineer in responsible charge of the project or his or her representative shall designate the location for sampling.

1913.2.9 Tests of shotcrete. Testing of shotcrete shall follow the provisions of Sections 1910, 1913.4, and the general requirements of ACI 318 Section 5.6.

1913.2.10 Gypsum field tests. Field tests shall be made during construction to verify gypsum strength. One sample consisting of three specimens shall be made for each 5,000 square feet (465 m^2) or fraction thereof of all gypsum poured, but not less than one sample shall be taken from each half-day's pour.

1913.2.11 Tests for post-installed anchors in concrete. When post-installed anchors are used in lieu of cast-in-place bolts, the installation verification test loads frequency and acceptance criteria shall be in accordance with this section.

1913.2.11.1 General. Test loads or torques and acceptance criteria shall be shown on the construction documents.

If any anchor fails testing, all anchors of the same type shall be tested, which are installed by the same trade, not previously tested until twenty (20) consecutive anchors pass, then resume the initial test frequency.

1913.2.11.2 Test loads. Required test loads shall be determined by one of the following methods:

1. Twice the maximum allowable tension load or one and a quarter ($1\frac{1}{4}$) times the maximum design strength of anchors as provided in an approved test report using criteria adopted in this code or determined in accordance with Appendix D of ACI 318.

Tension test load need not exceed 80 percent of the nominal yield strength of the anchor element ($= 0.8 A_{se} f_{ya}$).

2. The manufacturer's recommended installation torque based on approved test report using criteria adopted in this code.

1913.2.11.3 Test frequency. When post-installed anchors are used for sill plate bolting applications, 10 percent of the anchors shall be tested.

When post-installed anchors are used for other structural applications, all such anchors shall be tested.

When post-installed anchors are used for nonstructural applications such as equipment anchorage, 50 percent or alternate bolts in a group, including at least one-half the anchors in each group, shall be tested.

The testing of the post-installed anchors shall be done in the presence of the special inspector and a report of the test results shall be submitted to the enforcement agency.

Exceptions:

1. Undercut anchors that allow visual confirmation of full set shall not require testing.
2. Where the factored design tension on anchors is less than 100 lb and those anchors are clearly noted on the approved construction documents, only 10 percent of those anchors shall be tested.
3. Where adhesive anchor systems are used to install reinforcing dowel bars in hardened concrete, only 25 percent of the dowels shall be tested if all the following conditions are met:
 - a. The dowels are used exclusively to transmit shear forces across joints between existing and new concrete.
 - b. The number of dowels in any one member equals or exceeds 12.
 - c. The dowels are uniformly distributed across seismic force resisting members (such as shear walls, collectors and diaphragms).

Anchors to be tested shall be selected at random by the special inspector/inspector of record (IOR).

4. Testing of shear dowels across cold joints in slabs on grade, where the slab is not part of the lateral force-resisting system shall not be required.
5. Testing is not required for power actuated fasteners used to attach tracks of interior non-shear wall partitions for shear only, where there are at least three fasteners per segment of track.

1913.2.11.4 Test acceptance criteria. Acceptance criteria for post-installed anchors shall be based on an approved test report using criteria adopted in this code or manufacturer's written instruction, acceptable to the enforcement agency. Field test shall satisfy following minimum requirements.

I. Hydraulic ram method:

Anchors tested with a hydraulic jack or spring loaded devices shall maintain the test load for a minimum of 15 seconds and shall exhibit no discern-

ible movement during the tension test, e.g., as evidenced by loosening of the washer under the nut.

For adhesive anchors, where other than bond is being tested, the testing device shall not restrict the concrete shear cone type failure mechanism from occurring.

2. Torque wrench method:

Anchors tested with a calibrated torque wrench must attain the specified torque within $\frac{1}{2}$ turn of the nut.

Exceptions:

1. Wedge or sleeve type: One-quarter ($\frac{1}{4}$) turn of the nut for a $\frac{3}{8}$ in. sleeve anchor only.
2. Threaded type: One-quarter ($\frac{1}{4}$) turn of the screw after initial seating of the screw head.

1913.2.11.5 Testing procedure. Test procedure shall be as permitted by approved test report using criteria adopted in this code. Torque controlled post-installed anchors shall be permitted to be tested using torque based on approved test report using criteria adopted in this code. All other post-installed anchors shall be tension tested. Manufacturer's recommendation for testing may be approved by the enforcement agency based on approved test report using criteria adopted in this code.

1913.3 Modifications to ACI 318

1913.3.1 ACI 318, Section 5.6.2.1. Replace ACI 318 Section 5.6.2.1 by the following:

5.6.2.1 - Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, or not less than once for each 50 cubic yards (38.2 m^3) of concrete, or not less than once for each 2,000 square feet (186 m^2) of surface area for slabs or walls. Additional samples for seven-day compressive strength tests shall be taken for each class of concrete at the beginning of the concrete work or whenever the mix or aggregate is changed.

1913.3.2 ACI 318, Section 14.9. Modify ACI 318 by adding Section 14.9 as follows:

14.9 - Foundation walls. Horizontal reinforcing of concrete foundation walls for wood-frame or light-steel buildings shall consist of the equivalent of not less than one No. 5 bar located at the top and bottom of the wall. Where such walls exceed 3 feet (914 mm) in height, intermediate horizontal reinforcing shall be provided at spacing not to exceed 2 feet (610 mm) on center. Minimum vertical reinforcing shall consist of No. 3 bars at 24 inches (610 mm) on center.

Where concrete foundation walls or curbs extend above the floor line and support wood-frame or light-steel exterior, bearing or shear walls, they shall be doweled to the foundation wall below with a minimum of No. 3 bars at 24 inches (610 mm) on center. Where the height of the wall above the floor line exceeds 18

inches (457 mm), the wall above and below the floor line shall meet the requirements of ACI 318 Section 14.3.

1913.3.3 ACI 318, Section 21.9.2.2. Modify ACI 318, Section 21.9.2.2 by adding the following:

Where boundary members are not required by ACI 318 Section 21.9.6, minimum reinforcement parallel to the edges of all structural walls and the boundaries of all openings shall consist of twice the cross-sectional area of the minimum shear reinforcement required per lineal foot of wall. Horizontal extent of boundary element shall be per ACI 318 Section 21.9.6.4 (a) and (b).

1913.3.4 ACI 318, Section 21.9.4. Modify ACI 318 by adding Section 21.9.4.6 as follows:

21.9.4.6 - Walls and portions of walls with $P_u > 0.35P_o$ shall not be considered to contribute to the calculated strength of the structure for resisting earthquake-induced forces. Such walls shall conform to the requirements of ACI 318 Section 21.13.

1913.3.5 ACI 318, Section 21.11.4. Modify ACI 318 Section 21.11.4 by adding the following:

Collector and boundary elements in topping slabs placed over precast floor and roof elements shall not be less than 3 inches (76 mm) or $6 d_b$ thick, where d_b is the diameter of the largest reinforcement in the topping slab.

1913.3.6 ACI 318, Section 21.11.7. Modify ACI 318 Section 21.11.7 by adding Section 21.11.7.7 as follows:

21.11.7.7 - Where boundary members are not required by ACI 318 Section 21.11.7.5, minimum reinforcement parallel to the edges of all diaphragms and the boundaries of all openings shall consist of twice the cross-sectional area of the minimum shear reinforcement required per linear foot of diaphragm.

1913.3.7 ACI 318, Chapter 22. Plain concrete is not permitted.

1913.3.8 ACI 318, Section D.3.3. Replace the requirements of Section 1905.1.9 with the following. Modify ACI 318, Sections D.3.3.4.2, D.3.3.4.3(d), and D.3.3.5.2 to read as follows:

D.3.3.4.2 - Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with Section D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with Section D.3.3.4.4.

Exception:

Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 and Section 1604.8.2 of this code shall be deemed to satisfy Section D.3.3.4.3(d).

D.3.3.4.3(d) - The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_o . The anchor design tensile strength shall be calculated from Section D.3.3.4.4.

D.3.3.5.2 - Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with Section D.3.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with Section D.6.

Exceptions:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane design shear strength in accordance with Sections D.6.2 and D.6.3 need not be computed and Section D.3.3.5.3 shall be deemed to be satisfied, provided all of the following are met:

- 1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.
- 1.2. The maximum anchor nominal diameter is $5/8$ inches (16 mm).
- 1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).
- 1.4. Anchor bolts are located a minimum of $1\frac{3}{4}$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.
- 1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.
- 1.6. The sill plate is 2-inch or 3-inch nominal thickness.

2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of light-frame construction to foundations or foundation stem walls the in-plane design shear strength in accordance with Sections D.6.2 and D.6.3 need not be computed and Section D.3.3.5.3 shall be deemed to be satisfied provided all of the following are met:

- 2.1. The maximum anchor nominal diameter is $5/8$ inches (16 mm).
- 2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).

- 2.3. Anchors are located a minimum of $1\frac{3}{4}$ inches (45 mm) from the edge of the concrete parallel to the length of the track.
- 2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.
- 2.5. The track is 33 to 68 mil designation thickness.

Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete shall be permitted to be determined in accordance with AISI S100, Section E3.3.1.

- 3. In light-frame construction, bearing or non-bearing walls, shear strength of concrete anchors less than or equal to $\frac{5}{8}$ inch (16 mm) in diameter of sill plate or track to foundation or foundation stem wall need not satisfy Section D.3.3.5.3 (a) through (c) when the design strength of the anchors is determined in accordance with Section D.6.2.1(c).

1913.4 Shotcrete.

1913.4.1 Preconstruction tests. A test panel prepared in accordance with Section 1913.5 is required. Approval from the enforcement agency must be obtained prior to performing test panels.

1913.4.2 Surface preparation. Concrete or masonry to receive shotcrete shall have the entire surface thoroughly cleaned and roughened by sand blasting, and just prior to receiving shotcrete, shall be thoroughly cleaned of all debris, dirt and dust. Concrete and masonry shall be wetted before shotcrete is deposited, but not so wet as to overcome suction.

1913.4.3 Joints. The film of laitance which forms on the surface of the shotcrete shall be removed within approximately two hours after application by brushing with a stiff broom. If this film is not removed within two hours, it shall be removed by thorough wire brushing or sand blasting. Construction joints over eight hours old shall be thoroughly cleaned with air and water prior to receiving shotcrete.

1913.4.4 Forms and ground wires for shotcrete. Forms for shotcrete shall be substantial and rigid. Forms shall be built and placed so as to permit the escape of air and rebound.

Adequate ground wires, which are to be used as screeds, shall be placed to establish the thickness, surface planes and form of the shotcrete work. All surfaces shall be rodded to these wires.

1913.4.5 Placing. Shotcrete shall be placed in accordance with ACI 506.

1913.5 Existing concrete structures. The structural use of existing concrete with a core strength less than 1,500 psi (10.3 MPa) is not permitted in rehabilitation work.

For existing concrete structures, sufficient cores shall be taken at representative locations throughout the structure, as designated by the architect or structural engineer, so that knowledge will be had of the in-place strength of the concrete. At least three cores shall be taken from each building for each 4,000 square feet (372 m^2) of floor area, or fraction thereof. Cores shall be at least 4 inches (102 mm) in diameter. Cores as small as 2.75 inches (70 mm) in diameter may be allowed by the enforcement agency when reinforcement is closely spaced and the coarse aggregate does not exceed $\frac{3}{4}$ inch (19 mm).

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 19A – CONCRETE

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
 See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | X | | | X | | | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

CHAPTER 19A

CONCRETE

Italics are used for text within Sections 1903A through 1908A of this code to indicate provisions that differ from ACI 318. State of California amendments in these sections are shown in italics and underlined.

SECTION 1901A GENERAL

1901A.1 Scope. The provisions of this chapter shall govern the materials, quality control, design and construction of concrete used in structures.

1901A.1.1 Application. *The scope of application of Chapter 19A is as follows:*

1. *Structures regulated by the Division of the State Architect-Structural Safety (DSA-SS), which include those applications listed in Section 1.9.2.1. These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.*
2. *Applications listed in Sections 1.10.1, and 1.10.4, regulated by the Office of Statewide Health Planning and Development (OSHPD). These applications include hospitals, skilled nursing facilities, intermediate care facilities, and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 19 and any applicable amendments therein.

1901A.1.2 Amendments in this chapter. DSA and OSHPD adopt this chapter and all amendments.

Exception: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect-Structural Safety: [DSA-SS] For applications listed in Section 1.9.2.1*
2. *Office of Statewide Health Planning and Development.*
[OSHPD 1] – For applications listed in Section 1.10.1.
[OSHPD 4] – For applications listed in Section 1.10.4.

1901A.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905A of this code. Except for the provisions of Sections 1904A and 1907A, the design and construction of slabs on grade shall not be governed by this chapter unless they trans-

mit vertical loads or lateral forces from other parts of the structure to the soil.

1901A.3 Construction documents. The construction documents for structural concrete construction shall include:

1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. The specified strength or grade of reinforcement.
3. The size and location of structural elements, reinforcement and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. The magnitude and location of prestressing forces.
6. Anchorage length of reinforcement and location and length of lap splices.
7. Type and location of mechanical and welded splices of reinforcement.
8. Details and location of contraction or isolation joints specified for plain concrete.
9. Minimum concrete compressive strength at time of posttensioning.
10. Stressing sequence for posttensioning tendons.
11. For structures assigned to Seismic Design Category D, E or F, a statement if slab on grade is designed as a structural diaphragm.
12. *Openings larger than 12 inches (305 mm) in any dimension shall be detailed on the structural drawings.*

1901A.4 Special inspection. The special inspection of concrete elements of buildings and structures and concreting operations shall be as required by Chapter 17A.

SECTION 1902A DEFINITIONS

1902A.1 General. The words and terms defined in ACI 318 shall, for the purposes of this chapter and as used elsewhere in this code for concrete construction, have the meanings shown in ACI 318 as modified by Section 1905A.1.1.

SECTION 1903A SPECIFICATIONS FOR TESTS AND MATERIALS

1903A.1 General. Materials used to produce concrete, concrete itself and testing thereof shall comply with the applica-

ble standards listed in ACI 318. Where required, special inspections and tests shall be in accordance with Chapter 17A and Section 1913A.

1903A.2 Glass fiber reinforced concrete. Glass fiber reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL128 standard.

1903A.3 Flat wall insulating concrete form (ICF) systems. Insulating concrete form material used for forming flat concrete walls shall conform to ASTM E 2634. [OSHPD 1 & 4] Not Permitted by OSHPD.

1903A.4 Reporting requirements – Modify ACI 318 Section 3.2.1 by adding the following:

Each component (a) through (g), when present, as a percentage of total cementitious materials shall be reported for each mix design.

1903A.5 Fly ash – Add ACI 318 Section 3.2.3 as follows:

Fly ash or other pozzolan can be used as a partial substitute for ASTM C 150 portland cement, as follows:

1. Fly ash or other pozzolan shall conform to ASTM C 618 for Class N or Class F materials (Class C is not permitted), and
2. More than 15 percent by weight of fly ash or other pozzolans shall be permitted to be substituted for ASTM C 150 portland cement if the mix design is proportioned per ACI 318 Section 5.3. See Section 1904A for durability requirements.
3. More than 40 percent by weight of ground-granulated blast-furnace slag conforming to ASTM C 989 shall be permitted to be substituted for ASTM C 150 portland cement if the mix design is proportioned per ACI 318 Section 5.3. See Section 1904A for durability requirements.

1903A.6 Aggregates – ACI 318 Section 3.3.2 Modify ACI 318 Section 3.3.2 by adding the following:

Aggregate size limitations waiver shall be approved by the enforcement agency.

Evidence that the aggregate used is not reactive in the presence of cement alkalis may be required by the enforcement agency. If new aggregate sources are to be used or if past experience indicates problems with existing aggregate sources, test the aggregate for potential alkali-silica reactivity in accordance with ASTM C 1260 or ASTM C 1293 to determine the potential alkali-silica reactivity of the aggregate. If the results indicate an expansion greater than 0.10 percent at 16-days age with ASTM C 1260, or an expansion greater than 0.04 percent at 12 months age with ASTM C 1293, provide mitigation with one of the cementitious material systems noted below such that an expansion of less than 0.10 percent at 16-days age is obtained with ASTM C 1567:

1. Low-alkali portland cement containing not more than 0.6 percent total alkali when calculated as sodium oxide, as determined by the method given in ASTM C 114.

2. Blended hydraulic cement, Type IS or IP, conforming to ASTM C 595, except that Type IS cement shall not contain less than 40 percent slag cement.

3. Replacement of not less than 15 percent by weight of the portland cement with a pozzolan conforming to ASTM C 618 for Class N or F materials (Class C is not permitted).

4. Replacement of not less than 40 percent by weight of the portland cement used by a ground granulated blast-furnace with slag cement conforming to ASTM C 989.

5. Replacement of not less than 5 percent nor more than 10 percent by weight of portland cement with silica fume conforming to ASTM C 1240.

6. Replacement of portland cement with a ternary blend of portland cement, slag cement and pozzolan such that the resulting blend contains not more than 70 percent portland cement

ASTM C 1567 shall be performed separately on the fine and coarse aggregate with one requiring the higher percentage of supplementary cementitious materials dictating the required replacement.

ASTM C 1260, ASTM C 1293 and ASTM C 1567 tests must have been performed within the past three years.

1903A.7 Discontinuous steel fibers – Modify ACI 318 Section 3.5.1 by adding the following:

Discontinuous steel fibers are not permitted.

1903A.8 Welding of reinforcing bars – Modify ACI 318 Section 3.5.2 by adding the following:

If mill test reports are not available, chemical analysis shall be made of bars representative of the bars to be welded. Bars with a carbon equivalent (C.E.) above 0.75 shall not be welded. Welding shall not be done on or within two bar diameters of any bent portion of a bar that has been bent cold. Welding of crossing bars shall not be permitted for assembly of reinforcement unless authorized by the structural engineer and approved by the enforcement agency per approved procedures.

SECTION 1904A DURABILITY REQUIREMENTS

1904A.1 Exposure categories and classes. Concrete shall be assigned to exposure classes in accordance with the durability requirements of ACI 318 based on:

1. Exposure to freezing and thawing in a moist condition or deicer chemicals;
2. Exposure to sulfates in water or soil;
3. Exposure to water where the concrete is intended to have low permeability; and
4. Exposure to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater or spray from these sources, where the concrete has steel reinforcement.

1904A.2 Concrete properties. Concrete mixtures shall conform to the most restrictive maximum water-cementitious materials ratios, maximum cementitious admixtures, minimum air-entrainment and minimum specified concrete compressive strength requirements of ACI 318 based on the exposure classes assigned in Section 1904A.1.

Exception: For occupancies and appurtenances thereto in Group R occupancies that are in buildings less than four stories above grade plane, normal-weight aggregate concrete is permitted to comply with the requirements of Table 1904A.2 based on the weathering classification (freezing and thawing) determined from Figure 1904A.2 in lieu of the durability requirements of ACI 318.

**TABLE 1904A.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c)**

| TYPE OR LOCATION OF CONCRETE CONSTRUCTION | MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c at 28 days, psi) | | |
|--|--|----------------------|----------------------|
| | Negligible exposure | Moderate exposure | Severe exposure |
| Basement walls ^c and foundations not exposed to the weather | 2,500 | 2,500 | 2,500 ^a |
| Basement slabs and interior slabs on grade, except garage floor slabs | 2,500 | 2,500 | 2,500 ^a |
| Basement walls ^c , foundation walls, exterior walls and other vertical concrete surfaces exposed to the weather | 2,500 | 3,000 ^b | 3,000 ^b |
| Driveways, curbs, walks, patios, porches, carport slabs, steps and other flatwork exposed to the weather, and garage floor slabs | 2,500 | 3,000 ^{b,d} | 3,500 ^{b,d} |

For SI: 1 pound per square inch = 0.00689 MPa.

- a. Concrete in these locations that can be subjected to freezing and thawing during construction shall be of air entrained concrete in accordance with Section 1904A.2.
- b. Concrete shall be air entrained in accordance with ACI 318.
- c. Structural plain concrete basement walls are exempt from the requirements for exposure conditions of Section 1904A.2.
- d. For garage floor slabs where a steel trowel finish is used, the total air content required by ACI 318 is permitted to be reduced to not less than 3 percent, provided the minimum specified compressive strength of the concrete is increased to 4,000 psi.



**FIGURE 1904A.2
WEATHERING PROBABILITY MAP FOR CONCRETE^{a, b, c}**

- a. Lines defining areas are approximate only. Local areas can be more or less severe than indicated by the region classification.
- b. A "severe" classification is where weather conditions encourage or require the use of deicing chemicals or where there is potential for a continuous presence of moisture during frequent cycles of freezing and thawing. A "moderate" classification is where weather conditions occasionally expose concrete in the presence of moisture to freezing and thawing, but where deicing chemicals are not generally used. A "negligible" classification is where weather conditions rarely expose concrete in the presence of moisture to freezing and thawing.
- c. Alaska and Hawaii are classified as severe and negligible, respectively.

SECTION 1905A MODIFICATIONS TO ACI 318

1905A.1 General. The text of ACI 318 shall be modified as indicated in Sections 1905A.1.1 through 1905A.1.21.

1905A.1.1 ACI 318, Section 5.1.1. Modify ACI 318, Section 5.1.1, as follows:

For concrete designed and constructed in accordance with this chapter, f'_c shall not be less than 3,000 psi (20.7 MPa). Reinforced concrete with specified compressive strength higher than 8,000 psi (55 MPa) shall require prior approval of structural design method and acceptance criteria by the enforcement agency.

1905A.1.2 ACI 318, Section 5.6.2.1. Replace ACI 318, Section 5.6.2.1, by adding the following:

5.6.2.1 Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, or not less than once for each 50 cubic yards (38.2 m^3) of concrete, or not less than once for each 2,000 square feet (186 m^2) of surface area for slabs or walls. Additional samples for seven-day compressive strength tests shall be taken for each class of concrete at the beginning of the concrete work or whenever the mix or aggregate is changed.

1905A.1.3 ACI 318, Section 8.13.5. Replace ACI 318, Section 8.13.5, as follows:

8.13.5 – Permanent burned clay or concrete tile fillers shall be considered only as forms and shall not be included in the calculations involving shear or bending moments.

The thickness of the concrete slab on the permanent fillers shall be designed as described in ACI 318, Section 8.13.6, as modified in Section 1905A.1.4.

1905A.1.4 ACI 318, Section 8.13.6. Replace ACI 318, Section 8.13.6, as follows:

8.13.6 – Where removable forms or fillers are used, the thickness of the concrete slab shall not be less than $\frac{1}{12}$ of the clear distance between joists and in no case less than $2\frac{1}{2}$ inches (64 mm). Such slab shall be reinforced at right angles to the joists with at least the amount of reinforcement required for flexure, considering load concentrations, if any, but in no case shall the reinforcement be less than that required by ACI 318, Section 7.12.

1905A.1.5 ACI 318, Section 8.13. Add Section 8.13.9 to ACI 318 as follows:

8.13.9 Concrete bridging. Concrete bridging shall be provided as follows: one near the center of spans for 20 to 30 feet (6096 mm to 9144 mm) spans and two near the third points of spans over 30 feet (9144 mm). Such bridging shall be either:

(a) A continuous concrete web having a depth equal to the joist and a width not less than $3\frac{1}{2}$ inches (89 mm) reinforced with a minimum of one No. 4 bar in the top and bottom; or

(b) Any other concrete element capable of transferring a concentrated load of 1,000 pounds (4.5 kN) from any joist to the two adjacent joists.

Such bridging shall not be required in roof framing if an individual member is capable of carrying dead load plus a concentrated load of 1,500 pounds (6.7 kN) at any point.

1905A.1.6 ACI 318, Section 10.5.3. Modify ACI 318, Section 10.5.3, by adding the following:

This section shall not be used for members that resist seismic loads, except that reinforcement provided for foundation elements for one-story wood-frame or one-story light steel buildings need not be more than one-third greater than that required by analysis for all loading conditions.

1905A.1.7 ACI 318, Section 12.14.3. Add Section 12.14.3.6 to ACI 318 as follows:

12.14.3.6 – Welded splices and mechanical connections shall maintain the clearance and coverage requirements of ACI 318, Sections 7.6 and 7.7.

1905A.1.8 ACI 318, Section 14.2.6. Replace ACI 318, Section 14.2.6, as follows:

14.2.6 – Walls shall be anchored to intersecting elements such as floors or roofs; or to columns, pilasters, buttresses, of intersecting walls and footings with reinforcement at least equivalent to No. 4 bars at 12 inches (305 mm) on center for each layer of reinforcement.

1905A.1.9 ACI 318, Section 14.5 – Empirical design method. Not permitted by DSA-SS and OSHPD.

1905A.1.10 ACI 318, Section 14.9. Modify ACI 318 by adding Section 14.9 as follows:

14.9 – Foundation walls. Horizontal reinforcing of concrete foundation walls for wood-frame or light-steel buildings shall consist of the equivalent of not less than one No. 5 bar located at the top and bottom of the wall. Where such walls exceed 3 feet (914 mm) in height, intermediate horizontal reinforcing shall be provided at spacing not to exceed 2 feet (610 mm) on center. Minimum vertical reinforcing shall consist of No. 3 bars at 24 inches (610 mm) on center.

Where concrete foundation walls or curbs extend above the floor line and support wood-frame or light-steel exterior, bearing or shear walls, they shall be dowled to the foundation wall below with a minimum of No. 3 bars at 24 inches (610 mm) on center. Where the height of the wall above the floor line exceeds 18 inches (457 mm), the wall above and below the floor line shall meet the requirements of ACI 318, Section 14.3.

1905A.1.11 ACI 318 Section 16. Add Section 16.11 to ACI 318.1, as follows:

16.11 – Reinforcement. Perimeters of precast walls shall be reinforced continuously with a minimum of one No. 5 bar extending the full height and width of the wall panel. Bars shall be continuous around corners. Where wall panels do not abut columns or other wall panels,

perimeter bars shall be retained by hooked wall bars.
Edges of openings in precast walls shall be reinforced
with a minimum of one No. 5 bar continuous past cor-
ners sufficient to develop the bar.

A continuous tie or bond beam shall be provided at
the roof line either as a part of the roof structure or
part of the wall panels as described in the next para-
graph below. This tie may be designed as the edge
member of the roof diaphragm but, in any case, shall
not be less than equivalent to two No. 6 bars continu-
ous. A continuous tie equivalent to two No. 5 bars mini-
mum shall also be provided either in the footing or with
an enlarged section of the floor slab.

Wall panels of shear wall buildings shall be con-
nected to columns or to each other in such a manner as
to develop at least 75 percent of the horizontal wall
steel. Half of this continuous horizontal reinforcing
may be concentrated in bond or tie beams at the top
and bottom of the walls and at points of intermediate
lateral support. If possible, cast in-place joints with
reinforcing bars extending from the panels into the
joint a sufficient distance to meet the splice require-
ments of ACI 318, Section 12.15, for Class A shall be
used. The reinforcing bars or welded tie details shall
not be spaced over eight times the wall thickness verti-
cally nor fewer than four used in the wall panel height.
Where wall panels are designed for their respective
overturning forces, the panel connections need not
comply with the requirements of this paragraph.

Where splicing of reinforcement must be made at
points of maximum stress or at closer spacing than per-
mitted by ACI 318, Section 7.6, welding may be used
when the entire procedure is suitable for the particular
quality of steel used and the ambient conditions. Unless
the welds develop 125 percent of the specified yield
strength of the steel used, reinforcement in the form of
continuous bars or fully anchored dowels shall be
added to provide 25 percent excess steel area and the
welds shall develop not less than the specified yield
strength of the steel.

Exception: Nonbearing, nonshear panels such as
 nonstructural architectural cladding panels or column
 covers are not required to meet the provisions of this section.

1905A.1.12 ACI 318, Section 17.5.1. Modify ACI 318, Section 17.5.1, by adding Sections 17.5.1.1 and 17.5.1.2 as follows:

17.5.1.1 – Full transfer of horizontal shear forces may
be assumed when all of the following are satisfied:

1. Contact surfaces are clean, free of laitance, and intentionally roughened to full amplitude of approximately $\frac{1}{4}$ inch (6.4 mm).
2. Minimum ties are provided in accordance with ACI 318 Section 17.6.
3. Web members are designed to resist total vertical shear, and

4. All shear reinforcement is fully anchored into all
interconnected elements.

17.5.1.2 - If any of the requirements of ACI 318, Section 17.5.1.1, is not satisfied, horizontal shear shall be
investigated in accordance with ACI 318, Section 17.5.3 or 17.5.4.

1905A.1.13 ACI 318, Section 18.2.3. Modify ACI 318 Section 18.2.3 by adding the following:

For prestressed concrete members with recessed or
dapped ends, an analysis of the connections shall be made
in accordance with procedures given in PCI Design Handbook, 7th Edition.

1905A.1.14 ACI 318 Section 18.2.4. Modify ACI 318, Section 18.2.4, by adding the following:

Where prestressed concrete elements are restrained
from movement, an analysis of the stresses in the pre-
stressed elements and loads in the adjoining structural sys-
tem induced by the above-described effects shall be made
in accordance with PCI Design Handbook, 7th Edition.

1905A.1.15 ACI 318, Section 18.2. Add Section 18.2.7 to ACI 318 as follows:

18.2.7 – Span to depth ratio. Span to depth ratios for
continuous prestressed concrete members shall not
exceed the following, except when calculations of
deflections prove that greater values may be used with-
out adverse effects

| | |
|---------------------------------|-----------|
| <u>Beams.....</u> | <u>30</u> |
| <u>One-way slabs.....</u> | <u>40</u> |
| <u>Two-way floor slabs.....</u> | <u>40</u> |
| <u>Two-way roof slabs.....</u> | <u>44</u> |

These ratios should be decreased for special condi-
tions such as heavy loads and simple spans.

Maximum deflection criteria shall be in accordance
with ACI 318 Section 9.5

1905A.1.16. (Chapter 19, Section 1905.1.3) **ACI 318, Section 21.4.** [DSA-SS] Modify ACI 318, Section 21.4, by modifying Section 21.4.2 and adding Section 21.4.2.1 as follows:

21.4.2 In connections between wall panels, yielding
shall be restricted to steel elements or reinforcement.
In connections between wall panels and the foundation,
they shall be designed per Section 1616A.1.16.

21.4.2.1 – Connections that are designed to yield shall
be capable of maintaining 80 percent of their design
strength at the deformation induced by the design dis-
placement or shall use Type 2 mechanical splices.

1905A.1.17 ACI 318, Section 21.9.2.2. Modify ACI 318, Section 21.9.2.2 by adding the following:

Where boundary members are not required by ACI 318
Section 21.9.6, minimum reinforcement parallel to the
edges of all structural walls and the boundaries of all
openings shall consist of twice the cross-sectional area of
the minimum shear reinforcement required per lineal foot

of wall. Horizontal extent of boundary element shall be per ACI 318 Section 21.9.6.4 (a) & (b).

1905A.1.18 ACI 318, Section 21.9.4. Modify ACI 318 by adding Section 21.9.4.6 as follows:

21.9.4.6 – Walls and portions of walls with $P_u > 0.35P_o$ shall not be considered to contribute to the calculated strength of the structure for resisting earthquake-induced forces. Such walls shall conform to the requirements of ACI 318 Section 21.13.

1905A.1.19 ACI 318, Section 21.11.4. Modify ACI 318 Section 21.11.4 by adding the following:

Collector and boundary elements in topping slabs placed over precast floor and roof elements shall not be less than 3 inches (76 mm) or $6 d_b$ thick, where d_b is the diameter of the largest reinforcement in the topping slab.

1905A.1.20 ACI 318, Section 21.11.7. Modify ACI 318 Section 21.11.7 by adding Section 21.11.7.7 as follows:

21.11.7.7 – Where boundary members are not required by ACI 318 Section 21.11.7.5, minimum reinforcement parallel to the edges of all diaphragms and the boundaries of all openings shall consist of twice the cross-sectional area of the minimum shear reinforcement required per linear foot of diaphragm.

1905A.1.21 (Chapter 19, Section 1905.1.9) ACI 318, Section D.3.3. Modify ACI 318, Sections D.3.3.4.2, D.3.3.4.3(d) and D.3.3.5.2, to read as follows:

D.3.3.4.2 – Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with Section D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with Section D.3.3.4.4.

Exception:

Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7, Equation 12.11-1 or 12.14-10, and Section 1604A.8.2 of this code shall be deemed to satisfy Section D.3.3.4.3(d).

D.3.3.4.3(d) – The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_o . The anchor design tensile strength shall be calculated from Section D.3.3.4.4.

D.3.3.5.2 – Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with Section D.3.3.5.3. The anchor design shear strength for

resisting earthquake forces shall be determined in accordance with Section D.6.

Exceptions:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane design shear strength in accordance with Sections D.6.2 and D.6.3 need not be computed and Section D.3.3.5.3 shall be deemed to be satisfied, provided all of the following are met:

- 1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.
- 1.2. The maximum anchor nominal diameter is $5/8$ inch (16 mm).
- 1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).
- 1.4. Anchor bolts are located a minimum of $1\frac{3}{4}$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.
- 1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.
- 1.6. The sill plate is 2-inch or 3-inch nominal thickness.

2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of light-frame construction to foundations or foundation stem walls the in-plane design shear strength in accordance with Sections D.6.2 and D.6.3 need not be computed and Section D.3.3.5.3 shall be deemed to be satisfied, provided all of the following are met:

- 2.1. The maximum anchor nominal diameter is $5/8$ inch (16 mm).
- 2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).
- 2.3. Anchors are located a minimum of $1\frac{3}{4}$ inches (45 mm) from the edge of the concrete parallel to the length of the track.
- 2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.

2.5. The track is 33 to 68 mil designation thickness.

Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete shall be permitted to be determined in accordance with AISI S100, Section E3.3.1.

3. In light-frame construction, bearing or non-bearing walls, shear strength of concrete anchors less than or equal to $\frac{5}{8}$ inch (16 mm) in diameter of sill plate or track to foundation or foundation stem wall need not satisfy Section D.3.3.5.3 (a) through (c) when the design strength of the anchors is determined in accordance with Section D.6.2.1(c).

SECTION 1906A STRUCTURAL PLAIN CONCRETE

Not permitted by OSHPD and DSA-SS

SECTION 1907A MINIMUM SLAB PROVISIONS

1907A.1 General. The thickness of concrete floor slabs supported directly on the ground shall not be less than $3\frac{1}{2}$ inches (89 mm). A 6-mil (0.006 inch; 0.15 mm) polyethylene vapor retarder with joints lapped not less than 6 inches (152 mm) shall be placed between the base course or subgrade and the concrete floor slab, or other approved equivalent methods or materials shall be used to retard vapor transmission through the floor slab.

Exception: A vapor retarder is not required:

1. For detached structures accessory to occupancies in Group R-3, such as garages, utility buildings or other unheated facilities.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m^2) and carports attached to occupancies in Group R-3.
3. For buildings of other occupancies where migration of moisture through the slab from below will not be detrimental to the intended occupancy of the building.
4. For driveways, walks, patios and other flatwork which will not be enclosed at a later date.
5. Where approved based on local site conditions.

SECTION 1908A ANCHORAGE TO CONCRETE— ALLOWABLE STRESS DESIGN

1908A.1 Scope. The provisions of this section shall govern the allowable stress design of headed bolts and headed stud anchors cast in normal-weight concrete for purposes of transmitting structural loads from one connected element to the other. These provisions do not apply to anchors installed in hardened concrete or where load combinations include earth-

quake loads or effects. The bearing area of headed anchors shall be not less than one and one-half times the shank area. Where strength design is used, or where load combinations include earthquake loads or effects, the design strength of anchors shall be determined in accordance with Section 1909A. Bolts shall conform to ASTM A 307 or an approved equivalent.

1908A.1.1 Power actuated fasteners. Power actuated fasteners qualified in accordance with ICC-ES AC 70 shall be deemed to satisfy the requirements of this section.

Power actuated fasteners shall be permitted in seismic shear for components exempt from permit requirements by Section 1616A.1.18 of this code and for interior nonbearing non-shear wall partitions. Power actuated fastener shall not be used to anchor exterior cladding or curtain wall systems.

1908A.2 Allowable service load. The allowable service load for headed anchors in shear or tension shall be as indicated in Table 1908A.2. Where anchors are subject to combined shear and tension, the following relationship shall be satisfied:

$$(P_s / P_t)^{5/3} + (V_s / V_t)^{5/3} \leq 1 \quad (\text{Equation 19A-1})$$

where:

P_s = Applied tension service load, pounds (N).

P_t = Allowable tension service load from Table 1908A.2, pounds (N).

V_s = Applied shear service load, pounds (N).

V_t = Allowable shear service load from Table 1908A.2, pounds (N).

1908A.3 Required edge distance and spacing. The allowable service loads in tension and shear specified in Table 1908A.2 are for the edge distance and spacing specified. The edge distance and spacing are permitted to be reduced to 50 percent of the values specified with an equal reduction in allowable service load. Where edge distance and spacing are reduced less than 50 percent, the allowable service load shall be determined by linear interpolation.

1908A.4 Increase in allowable load. Increase of the values in Table 1908A.2 by one-third is permitted where the provisions of Section 1605A.3.2 permit an increase in allowable stress for wind loading.

1908A.5 Increase for special inspection. Where special inspection is provided for the installation of anchors, a 100-percent increase in the allowable tension values of Table 1908A.2 is permitted. No increase in shear value is permitted.

SECTION 1909A ANCHORAGE TO CONCRETE— STRENGTH DESIGN

1909A.1 Scope. The provisions of this section shall govern the strength design of anchors installed in concrete for purposes of transmitting structural loads from one connected element to the other. Headed bolts, headed studs and hooked (J- or L-) bolts cast in concrete and expansion anchors and undercut anchors installed in hardened concrete shall be designed in accordance with Appendix D of ACI 318 as mod-

**TABLE 1908A.2
ALLOWABLE SERVICE LOAD ON EMBEDDED BOLTS (pounds)**

| BOLT DIAMETER (inches) | MINIMUM EMBEDMENT (inches) | EDGE DISTANCE (inches) | SPACING (inches) | MINIMUM CONCRETE STRENGTH (psi) | | | |
|------------------------|----------------------------|------------------------|------------------|---------------------------------|-------|----------------|-------|
| | | | | $f'_c = 2,500$ | | $f'_c = 3,000$ | |
| | | | | Tension | Shear | Tension | Shear |
| $\frac{1}{4}$ | $2\frac{1}{2}$ | $1\frac{1}{2}$ | 3 | 200 | 500 | 200 | 500 |
| $\frac{3}{8}$ | 3 | $2\frac{1}{4}$ | $4\frac{1}{2}$ | 500 | 1,100 | 500 | 1,100 |
| $\frac{1}{2}$ | 4 | 3 | 6 | 950 | 1,250 | 950 | 1,250 |
| | 4 | 5 | 6 | 1,450 | 1,600 | 1,500 | 1,650 |
| $\frac{5}{8}$ | $4\frac{1}{2}$ | $3\frac{3}{4}$ | $7\frac{1}{2}$ | 1,500 | 2,750 | 1,500 | 2,750 |
| | $4\frac{1}{2}$ | $6\frac{1}{4}$ | $7\frac{1}{2}$ | 2,125 | 2,950 | 2,200 | 3,000 |
| $\frac{3}{4}$ | 5 | $4\frac{1}{2}$ | 9 | 2,250 | 3,250 | 2,250 | 3,560 |
| | 5 | $7\frac{1}{2}$ | 9 | 2,825 | 4,275 | 2,950 | 4,300 |
| $\frac{7}{8}$ | 6 | $5\frac{1}{4}$ | $10\frac{1}{2}$ | 2,550 | 3,700 | 2,550 | 4,050 |
| 1 | 7 | 6 | 12 | 3,050 | 4,125 | 3,250 | 4,500 |
| $1\frac{1}{8}$ | 8 | $6\frac{3}{4}$ | $13\frac{1}{2}$ | 3,400 | 4,750 | 3,400 | 4,750 |
| $1\frac{1}{4}$ | 9 | $7\frac{1}{2}$ | 15 | 4,000 | 5,800 | 4,000 | 5,800 |

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa, 1 pound = 4.45 N.

ified by Section 1905A.1.21, provided they are within the scope of Appendix D.

The strength design of anchors that are not within the scope of Appendix D of ACI 318, and as amended in Section 1905A.1.21, shall be in accordance with an approved procedure.

1909A.1.1 Specialty inserts. Specialty inserts, including cast-in-place specialty inserts, tested in accordance with ICC-ES AC 193 shall be deemed to satisfy the requirements of this section.

SECTION 1910A SHOTCRETE

1910A.1 General. Shotcrete is mortar or concrete that is pneumatically projected at high velocity onto a surface. Except as specified in this section, shotcrete shall conform to the requirements of this chapter for reinforced concrete and the provisions of ACI 506. The specified compressive strength of shotcrete shall not be less than 3,000 psi (20.69 MPa).

Concrete or masonry to receive shotcrete shall have the entire surface thoroughly cleaned and roughened by sand blasting, and just prior to receiving shotcrete, shall be thoroughly cleaned of all debris, dirt and dust. Concrete and masonry shall be wetted before shotcrete is deposited, but not so wet as to overcome suction. Sand for sand blasting shall be clean, sharp and uniform in size, with no particles that will pass a 50-mesh screen.

1910A.2 Proportions and materials. Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in finished in-place hardened shotcrete meeting the strength requirements of this code.

1910A.3 Aggregate. Coarse aggregate, if used, shall not exceed $\frac{3}{4}$ inch (19.1 mm).

For shear walls, when total rebar in any direction is more than $0.31 \text{ in}^2 / \text{ft.}$ or rebar size is larger than # 5, shotcrete shall conform to coarse aggregate grading No. 2 per Table 1.1 of ACI 506.

1910A.4 Reinforcement. Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1913A.4.1 through 1913A.4.4.

1910A.4.1 Size. The maximum size of reinforcement shall be No. 5 bars unless it is demonstrated by preconstruction tests that adequate encasement of larger bars will be achieved.

1910A.4.2 Clearance. When No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of $2\frac{1}{2}$ inches (64 mm). When bars larger than No. 5 are permitted, there shall be a minimum clearance between parallel bars equal to six diameters of the bars used. When two curtains of steel are provided, the curtain nearer the nozzle shall have a minimum spacing equal to 12 bar diameters and the remaining curtain shall have a minimum spacing of six bar diameters.

Exception: Subject to the approval of the building official, required clearances shall be reduced where it is demonstrated by preconstruction tests that adequate encasement of the bars used in the design will be achieved.

1910A.4.3 Splices. Lap splices of reinforcing bars shall utilize the noncontact lap splice method with a minimum clearance of 2 inches (51 mm) between bars. The use of contact lap splices necessary for support of the reinforcing is permitted when approved by the building official, based on satisfactory preconstruction tests that show that adequate encasement of the bars will be achieved, and provided that the splice is oriented so that a plane through the center of the spliced bars is perpendicular to the surface of the shotcrete.

1910A.4.4 Spirally tied columns. Shotcrete shall not be applied to spirally tied columns.

> **1910A.5 Preconstruction tests.** A test panel shall be shot, cured, cored or sawn, examined and tested prior to commencement of the project. The sample panel shall be representative of the project and simulate job conditions as closely as possible. The panel thickness and reinforcing shall reproduce the thickest and most congested area specified in the structural design. It shall be shot at the same angle, using the same nozzleman and with the same concrete mix design that will be used on the project. The equipment used in preconstruction testing shall be the same equipment used in the work requiring such testing, unless substitute equipment is approved by the building official.

1910A.6 Rebound. Any rebound or accumulated loose aggregate shall be removed from the surfaces to be covered prior to placing the initial or any succeeding layers of shotcrete. Rebound shall not be used as aggregate.

1910A.7 Joints. Except where permitted herein, unfinished work shall not be allowed to stand for more than 30 minutes unless edges are sloped to a thin edge. For structural elements that will be under compression and for construction joints shown on the approved construction documents, square joints are permitted. Before placing additional material adjacent to previously applied work, sloping and square edges shall be cleaned and wetted.

The film of laitance which forms on the surface of the shotcrete shall be removed within approximately two hours after application by brushing with a stiff broom. If this film is not removed within two hours, it shall be removed by thorough wire brushing or sand blasting. Construction joints over eight hours old shall be thoroughly cleaned with air and water prior to receiving shotcrete.

1910A.8 Damage. In-place shotcrete that exhibits sags, sloughs, segregation, honeycombing, sand pockets or other obvious defects shall be removed and replaced. Shotcrete above sags and sloughs shall be removed and replaced while still plastic.

1910A.9 Curing. During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.

1910A.9.1 Initial curing. Shotcrete shall be kept continuously moist for 24 hours after shotcreting is complete or shall be sealed with an approved curing compound.

1910A.9.2 Final curing. Final curing shall continue for seven days after shotcreting, or for three days if high-early-strength cement is used, or until the specified strength is obtained. Final curing shall consist of the initial curing process or the shotcrete shall be covered with an approved moisture-retaining cover.

1910A.9.3 Natural curing. Natural curing shall not be used in lieu of that specified in this section unless the relative humidity remains at or above 85 percent, and is authorized by the registered design professional and approved by the building official.

1910A.10 Strength tests. Strength tests for shotcrete shall be made in accordance with ASTM standards by an approved agency on specimens that are representative of the work and which have been water soaked for at least 24 hours prior to testing. When the maximum-size aggregate is larger than $\frac{3}{8}$ inch (9.5 mm), specimens shall consist of not less than three 3-inch-diameter (76 mm) cores or 3-inch (76 mm) cubes. When the maximum-size aggregate is $\frac{3}{8}$ inch (9.5 mm) or smaller, specimens shall consist of not less than 2-inch-diameter (51 mm) cores or 2-inch (51 mm) cubes.

1910A.10.1 Sampling. Specimens shall be taken from the in-place work or from test panels, and shall be taken at least once each shift, but not less than one for each 50 cubic yards (38.2 m³) of shotcrete.

1910A.10.2 Panel criteria. When the maximum-size aggregate is larger than $\frac{3}{8}$ inch (9.5 mm), the test panels shall have minimum dimensions of 18 inches by 18 inches (457 mm by 457 mm). When the maximum size aggregate is $\frac{3}{8}$ inch (9.5 mm) or smaller, the test panels shall have minimum dimensions of 12 inches by 12 inches (305 mm by 305 mm). Panels shall be shot in the same position as the work, during the course of the work and by the nozzlemen doing the work. The conditions under which the panels are cured shall be the same as the work. *Approval from the enforcement agency shall be obtained prior to performing the test panel method.*

1910A.11 Forms and ground wires for shotcrete. Forms for shotcrete shall be substantial and rigid. Forms shall be built and placed so as to permit the escape of air and rebound.

Adequate ground wires, which are to be used as screeds, shall be placed to establish the thickness, surface planes and form of the shotcrete work. All surfaces shall be rodded to these wires.

1910A.12 Placing. Shotcrete shall be placed in accordance with ACI 506.

SECTION 1911A REINFORCED GYPSUM CONCRETE

1911A.1 General. Reinforced gypsum concrete shall comply with the requirements of ASTM C 317 and ASTM C 956. *Reinforced gypsum concrete shall be considered as an alternative system.*

1911A.2 Minimum thickness. The minimum thickness of reinforced gypsum concrete shall be 2 inches (51 mm) except the minimum required thickness shall be reduced to $1\frac{1}{2}$ inches (38 mm), provided the following conditions are satisfied:

1. The overall thickness, including the formboard, is not less than 2 inches (51 mm).
2. The clear span of the gypsum concrete between supports does not exceed 33 inches (838 mm).
3. Diaphragm action is not required.
4. The design live load does not exceed 40 pounds per square foot (psf) (1915A Pa).

SECTION 1912A CONCRETE-FILLED PIPE COLUMNS

1912A.1 General. Concrete-filled pipe columns shall be manufactured from standard, extra-strong or double-extra-strong steel pipe or tubing that is filled with concrete so placed and manipulated as to secure maximum density and to ensure complete filling of the pipe without voids.

1912A.2 Design. The safe supporting capacity of concrete-filled pipe columns shall be computed in accordance with the approved rules or as determined by a test.

1912A.3 Connections. Caps, base plates and connections shall be of approved types and shall be positively attached to the shell and anchored to the concrete core. Welding of brackets without mechanical anchorage shall be prohibited. Where the pipe is slotted to accommodate webs of brackets or other connections, the integrity of the shell shall be restored by welding to ensure hooping action of the composite section.

1912A.4 Reinforcement. To increase the safe load-supporting capacity of concrete-filled pipe columns, the steel reinforcement shall be in the form of rods, structural shapes or pipe embedded in the concrete core with sufficient clearance to ensure the composite action of the section, but not nearer than 1 inch (25 mm) to the exterior steel shell. Structural shapes used as reinforcement shall be milled to ensure bearing on cap and base plates.

1912A.5 Fire-resistance-rating protection. Pipe columns shall be of such size or so protected as to develop the required fire-resistance ratings specified in Table 601. Where an outer steel shell is used to enclose the fire protective covering, the shell shall not be included in the calculations for strength of the column section. The minimum diameter of pipe columns shall be 4 inches (102 mm) except that in structures of Type V construction not exceeding three stories above grade plane or 40 feet (12192 mm) in building height, pipe columns used in basements and as secondary steel members shall have a minimum diameter of 3 inches (76 mm).

1912A.6 Approvals. Details of column connections and splices shall be shop fabricated by approved methods and shall be approved only after tests in accordance with the approved rules. Shop-fabricated concrete-filled pipe columns shall be inspected by the building official or by an approved representative of the manufacturer at the plant.

SECTION 1913A CONCRETE, REINFORCEMENT AND ANCHOR TESTING

1913A.1 Cementitious material. The concrete supplier shall furnish to the enforcement agency certification that the cement proposed for use on the project has been manufactured and tested in compliance with the requirements of ASTM C 150 for portland cement and ASTM C 595 or ASTM C 1157 for blended hydraulic cement, whichever is applicable. When a mineral admixture or ground granulated blast-furnace slag is proposed for use, the concrete supplier shall furnish to the enforcement agency certification that they have been manufactured and tested in compliance with ASTM C 618 or ASTM C 989, whichever is applicable. The concrete

producer shall provide copies of the cementitious material supplier's Certificate of Compliance that represents the materials used by date of shipment for concrete. Cementitious materials without Certification of Compliance shall not be used.

1913A.2 Tests of reinforcing bars. Where samples are taken from bundles as delivered from the mill, with the bundles identified as to heat number and provided the mill analyses accompany the report, one tensile test and one bend test shall be made from a specimen from each 10 tons (9080 kg) or fraction thereof of each size of reinforcing steel.

Where positive identification of the heat number cannot be made or where random samples are to be taken, one series of tests shall be made from each 2 1/2 tons (2270 kg) or fraction thereof of each size of reinforcing steel.

Tests of reinforcing bars may be waived by the structural engineer with the approval of the Building Official for one-story buildings provided certified mill test reports are provided for each shipment of such reinforcement.

1913A.3 Tests for prestressing steel and anchorage. All wires or bars of each size from each mill heat and all strands from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each lot can be accurately identified at the jobsite. Each lot of tendon and anchorage assemblies and bar couplers to be installed shall be likewise identified.

The following samples of materials and tendons selected by the engineer or the designated testing laboratory from the prestressing steel at the plant or jobsite shall be furnished by the contractor and tested by an approved independent testing agency:

1. For wire, strand or bars, 7-foot-long (2134 mm) samples shall be taken of the coil of wire or strand reel or rods. A minimum of one random sample per 5,000 pounds (2270 kg) of each heat or lot used on the job shall be selected.
2. For prefabricated prestressing tendons other than bars, one completely fabricated tendon 10 feet (3048 mm) in length between grips with anchorage assembly at one end shall be furnished for each size and type of tendon and anchorage assembly.

Variations of the bearing plate size need not be considered.

The anchorages of unbonded tendons shall develop at least 95 percent of the minimum specified ultimate strength of the pre-stressing steel. The total elongation of the tendon under ultimate load shall not be less than 2 percent measured in a minimum gage length of 10 feet (3048 mm).

Anchorage of bonded tendons shall develop at least 90 percent of the minimum specified strength of the prestressing steel tested in an unbonded state. All couplings shall develop at least 95 percent of the minimum specified strength of the prestressing steel and shall not reduce the elongation at rupture below the requirements of the tendon itself.

3. If the prestressing tendon is a bar, one 7-foot (2134 mm) length complete with one end anchorage shall be furnished and, in addition, if couplers are to be used with the bar, two 4-foot (1219 mm) lengths of bar fabricated to fit and equipped with one coupler shall be furnished.
4. Mill tests of materials used for end anchorages shall be furnished. In addition, at least one Brinnell hardness test shall be made of each thickness of bearing plate.

1913A.4 Composite construction cores. Cores of the completed composite concrete construction shall be taken to demonstrate the shear strength along the contact surfaces. The cores shall be tested when the cast-in-place concrete is approximately 28 days old and shall be tested by a shear loading parallel to the joint between the precast concrete and the cast-in-place concrete. The minimum unit shear strength of the contact surface area of the core shall not be less than 100 psi (689 kPa).

At least one core shall be taken from each building for each 5,000 square feet (465m^2) of area of composite concrete construction and not less than three cores shall be taken from each project. The architect or structural engineer in responsible charge of the project or his or her representative shall designate the location for sampling.

1913A.5 Tests of shotcrete. Testing of shotcrete shall follow the provisions of Section 1910A and the general requirements of ACI 318, Section 5.6.

1913A.6 Gypsum field tests. Field tests shall be made during construction to verify gypsum strength. One sample consisting of three specimens shall be made for each 5,000 square feet (465 m^2) or fraction thereof of all gypsum poured, but not less than one sample shall be taken from each half day's pour.

1913A.7 Tests for post-installed anchors in concrete. When post-installed anchors are used in lieu of cast-in-place bolts, the installation verification test loads, frequency, and acceptance criteria shall be in accordance with this section.

1913A.7.1 General. Test loads or torques and acceptance criteria shall be shown on the construction documents.

If any anchor fails testing, all anchors of the same type shall be tested, which are installed by the same trade, not previously tested until twenty (20) consecutive anchors pass, then resume the initial test frequency.

1913A.7.2 Test loads. Required test loads shall be determined by one of the following methods:

1. Twice the maximum allowable tension load or one and a quarter ($1\frac{1}{4}$) times the maximum design strength of anchors as provided in an approved test report using criteria adopted in this code or determined in accordance with Appendix D of ACI 318.

Tension test load need not exceed 80 percent of the nominal yield strength of the anchor element ($= 0.8 A_{se} f_{ya}$).

2. The manufacturer's recommended installation torque based on approved test report using criteria adopted in this code.

1913A.7.3 Test frequency. When post-installed anchors are used for sill plate bolting applications, 10 percent of the anchors shall be tested.

When post-installed anchors are used for other structural applications, all such anchors shall be tested.

When post-installed anchors are used for nonstructural applications such as equipment anchorage, 50 percent or alternate bolts in a group, including at least one-half the anchors in each group, shall be tested.

The testing of the post-installed anchors shall be done in the presence of the special inspector and a report of the test results shall be submitted to the enforcement agency.

Exceptions:

1. Undercut anchors that allow visual confirmation of full set shall not require testing.
2. Where the factored design tension on anchors is less than 100 lbs and those anchors are clearly noted on the approved construction documents, only 10 percent of those anchors shall be tested.
3. Where adhesive anchor systems are used to install reinforcing dowel bars in hardened concrete, only 25 percent of the dowels shall be tested if all of the following conditions are met:
 - a. The dowels are used exclusively to transmit shear forces across joints between existing and new concrete.
 - b. The number of dowels in any one member equals or exceeds 12.
 - c. The dowels are uniformly distributed across seismic force resisting members (such as shear walls, collectors and diaphragms).

Anchors to be tested shall be selected at random by the special inspector/inspector of record (IOR).

4. Testing of shear dowels across cold joints in slabs on grade, where the slab is not part of the lateral force-resisting system shall not be required.
5. Testing is not required for power actuated fasteners used to attach tracks of interior non-shear wall partitions for shear only, where there are at least three fasteners per segment of track.

1913A.7.4 Test acceptance criteria. Acceptance criteria for post-installed anchors shall be based on approved test report using criteria adopted in this code. Field test shall satisfy following minimum requirements.

1. Hydraulic ram method:

Anchors tested with a hydraulic jack or spring loaded devices shall maintain the test load for a minimum of 15 seconds and shall exhibit no discernible movement during the tension test, e.g., as evidenced by loosening of the washer under the nut.

For adhesive anchors, where other than bond is being tested, the testing device shall not restrict the

concrete shear cone type failure mechanism from occurring.

2. Torque wrench method:

Anchors tested with a calibrated torque wrench must attain the specified torque within $\frac{1}{2}$ turn of the nut.

Exceptions:

- a. *Wedge or sleeve type:*

One-quarter ($\frac{1}{4}$) turn of the nut for a $\frac{3}{8}$ in. sleeve anchor only.

- b. *Threaded type:*

One-quarter ($\frac{1}{4}$) turn of the screw after initial seating of the screw head.

1913A.7.5 Testing procedure. Test procedure shall be as permitted by an approved test report using criteria adopted in this code. Torque controlled post-installed anchors shall be permitted to be tested using torque based on approved test report using criteria adopted in this code. All other post-installed anchors shall be tension tested. Manufacturer's recommendation for testing may be approved by the enforcement agency, based on an approved test report using criteria adopted in this code.

SECTION 1914A EXISTING CONCRETE STRUCTURES

1914A.1. Existing concrete structures.

The structural use of existing concrete with a core strength less than 1,500 psi (10.3 MPa) is not permitted in rehabilitation work.

For existing concrete structures, sufficient cores shall be taken at representative locations throughout the structure, as designated by the architect or structural engineer, so that knowledge will be had of the in-place strength of the concrete. At least three cores shall be taken from each building for each 4,000 square feet (372 m^2) of floor area, or fraction thereof. Cores shall be at least 4 inches (102 mm) in diameter. Cores as small as 2.75 inches (70 mm) in diameter may be allowed by the enforcement agency when reinforcement is closely spaced and the coarse aggregate does not exceed $\frac{3}{4}$ inch (19 mm).

1914A.2 Crack repair by epoxy injection. Crack repair of concrete and masonry member by epoxy injection, shall conform to all requirements of ACI 503.7.

1914A.3 Concrete strengthening by externally bonded fiber reinforced polymer (FRP). Design and construction of externally bonded FRP systems for strengthening concrete structures shall be in accordance with ACI 440.2R.

Exceptions:

1. *Near-Surface Mounted (NSM) FRP bars shall not be permitted.*
2. *Strengthening of shear walls and diaphragms (including chords and collectors) shall be considered as an alternative system.*

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 20 – ALUMINUM

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | X | X | | | | | | X | X | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | X | X | X | | | X | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | X | X | X | | | X | | | | | | | | |
| 2003 | | | | | | | | | | | | | | | | | | | | |

CHAPTER 20

ALUMINUM

SECTION 2001

GENERAL

2001.1 Scope. This chapter shall govern the quality, design, fabrication and erection of aluminum.

SECTION 2002

MATERIALS

2002.1 General. Aluminum used for structural purposes in buildings and structures shall comply with AA ASM 35 and AA ADM 1. The nominal loads shall be the minimum design loads required by Chapter 16.

SECTION 2003

INSPECTION

2003.1 Inspection. [DSA-SS, DSA-SS/CC, OSHPD 1 & 4]
Inspection of aluminum shall be required in accordance with the requirements for steel in Chapter 17A.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 21 – MASONRY

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | X | X | | | | | | X | X | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | X | | | | | | | | | | | |
| Adopt only those sections that are listed below | | X | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 2101.1.1 | | | | | | | | | X | | | | | | | | | | | |
| 2101.1.2 | | | | | | | | | X | | | | | | | | | | | |
| 2101.1.3 | | | | | | | | | X | | | | | | | | | | | |
| 2101.1.4 | | | | | | | | | X | | | | | | | | | | | |
| 2109.1.1 | | | | | | | | | | | | | | | | | | | | |
| 2113.9.2 | | X | | | | | | | | | | | | | | | | | | |
| 2114.1 | | | | | | | | | X | | | | | | | | | | | |
| 2114.2 | | | | | | | | | X | | | | | | | | | | | |
| 2114.3 | | | | | | | | | X | | | | | | | | | | | |
| 2114.4 | | | | | | | | | X | | | | | | | | | | | |
| 2114.5 | | | | | | | | | X | | | | | | | | | | | |
| 2114.6.1 | | | | | | | | | X | | | | | | | | | | | |
| > 2114.7 | | | | | | | | | X | | | | | | | | | | | |
| > 2114.8 | | | | | | | | | X | | | | | | | | | | | |
| > 2114.9.1 | | | | | | | | | X | | | | | | | | | | | |
| > 2114.9.2.1 | | | | | | | | | X | | | | | | | | | | | |
| 2114.9.3 | | | | | | | | | X | | | | | | | | | | | |
| 2114.10 | | | | | | | | | X | | | | | | | | | | | |
| > 2114.11.1 | | | | | | | | | X | | | | | | | | | | | |
| > 2114.11.2 | | | | | | | | | X | | | | | | | | | | | |
| 2114.12 | | | | | | | | | X | | | | | | | | | | | |
| 2114.13 | | | | | | | | | X | | | | | | | | | | | |
| 2114.14 | | | | | | | | | X | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 21

MASONRY

SECTION 2101 GENERAL

2101.1 Scope. This chapter shall govern the materials, design, construction and quality of masonry.

2101.1.1 Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC)

Community college buildings regulated by the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC) as listed in Section 1.9.2.2.

2101.1.2 Amendments in this chapter. DSA-SS/CC adopts this chapter and all amendments.

Exception: Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC) amendments appear in this chapter preceded with the appropriate acronym, as follows:

[DSA-SS/CC] – For community college buildings listed in Section 1.9.2.2.

2101.1.3 Reference to other chapters. [DSA-SS/CC] Where reference within this chapter is made to sections in Chapters 17 and 18, the provisions in Chapters 17A and 18A respectively shall apply instead.

2101.1.4 Amendments. [DSA-SS/CC] See Section 2114 for additional requirements.

2101.2 Design methods. Masonry shall comply with the provisions of one of the following design methods in this chapter as well as the requirements of Sections 2101 through 2104. Masonry designed by the allowable stress design provisions of Section 2101.2.1, the strength design provisions of Section 2101.2.2, the prestressed masonry provisions of Section 2101.2.3, or the direct design requirements of Section 2101.2.7 shall comply with Section 2105.

2101.2.1 Allowable stress design. Masonry designed by the allowable stress design method shall comply with the provisions of Sections 2106 and 2107.

2101.2.2 Strength design. Masonry designed by the strength design method shall comply with the provisions of Sections 2106 and 2108, except that autoclaved aerated concrete (AAC) masonry shall comply with the provisions of Section 2106 and Chapters 1 and 8 of TMS 402/ACI 530/ASCE 5.

2101.2.3 Prestressed masonry. Prestressed masonry shall be designed in accordance with Chapters 1 and 4 of TMS 402/ACI 530/ASCE 5 and Section 2106. Special inspection during construction shall be provided as set forth in Section 1705.4.

2101.2.4 Empirical design. Masonry designed by the empirical design method shall comply with the provisions of Sections 2106 and 2109 or Chapter 5 of TMS 402/ACI 530/ASCE 5.

2101.2.5 Glass unit masonry. Glass unit masonry shall comply with the provisions of Section 2110 or Chapter 7 of TMS 402/ACI 530/ASCE 5.

2101.2.6 Masonry veneer. Masonry veneer shall comply with the provisions of Chapter 14 or Chapter 6 of TMS 402/ACI 530/ASCE 5.

2101.2.7 Direct design. Masonry designed by the direct design method shall comply with the provisions of TMS 403.

2101.3 Construction documents. The construction documents shall show all of the items required by this code including the following:

1. Specified size, grade, type and location of reinforcement, anchors and wall ties.
2. Reinforcing bars to be welded and welding procedure.
3. Size and location of structural elements.
4. Provisions for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature and moisture.
5. Loads used in the design of masonry.
6. Specified compressive strength of masonry at stated ages or stages of construction for which masonry is designed, except where specifically exempted by this code.
7. Details of anchorage of masonry to structural members, frames and other construction, including the type, size and location of connectors.
8. Size and permitted location of conduits, pipes and sleeves.
9. The minimum level of testing and inspection as defined in Chapter 17, or an itemized testing and inspection program that meets or exceeds the requirements of Chapter 17.

2101.3.1 Fireplace drawings. The construction documents shall describe in sufficient detail the location, size and construction of masonry fireplaces. The thickness and characteristics of materials and the clearances from walls, partitions and ceilings shall be indicated.

SECTION 2102 DEFINITIONS AND NOTATIONS

2102.1 General. The following terms are defined in Chapter 2:

AAC MASONRY.

ADOBE CONSTRUCTION.

Adobe, stabilized.

Adobe, unstabilized.

MASONRY

ANCHOR.

ARCHITECTURAL TERRA COTTA.

AREA.

Gross cross-sectional.

Net cross-sectional.

AUTOCLAVED AERATED CONCRETE (AAC).

BED JOINT.

BOND BEAM.

BRICK.

Calcium silicate (sand lime brick).

Clay or shale.

Concrete.

CAST STONE.

CELL.

CHIMNEY.

CHIMNEY TYPES.

High-heat appliance type.

Low-heat appliance type.

Masonry type.

Medium-heat appliance type.

CLEANOUT.

COLLAR JOINT.

COMPRESSIVE STRENGTH OF MASONRY.

DIMENSIONS.

Nominal.

Specified.

FIREPLACE.

FIREPLACE THROAT.

FOUNDATION PIER.

HEAD JOINT.

MASONRY.

Ashlar masonry.

Coursed ashlar.

Glass unit masonry.

Plain masonry.

Random ashlar.

Reinforced masonry.

Solid masonry.

Unreinforced (plain) masonry.

MASONRY UNIT.

Hollow.

Solid.

MORTAR.

MORTAR, SURFACE-BONDING.

PRESTRESSED MASONRY.

PRISM.

RUBBLE MASONRY.

Coursed rubble.

Random rubble.

Rough or ordinary rubble.

RUNNING BOND.

SHEAR WALL.

Detailed plain masonry shear wall.

Intermediate prestressed masonry shear wall.

Intermediate reinforced masonry shear wall.

Ordinary plain masonry shear wall.

Ordinary plain prestressed masonry shear wall.

Ordinary reinforced masonry shear wall.

Special prestressed masonry shear wall.

Special reinforced masonry shear wall.

SPECIFIED.

SPECIFIED COMPRESSIVE STRENGTH OF
MASONRY, f'_{m} .

STACK BOND.

STONE MASONRY.

Ashlar stone masonry.

Rubble stone masonry.

STRENGTH.

Design strength.

Nominal strength.

Required strength.

THIN-BED MORTAR.

TIE, WALL.

TILE, STRUCTURAL CLAY.

WALL.

Cavity wall.

Composite wall.

Dry-stacked, surface-bonded wall.

Masonry-bonded hollow wall.

Parapet wall.

WYTHER.

NOTATIONS.

d_b = Diameter of reinforcement, inches (mm).

F_s = Allowable tensile or compressive stress in
reinforcement, psi (MPa).

f_r = Modulus of rupture, psi (MPa).

- f'_{AAC} = Specified compressive strength of AAC masonry, the minimum compressive strength for a class of AAC masonry as specified in ASTM C 1386, psi (MPa).
- f'_{m} = Specified compressive strength of masonry at age of 28 days, psi (MPa).
- f'_{mi} = Specified compressive strength of masonry at the time of prestress transfer, psi (MPa).
- K = The lesser of the masonry cover, clear spacing between adjacent reinforcement, or five times d_b , inches (mm).
- L_s = Distance between supports, inches (mm).
- l_d = Required development length or lap length of reinforcement, inches (mm).
- P = The applied load at failure, pounds (N).
- S_t = Thickness of the test specimen measured parallel to the direction of load, inches (mm).
- S_w = Width of the test specimen measured parallel to the loading cylinder, inches (mm).

SECTION 2103 MASONRY CONSTRUCTION MATERIALS

2103.1 Concrete masonry units. Concrete masonry units shall conform to the following standards: ASTM C 55 for concrete brick; ASTM C 73 for calcium silicate face brick; ASTM C 90 for load-bearing concrete masonry units or ASTM C 744 for prefaced concrete and calcium silicate masonry units.

2103.2 Clay or shale masonry units. Clay or shale masonry units shall conform to the following standards: ASTM C 34 for structural clay load-bearing wall tile; ASTM C 56 for structural clay nonload-bearing wall tile; ASTM C 62 for building brick (solid masonry units made from clay or shale); ASTM C 1088 for solid units of thin veneer brick; ASTM C 126 for ceramic-glazed structural clay facing tile, facing brick and solid masonry units; ASTM C 212 for structural clay facing tile; ASTM C 216 for facing brick (solid masonry units made from clay or shale); ASTM C 652 for hollow brick (hollow masonry units made from clay or shale) or ASTM C 1405 for glazed brick (single-fired solid brick units).

Exception: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 or UL 263 and shall comply with the requirements of Table 602.

2103.3 AAC masonry. AAC masonry units shall conform to ASTM C 1386 for the strength class specified.

2103.4 Stone masonry units. Stone masonry units shall conform to the following standards: ASTM C 503 for marble building stone (exterior); ASTM C 568 for limestone building stone; ASTM C 615 for granite building stone; ASTM C 616 for sandstone building stone; or ASTM C 629 for slate building stone.

2103.5 Architectural cast stone. Architectural cast stone shall conform to ASTM C 1364.

2103.6 Ceramic tile. Ceramic tile shall be as defined in, and shall conform to the requirements of, ANSI A137.1.

2103.7 Glass unit masonry. Hollow glass units shall be partially evacuated and have a minimum average glass face thickness of $\frac{3}{16}$ inch (4.8 mm). Solid glass-block units shall be provided when required. The surfaces of units intended to be in contact with mortar shall be treated with a polyvinyl butyral coating or latex-based paint. Reclaimed units shall not be used.

2103.8 Second-hand units. Second-hand masonry units shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old mortar shall be cleaned from the unit before reuse.

2103.9 Mortar. Mortar for use in masonry construction shall conform to ASTM C 270 and Articles 2.1 and 2.6 A of TMS 602/ACI 530.1/ASCE 6, except for mortars listed in Sections 2103.10, 2103.11 and 2103.12. Type S or N mortar conforming to ASTM C 270 shall be used for glass unit masonry.

2103.10 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C 887. Surface bonding of concrete masonry units shall comply with ASTM C 946.

2103.11 Mortars for ceramic wall and floor tile. Portland cement mortars for installing ceramic wall and floor tile shall comply with ANSI A108.1A and ANSI A108.1B and be of the compositions indicated in Table 2103.11.

TABLE 2103.11
CERAMIC TILE MORTAR COMPOSITIONS

| LOCATION | MORTAR | COMPOSITION |
|----------|-------------------------------|---|
| Walls | Scratchcoat | 1 cement; $\frac{1}{5}$ hydrated lime; 4 dry or 5 damp sand |
| | Setting bed and leveling coat | 1 cement; $\frac{1}{2}$ hydrated lime; 5 damp sand to 1 cement 1 hydrated lime, 7 damp sand |
| Floors | Setting bed | 1 cement; $\frac{1}{10}$ hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand |
| Ceilings | Scratchcoat and sand bed | 1 cement; $\frac{1}{2}$ hydrated lime; $2\frac{1}{2}$ dry sand or 3 damp sand |

2103.11.1 Dry-set Portland cement mortars. Premixed prepared Portland cement mortars, which require only the addition of water and are used in the installation of ceramic tile, shall comply with ANSI A118.1. The shear bond strength for tile set in such mortar shall be as required in accordance with ANSI A118.1. Tile set in dry-set Portland cement mortar shall be installed in accordance with ANSI A108.5.

2103.11.2 Latex-modified Portland cement mortar. Latex-modified Portland cement thin-set mortars in which latex is added to dry-set mortar as a replacement for all or part of the gauging water that are used for the installation of ceramic tile shall comply with ANSI A118.4. Tile set in

latex-modified Portland cement shall be installed in accordance with ANSI A108.5.

2103.11.3 Epoxy mortar. Ceramic tile set and grouted with chemical-resistant epoxy shall comply with ANSI A118.3. Tile set and grouted with epoxy shall be installed in accordance with ANSI A108.6.

2103.11.4 Furan mortar and grout. Chemical-resistant furan mortar and grout that are used to install ceramic tile shall comply with ANSI A118.5. Tile set and grouted with furan shall be installed in accordance with ANSI A108.8.

2103.11.5 Modified epoxy-emulsion mortar and grout. Modified epoxy-emulsion mortar and grout that are used to install ceramic tile shall comply with ANSI A118.8. Tile set and grouted with modified epoxy-emulsion mortar and grout shall be installed in accordance with ANSI A108.9.

2103.11.6 Organic adhesives. Water-resistant organic adhesives used for the installation of ceramic tile shall comply with ANSI A136.1. The shear bond strength after water immersion shall not be less than 40 psi (275 kPa) for Type I adhesive and not less than 20 psi (138 kPa) for Type II adhesive when tested in accordance with ANSI A136.1. Tile set in organic adhesives shall be installed in accordance with ANSI A108.4.

2103.11.7 Portland cement grouts. Portland cement grouts used for the installation of ceramic tile shall comply with ANSI A118.6. Portland cement grouts for tile work shall be installed in accordance with ANSI A108.10.

2103.12 Mortar for AAC masonry. Thin-bed mortar for AAC masonry shall comply with Article 2.1 C.1 of TMS 602/ACI 530.1/ASCE 6. Mortar used for the leveling courses of AAC masonry shall comply with Article 2.1 C.2 of TMS 602/ACI 530.1/ASCE 6.

2103.13 Grout. Grout shall comply with Article 2.2 of TMS 602/ACI 530.1/ASCE 6.

2103.14 Metal reinforcement and accessories. Metal reinforcement and accessories shall conform to Article 2.4 of TMS 602/ACI 530.1/ASCE 6. Where unidentified reinforcement is approved for use, not less than three tension and three bending tests shall be made on representative specimens of the reinforcement from each shipment and grade of reinforcing steel proposed for use in the work.

SECTION 2104 CONSTRUCTION

2104.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104.1.1 through 2104.4 and with TMS 602/ACI 530.1/ASCE 6.

2104.1.1 Tolerances. Masonry, except masonry veneer, shall be constructed within the tolerances specified in TMS 602/ACI 530.1/ASCE 6.

2104.1.2 Placing mortar and units. Placement of mortar, grout, and clay, concrete, glass, and AAC masonry units shall comply with TMS 602/ACI 530.1/ASCE 6.

2104.1.3 Installation of wall ties. Wall ties shall be installed in accordance with TMS 602/ACI 530.1/ASCE 6.

2104.1.4 Chases and recesses. Chases and recesses shall be constructed as masonry units are laid. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on lintels.

2104.1.5 Lintels. The design for lintels shall be in accordance with the masonry design provisions of either Section 2107 or 2108.

2104.1.6 Support on wood. Masonry shall not be supported on wood girders or other forms of wood construction except as permitted in Section 2304.12.

2104.2 Corbeled masonry. Corbeled masonry shall comply with the requirements of Section 1.12 of TMS 402/ACI 530/ASCE 5.

2104.2.1 Molded cornices. Unless structural support and anchorage are provided to resist the overturning moment, the center of gravity of projecting masonry or molded cornices shall lie within the middle one-third of the supporting wall. Terra cotta and metal cornices shall be provided with a structural frame of approved noncombustible material anchored in an approved manner.

2104.3 Cold weather construction. The cold weather construction provisions of TMS 602/ACI 530.1/ASCE 6, Article 1.8 C, shall be implemented when the ambient temperature falls below 40°F (4°C).

2104.4 Hot weather construction. The hot weather construction provisions of TMS 602/ACI 530.1/ASCE 6, Article 1.8 D, shall be implemented when the ambient air temperature exceeds 100°F (37.8°C), or 90°F (32.2°C) with a wind velocity greater than 8 mph (12.9 km/hr).

SECTION 2105 QUALITY ASSURANCE

2105.1 General. A quality assurance program shall be used to ensure that the constructed masonry is in compliance with the construction documents.

The quality assurance program shall comply with the inspection and testing requirements of Chapter 17.

2105.2 Acceptance relative to strength requirements. Where required by Chapter 17, verification of the strength of masonry shall be in accordance with Sections 2105.2.1 and 2105.2.2.

2105.2.1 Compliance with f'_{m} and f'_{AAC} . Compressive strength of masonry shall be considered satisfactory if the compressive strength of each masonry wythe and grouted collar joint equals or exceeds the value of f'_{m} for clay and concrete masonry and f'_{AAC} for AAC masonry. For partially grouted clay and concrete masonry, the compressive strength of both the grouted and ungrouted masonry shall equal or exceed the applicable f'_{m} . At the time of prestress, the compressive strength of the masonry shall equal or exceed $f'_{m,p}$, which shall be less than or equal to f'_{m} .

2105.2.2 Determination of compressive strength. The compressive strength for each wythe shall be determined

by the unit strength method or by the prism test method as specified herein.

2105.2.2.1 Unit strength method. The determination of compressive strength by the unit strength method shall be in accordance with Section 2105.2.2.1.1 for clay masonry, Section 2105.2.2.1.2 for concrete masonry and Section 2105.2.2.1.3 for AAC masonry.

2105.2.2.1.1 Clay masonry. The compressive strength of masonry shall be determined based on the strength of the units and the type of mortar specified using Table 2105.2.2.1.1, provided:

1. Units are sampled and tested to verify compliance with ASTM C 62, ASTM C 216 or ASTM C 652.
2. Thickness of bed joints does not exceed $\frac{5}{8}$ inch (15.9 mm).
3. For grouted masonry, the grout meets one of the following requirements:
 - 3.1. Grout conforms to Article 2.2 of TMS 602/ACI 530.1/ASCE 6.
 - 3.2. Minimum grout compressive strength equals or exceeds f'_{m} , but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

TABLE 2105.2.2.1.1
COMPRESSIVE STRENGTH OF CLAY MASONRY

| NET AREA COMPRESSIVE STRENGTH OF CLAY MASONRY UNITS (psi) | | NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi) |
|---|---------------|--|
| Type M or S mortar | Type N mortar | |
| 1,700 | 2,100 | 1,000 |
| 3,350 | 4,150 | 1,500 |
| 4,950 | 6,200 | 2,000 |
| 6,600 | 8,250 | 2,500 |
| 8,250 | 10,300 | 3,000 |
| 9,900 | — | 3,500 |
| 11,500 | — | 4,000 |

For SI: 1 pound per square inch = 0.00689 MPa.

2105.2.2.1.2 Concrete masonry. The compressive strength of masonry shall be determined based on the strength of the unit and type of mortar specified using Table 2105.2.2.1.2, provided:

1. Units are sampled and tested to verify compliance with ASTM C 55 or ASTM C 90.
2. Thickness of bed joints does not exceed $\frac{5}{8}$ inch (15.9 mm).
3. For grouted masonry, the grout meets one of the following requirements:
 - 3.1. Grout conforms to Article 2.2 of TMS 602/ACI 530.1/ASCE 6.

3.2. Minimum grout compressive strength equals or exceeds f'_{m} , but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

TABLE 2105.2.2.1.2
COMPRESSIVE STRENGTH OF CONCRETE MASONRY

| NET AREA COMPRESSIVE STRENGTH OF CONCRETE MASONRY UNITS (psi) | | NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi) ^a |
|---|---------------|---|
| Type M or S mortar | Type N mortar | |
| 1,250 | 1,300 | 1,000 |
| 1,900 | 2,150 | 1,500 |
| 2,800 | 3,050 | 2,000 |
| 3,750 | 4,050 | 2,500 |
| 4,800 | 5,250 | 3,000 |

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa.

a. For units less than 4 inches in height, 85 percent of the values listed.

2105.2.2.1.3 AAC masonry. The compressive strength of AAC masonry shall be based on the strength of the AAC masonry unit only and the following shall be met:

1. Units conform to ASTM C 1386.
2. Thickness of bed joints does not exceed $\frac{1}{8}$ inch (3.2 mm).
3. For grouted masonry, the grout meets one of the following requirements:
 - 3.1. Grout conforms to Article 2.2 of TMS 602/ACI 530.1/ASCE 6.
 - 3.2. Minimum grout compressive strength equals or exceeds f'_{AAC} but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

2105.2.2.2 Prism test method. The determination of compressive strength by the prism test method shall be in accordance with Sections 2105.2.2.2.1 and 2105.2.2.2.2.

2105.2.2.2.1 General. The compressive strength of clay and concrete masonry shall be determined by the prism test method:

1. Where specified in the construction documents.
2. Where masonry does not meet the requirements for application of the unit strength method in Section 2105.2.2.1.

2105.2.2.2.2 Number of prisms per test. A prism test shall consist of three prisms constructed and tested in accordance with ASTM C 1314.

2105.3 Testing prisms from constructed masonry. When approved by the building official, acceptance of masonry that does not meet the requirements of Section 2105.2.2.1 or 2105.2.2.2 shall be permitted to be based on tests of prisms cut from the masonry construction in accordance with Sections 2105.3.1, 2105.3.2 and 2105.3.3.

2105.3.1 Prism sampling and removal. A set of three masonry prisms that are at least 28 days old shall be saw cut from the masonry for each 5,000 square feet (465 m^2) of the wall area that is in question but not less than one set of three masonry prisms for the project. The length, width and height dimensions of the prisms shall comply with the requirements of ASTM C 1314. Transporting, preparation and testing of prisms shall be in accordance with ASTM C 1314.

2105.3.2 Compressive strength calculations. The compressive strength of prisms shall be the value calculated in accordance ASTM C 1314, except that the net cross-sectional area of the prism shall be based on the net mortar bedded area.

2105.3.3 Compliance. Compliance with the requirement for the specified compressive strength of masonry, f'_{m} , shall be considered satisfied provided the modified compressive strength equals or exceeds the specified f'_{m} . Additional testing of specimens cut from locations in question shall be permitted.

SECTION 2106 SEISMIC DESIGN

2106.1 Seismic design requirements for masonry. Masonry structures and components shall comply with the requirements in Section 1.18 of TMS 402/ACI 530/ASCE 5 depending on the structure's seismic design category.

SECTION 2107 ALLOWABLE STRESS DESIGN

2107.1 General. The design of masonry structures using allowable stress design shall comply with Section 2106 and the requirements of Chapters 1 and 2 of TMS 402/ACI 530/ASCE 5 except as modified by Sections 2107.2 through 2107.4.

2107.2 TMS 402/ACI 530/ASCE 5, Section 2.1.8.7.1.1, lap splices. In lieu of Section 2.1.8.7.1.1, it shall be permitted to design lap splices in accordance with Section 2107.2.1.

2107.2.1 Lap splices. The minimum length of lap splices for reinforcing bars in tension or compression, l_d , shall be

$$l_d = 0.002d_b f_s \quad (\text{Equation 21-1})$$

For SI: $l_d = 0.29d_b f_s$

but not less than 12 inches (305 mm). In no case shall the length of the lapped splice be less than 40 bar diameters.

where:

d_b = Diameter of reinforcement, inches (mm).

f_s = Computed stress in reinforcement due to design loads, psi (MPa).

In regions of moment where the design tensile stresses in the reinforcement are greater than 80 percent of the allowable steel tension stress, F_s , the lap length of splices shall be increased not less than 50 percent of the minimum required length. Other equivalent means of stress transfer to accomplish the same 50 percent increase shall be permitted. Where epoxy coated bars are used, lap length shall be increased by 50 percent.

2107.3 TMS 402/ACI 530/ASCE 5, Section 2.1.8.7, splices of reinforcement. Modify Section 2.1.8.7 as follows:

2.1.8.7 Splices of reinforcement. Lap splices, welded splices or mechanical splices are permitted in accordance with the provisions of this section. All welding shall conform to AWS D1.4. Welded splices shall be of ASTM A 706 steel reinforcement. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section 2.1.8.7.3.

2107.4 TMS 402/ACI 530/ASCE 5, Section 2.3.7, maximum bar size. Add the following to Chapter 2:

2.3.7 Maximum bar size. The bar diameter shall not exceed one-eighth of the nominal wall thickness and shall not exceed one-quarter of the least dimension of the cell, course or collar joint in which it is placed.

SECTION 2108 STRENGTH DESIGN OF MASONRY

2108.1 General. The design of masonry structures using strength design shall comply with Section 2106 and the requirements of Chapters 1 and 3 of TMS 402/ACI 530/ASCE 5, except as modified by Sections 2108.2 through 2108.3.

Exception: AAC masonry shall comply with the requirements of Chapters 1 and 8 of TMS 402/ACI 530/ASCE 5.

2108.2 TMS 402/ACI 530/ASCE 5, Section 3.3.3.3 development. Modify the second paragraph of Section 3.3.3.3 as follows:

The required development length of reinforcement shall be determined by Equation (3-16), but shall not be less than 12 inches (305 mm) and need not be greater than $72 d_b$.

2108.3 TMS 402/ACI 530/ASCE 5, Section 3.3.3.4, splices. Modify items (c) and (d) of Section 3.3.3.4 as follows:

3.3.3.4 (c). A welded splice shall have the bars butted and welded to develop at least 125 percent of the yield strength, f_y , of the bar in tension or compression, as required. Welded splices shall be of ASTM A 706 steel reinforcement. Welded splices shall not be permitted in plastic hinge zones of intermediate or special reinforced walls or special moment frames of masonry.

3.3.3.4 (d). Mechanical splices shall be classified as Type 1 or 2 according to Section 21.2.6.1 of ACI 318. Type 1 mechanical splices shall not be used within a plastic hinge zone or within a beam-column joint of intermediate or special reinforced masonry shear walls or special moment frames. Type 2 mechanical splices are permitted in any location within a member.

SECTION 2109 EMPIRICAL DESIGN OF MASONRY

2109.1 General. Empirically designed masonry shall conform to the requirements of Chapter 5 of TMS 402/ACI 530/ASCE 5, except where otherwise noted in this section.

2109.1.1 Limitations. The use of empirical design of masonry shall be limited as noted in Section 5.1.2 of TMS 402/ACI 530/ASCE 5. The use of dry-stacked, surface-bonded masonry shall be prohibited in Risk Category IV structures. In buildings that exceed one or more of the limitations of Section 5.1.2 of TMS 402/ACI 530/ASCE 5, masonry shall be designed in accordance with the engineered design provisions of Section 2101.2.1, 2101.2.2 or 2101.2.3 or the foundation wall provisions of Section 1807.1.5.

Section 5.1.2.2 of TMS 402/ACI 530/ASCE 5 shall be modified as follows:

5.1.2.2 Wind – Empirical requirements shall not apply to the design or construction of masonry for buildings, parts of buildings, or other structures to be located in areas where V_{asq} as determined in accordance with Section 1609.3.1 of the *California Building Code* exceeds 110 mph.

2109.2 Surface-bonded walls. Dry-stacked, surface-bonded concrete masonry walls shall comply with the requirements of Chapter 5 of TMS 402/ACI 530/ASCE 5, except where otherwise noted in this section.

2109.2.1 Strength. Dry-stacked, surface-bonded concrete masonry walls shall be of adequate strength and proportions to support all superimposed loads without exceeding the allowable stresses listed in Table 2109.2.1. Allowable stresses not specified in Table 2109.2.1 shall comply with the requirements of TMS 402/ACI 530/ASCE 5.

**TABLE 2109.2.1
ALLOWABLE STRESS GROSS CROSS-SECTIONAL
AREA FOR DRY-STACKED, SURFACE-BONDED
CONCRETE MASONRY WALLS**

| DESCRIPTION | MAXIMUM ALLOWABLE STRESS (psi) |
|----------------------------|--------------------------------|
| Compression standard block | 45 |
| Flexural tension | |
| Horizontal span | 30 |
| Vertical span | 18 |
| Shear | 10 |

For SI: 1 pound per square inch = 0.006895 MPa.

2109.2.2 Construction. Construction of dry-stacked, surface-bonded masonry walls, including stacking and leveling of units, mixing and application of mortar and curing and protection shall comply with ASTM C 946.

2109.3 Adobe construction. Adobe construction shall comply with this section and shall be subject to the requirements of this code for Type V construction, Chapter 5 of TMS 402/ACI 530/ASCE 5, and this section.

2109.3.1 Unstabilized adobe. Unstabilized adobe shall comply with Sections 2109.3.1.1 through 2109.3.1.4.

2109.3.1.1 Compressive strength. Adobe units shall have an average compressive strength of 300 psi (2068 kPa) when tested in accordance with ASTM C 67. Five samples shall be tested and no individual unit is permitted to have a compressive strength of less than 250 psi (1724 kPa).

2109.3.1.2 Modulus of rupture. Adobe units shall have an average modulus of rupture of 50 psi (345 kPa) when tested in accordance with the following procedure. Five samples shall be tested and no individual unit shall have a modulus of rupture of less than 35 psi (241 kPa).

2109.3.1.2.1 Support conditions. A cured unit shall be simply supported by 2-inch-diameter (51 mm) cylindrical supports located 2 inches (51 mm) in from each end and extending the full width of the unit.

2109.3.1.2.2 Loading conditions. A 2-inch-diameter (51 mm) cylinder shall be placed at midspan parallel to the supports.

2109.3.1.2.3 Testing procedure. A vertical load shall be applied to the cylinder at the rate of 500 pounds per minute (37 N/s) until failure occurs.

2109.3.1.2.4 Modulus of rupture determination. The modulus of rupture shall be determined by the equation:

$$f_r = 3 PL_s / 2 S_w (S_t^2) \quad (\text{Equation 21-2})$$

where, for the purposes of this section only:

S_w = Width of the test specimen measured parallel to the loading cylinder, inches (mm).

f_r = Modulus of rupture, psi (MPa).

L_s = Distance between supports, inches (mm).

S_t = Thickness of the test specimen measured parallel to the direction of load, inches (mm).

P = The applied load at failure, pounds (N).

2109.3.1.3 Moisture content requirements. Adobe units shall have a moisture content not exceeding 4 percent by weight.

2109.3.1.4 Shrinkage cracks. Adobe units shall not contain more than three shrinkage cracks and any single shrinkage crack shall not exceed 3 inches (76 mm) in length or $\frac{1}{8}$ inch (3.2 mm) in width.

2109.3.2 Stabilized adobe. Stabilized adobe shall comply with Section 2109.3.1 for unstabilized adobe in addition to Sections 2109.3.2.1 and 2109.3.2.2.

2109.3.2.1 Soil requirements. Soil used for stabilized adobe units shall be chemically compatible with the stabilizing material.

2109.3.2.2 Absorption requirements. A 4-inch (102 mm) cube, cut from a stabilized adobe unit dried to a constant weight in a ventilated oven at 212°F to 239°F (100°C to 115°C), shall not absorb more than 2 $\frac{1}{2}$ percent moisture by weight when placed upon a constantly water-saturated, porous surface for seven days. A minimum of five specimens shall be tested and each specimen shall be cut from a separate unit.

2109.3.3 Allowable stress. The allowable compressive stress based on gross cross-sectional area of adobe shall not exceed 30 psi (207 kPa).

2109.3.3.1 Bolts. Bolt values shall not exceed those set forth in Table 2109.3.3.1.

**TABLE 2109.3.3.1
ALLOWABLE SHEAR ON BOLTS IN ADOBE MASONRY**

| DIAMETER OF BOLTS (inches) | MINIMUM EMBEDMENT (inches) | SHEAR (pounds) |
|-------------------------------|-------------------------------|-------------------|
| $\frac{1}{2}$ | — | — |
| $\frac{5}{8}$ | 12 | 200 |
| $\frac{3}{4}$ | 15 | 300 |
| $\frac{7}{8}$ | 18 | 400 |
| 1 | 21 | 500 |
| $1\frac{1}{8}$ | 24 | 600 |

For SI: 1 inch = 25.4 mm, 1 pound = 4.448 N.

2109.3.4 Detailed requirements. Adobe construction shall comply with Sections 2109.3.4.1 through 2109.3.4.9.

2109.3.4.1 Number of stories. Adobe construction shall be limited to buildings not exceeding one story, except that two-story construction is allowed when designed by a registered design professional.

2109.3.4.2 Mortar. Mortar for adobe construction shall comply with Sections 2109.3.4.2.1 and 2109.3.4.2.2.

2109.3.4.2.1 General. Mortar for stabilized adobe units shall comply with Chapter 21 or adobe soil. Adobe soil used as mortar shall comply with material requirements for stabilized adobe. Mortar for unstabilized adobe shall be Portland cement mortar.

2109.3.4.2.2 Mortar joints. Adobe units shall be laid with full head and bed joints and in full running bond.

2109.3.4.3 Parapet walls. Parapet walls constructed of adobe units shall be waterproofed.

2109.3.4.4 Wall thickness. The minimum thickness of exterior walls in one-story buildings shall be 10 inches (254 mm). The walls shall be laterally supported at intervals not exceeding 24 feet (7315 mm). The minimum thickness of interior load-bearing walls shall be 8 inches (203 mm). In no case shall the unsupported height of any wall constructed of adobe units exceed 10 times the thickness of such wall.

2109.3.4.5 Foundations. Foundations for adobe construction shall be in accordance with Sections 2109.3.4.5.1 and 2109.3.4.5.2.

2109.3.4.5.1 Foundation support. Walls and partitions constructed of adobe units shall be supported by foundations or footings that extend not less than 6 inches (152 mm) above adjacent ground surfaces and are constructed of solid masonry (excluding adobe) or concrete. Footings and foundations shall comply with Chapter 18.

2109.3.4.5.2 Lower course requirements. Stabilized adobe units shall be used in adobe walls for the first 4 inches (102 mm) above the finished first-floor elevation.

2109.3.4.6 Isolated piers or columns. Adobe units shall not be used for isolated piers or columns in a load-bearing capacity. Walls less than 24 inches (610 mm) in length shall be considered isolated piers or columns.

2109.3.4.7 Tie beams. Exterior walls and interior load-bearing walls constructed of adobe units shall have a continuous tie beam at the level of the floor or roof bearing and meeting the following requirements.

2109.3.4.7.1 Concrete tie beams. Concrete tie beams shall be a minimum depth of 6 inches (152 mm) and a minimum width of 10 inches (254 mm). Concrete tie beams shall be continuously reinforced with a minimum of two No. 4 reinforcing bars. The specified compressive strength of concrete shall be at least 2,500 psi (17.2 MPa).

2109.3.4.7.2 Wood tie beams. Wood tie beams shall be solid or built up of lumber having a minimum nominal thickness of 1 inch (25 mm), and shall have a minimum depth of 6 inches (152 mm) and a minimum width of 10 inches (254 mm). Joints in wood tie beams shall be spliced a minimum of 6 inches (152 mm). No splices shall be allowed within 12 inches (305 mm) of an opening. Wood used in tie beams shall be approved naturally decay-resistant or preservative-treated wood.

2109.3.4.8 Exterior finish. Exterior walls constructed of unstabilized adobe units shall have their exterior surface covered with a minimum of two coats of Portland cement plaster having a minimum thickness of $\frac{3}{4}$ inch (19.1 mm) and conforming to ASTM C 926. Lathing shall comply with ASTM C 1063. Fasteners shall be spaced at 16 inches (406 mm) o.c. maximum. Exposed wood surfaces shall be treated with an approved wood preservative or other protective coating prior to lath application.

2109.3.4.9 Lintels. Lintels shall be considered structural members and shall be designed in accordance with the applicable provisions of Chapter 16.

SECTION 2110 GLASS UNIT MASONRY

2110.1 General. Glass unit masonry construction shall comply with Chapter 7 of TMS 402/ACI 530/ASCE 5 and this section.

2110.1.1 Limitations. Solid or hollow approved glass block shall not be used in fire walls, party walls, fire barriers, fire partitions or smoke barriers, or for load-bearing construction. Such blocks shall be erected with mortar and reinforcement in metal channel-type frames, structural frames, masonry or concrete recesses, embedded panel anchors as provided for both exterior and interior walls or other approved joint materials. Wood strip framing shall not be used in walls required to have a fire-resistance rating by other provisions of this code.

Exceptions:

1. Glass-block assemblies having a fire protection rating of not less than $\frac{3}{4}$ hour shall be permitted as opening protectives in accordance with Section 716 in fire barriers, fire partitions and smoke barriers that have a required fire-resistance rating of 1 hour or less and do not enclose exit stairways, exit ramps or exit passageways.
2. Glass-block assemblies as permitted in Section 404.6, Exception 2.

SECTION 2111 MASONRY FIREPLACES

2111.1 Definition. A masonry fireplace is a fireplace constructed of concrete or masonry. Masonry fireplaces shall be constructed in accordance with this section.

2111.2 Footings and foundations. Footings for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and shall extend at least 6 inches (153 mm) beyond the face of the fireplace or foundation wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

2111.2.1 Ash dump cleanout. Cleanout openings, located within foundation walls below fireboxes, when provided, shall be equipped with ferrous metal or masonry doors and frames constructed to remain tightly closed, except when in use. Cleanouts shall be accessible and located so that ash removal will not create a hazard to combustible materials.

2111.3 Seismic reinforcing. In structures assigned to *Seismic Design Category A or B*, reinforcement and seismic anchorage are not required. Masonry or concrete fireplaces shall be constructed, anchored, supported and reinforced as required in this chapter. In structures assigned to *Seismic Design Category C or D*, masonry and concrete fireplaces shall be reinforced and anchored as detailed in Sections 2111.3.1, 2111.3.2, 2111.4 and 2111.4.1 for chimneys serving fireplaces. In structures assigned to *Seismic Design Category E or F*, masonry and concrete chimneys shall be reinforced in

accordance with the requirements of Sections 2101 through 2108.

2111.3.1 Vertical reinforcing. For fireplaces with chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete between wythes of solid masonry or within the cells of hollow unit masonry and grouted in accordance with Section 2103.12. For fireplaces with chimneys greater than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 inches (1016 mm) in width or fraction thereof.

2111.3.2 Horizontal reinforcing. Vertical reinforcement shall be placed enclosed within $\frac{1}{4}$ -inch (6.4 mm) ties or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) on center in concrete; or placed in the bed joints of unit masonry at a minimum of every 18 inches (457 mm) of vertical height. Two such ties shall be provided at each bend in the vertical bars.

2111.4 Seismic anchorage. Masonry and concrete chimneys in structures assigned to *Seismic Design Category C or D* shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade, except where constructed completely within the exterior walls. Anchorage shall conform to the following requirements.

2111.4.1 Anchorage. Two $\frac{3}{16}$ -inch by 1-inch (4.8 mm by 25.4 mm) straps shall be embedded a minimum of 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to a minimum of four floor joists with two $\frac{1}{2}$ -inch (12.7 mm) bolts.

2111.5 Firebox walls. Masonry fireboxes shall be constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete. When a lining of firebrick at least 2 inches (51 mm) in thickness or other approved lining is provided, the minimum thickness of back and sidewalls shall each be 8 inches (203 mm) of solid masonry, including the lining. The width of joints between firebricks shall not be greater than $\frac{1}{4}$ inch (6.4 mm). When no lining is provided, the total minimum thickness of back and sidewalls shall be 10 inches (254 mm) of solid masonry. Firebrick shall conform to ASTM C 27 or ASTM C 1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C 199.

2111.5.1 Steel fireplace units. Steel fireplace units are permitted to be installed with solid masonry to form a masonry fireplace provided they are installed according to either the requirements of their listing or the requirements of this section. Steel fireplace units incorporating a steel firebox lining shall be constructed with steel not less than $\frac{1}{4}$ inch (6.4 mm) in thickness, and an air-circulating chamber which is ducted to the interior of the building. The firebox lining shall be encased with solid masonry to provide a total thickness at the back and sides of not less than 8 inches (203 mm), of which not less than 4 inches (102 mm) shall be of solid masonry or concrete. Circulating air ducts employed with steel fireplace units shall be constructed of metal or masonry.

2111.6 Firebox dimensions. The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall not be less than 8 inches (203 mm) above the fireplace opening. The throat opening shall not be less than 4 inches (102 mm) in depth. The cross-sectional area of the passageway above the firebox, including the throat, damper and smoke chamber, shall not be less than the cross-sectional area of the flue.

Exception: Rumford fireplaces shall be permitted provided that the depth of the fireplace is at least 12 inches (305 mm) and at least one-third of the width of the fireplace opening, and the throat is at least 12 inches (305 mm) above the lintel, and at least $\frac{1}{20}$ the cross-sectional area of the fireplace opening.

2111.7 Lintel and throat. Masonry over a fireplace opening shall be supported by a lintel of noncombustible material. The minimum required bearing length on each end of the fireplace opening shall be 4 inches (102 mm). The fireplace throat or damper shall be located a minimum of 8 inches (203 mm) above the top of the fireplace opening.

2111.7.1 Damper. Masonry fireplaces shall be equipped with a ferrous metal damper located at least 8 inches (203 mm) above the top of the fireplace opening. Dampers shall be installed in the fireplace or at the top of the flue venting the fireplace, and shall be operable from the room containing the fireplace. Damper controls shall be permitted to be located in the fireplace.

2111.8 Smoke chamber walls. Smoke chamber walls shall be constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete. The total minimum thickness of front, back and sidewalls shall be 8 inches (203 mm) of solid masonry. The inside surface shall be parged smooth with refractory mortar conforming to ASTM C 199. When a lining of firebrick at least 2 inches (51 mm) thick, or a lining of vitrified clay at least $\frac{5}{8}$ inch (15.9 mm) thick, is provided, the total minimum thickness of front, back and sidewalls shall be 6 inches (152 mm) of solid masonry, including the lining. Firebrick shall conform to ASTM C 1261 and shall be laid with refractory mortar conforming to ASTM C 199. Vitrified clay linings shall conform to ASTM C 315.

2111.8.1 Smoke chamber dimensions. The inside height of the smoke chamber from the fireplace throat to the beginning of the flue shall not be greater than the inside width of the fireplace opening. The inside surface of the smoke chamber shall not be inclined more than 45 degrees (0.76 rad) from vertical when prefabricated smoke chamber linings are used or when the smoke chamber walls are rolled or sloped rather than corbeled. When the inside surface of the smoke chamber is formed by corbeled masonry, the walls shall not be corbeled more than 30 degrees (0.52 rad) from vertical.

2111.9 Hearth and hearth extension. Masonry fireplace hearths and hearth extensions shall be constructed of concrete or masonry, supported by noncombustible materials, and reinforced to carry their own weight and all imposed loads. No combustible material shall remain against the underside of hearths or hearth extensions after construction.

2111.9.1 Hearth thickness. The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

2111.9.2 Hearth extension thickness. The minimum thickness of hearth extensions shall be 2 inches (51 mm).

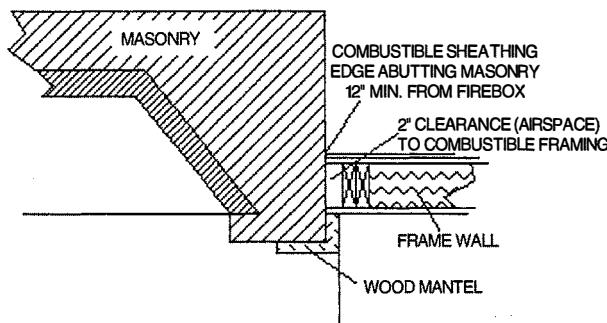
Exception: When the bottom of the firebox opening is raised at least 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than $\frac{3}{8}$ -inch-thick (9.5 mm) brick, concrete, stone, tile or other approved noncombustible material is permitted.

2111.10 Hearth extension dimensions. Hearth extensions shall extend at least 16 inches (406 mm) in front of, and at least 8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m²) or larger, the hearth extension shall extend at least 20 inches (508 mm) in front of, and at least 12 inches (305 mm) beyond, each side of the fireplace opening.

2111.11 Fireplace clearance. Any portion of a masonry fireplace located in the interior of a building or within the exterior wall of a building shall have a clearance to combustibles of not less than 2 inches (51 mm) from the front faces and sides of masonry fireplaces and not less than 4 inches (102 mm) from the back faces of masonry fireplaces. The airspace shall not be filled, except to provide fireblocking in accordance with Section 2111.12.

Exceptions:

1. Masonry fireplaces listed and labeled for use in contact with combustibles in accordance with UL 127 and installed in accordance with the manufacturer's installation instructions are permitted to have combustible material in contact with their exterior surfaces.
2. When masonry fireplaces are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete walls less than 12 inches (306 mm) from the inside surface of the nearest firebox lining.
3. Exposed combustible trim and the edges of sheathing materials, such as wood siding, flooring and drywall, are permitted to abut the masonry fireplace sidewalls and hearth extension, in accordance with



For SI: 1 inch = 25.4 mm

FIGURE 2111.11
ILLUSTRATION OF EXCEPTION TO FIREPLACE CLEARANCE PROVISION

Figure 2111.11, provided such combustible trim or sheathing is a minimum of 12 inches (306 mm) from the inside surface of the nearest firebox lining.

4. Exposed combustible mantels or trim is permitted to be placed directly on the masonry fireplace front surrounding the fireplace opening, provided such combustible materials shall not be placed within 6 inches (153 mm) of a fireplace opening. Combustible material directly above and within 12 inches (305 mm) of the fireplace opening shall not project more than $\frac{1}{8}$ inch (3.2 mm) for each 1-inch (25 mm) distance from such opening. Combustible materials located along the sides of the fireplace opening that project more than $1\frac{1}{2}$ inches (38 mm) from the face of the fireplace shall have an additional clearance equal to the projection.

2111.12 Fireplace fireblocking. All spaces between fireplaces and floors and ceilings through which fireplaces pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between wood joists, beams or headers shall be to a depth of 1 inch (25 mm) and shall only be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

2111.13 Exterior air. Factory-built or masonry fireplaces covered in this section shall be equipped with an exterior air supply to ensure proper fuel combustion unless the room is mechanically ventilated and controlled so that the indoor pressure is neutral or positive.

2111.13.1 Factory-built fireplaces. Exterior combustion air ducts for factory-built fireplaces shall be listed components of the fireplace, and installed according to the fireplace manufacturer's instructions.

2111.13.2 Masonry fireplaces. Listed combustion air ducts for masonry fireplaces shall be installed according to the terms of their listing and manufacturer's instructions.

2111.13.3 Exterior air intake. The exterior air intake shall be capable of providing all combustion air from the exterior of the dwelling. The exterior air intake shall not be located within a garage, attic, basement or crawl space of the dwelling nor shall the air intake be located at an elevation higher than the firebox. The exterior air intake shall be covered with a corrosion-resistant screen of $\frac{1}{4}$ -inch (6.4 mm) mesh.

2111.13.4 Clearance. Unlisted combustion air ducts shall be installed with a minimum 1-inch (25 mm) clearance to combustibles for all parts of the duct within 5 feet (1524 mm) of the duct outlet.

2111.13.5 Passageway. The combustion air passageway shall be a minimum of 6 square inches (3870 mm^2) and not more than 55 square inches (0.035 m^2), except that combustion air systems for listed fireplaces or for fireplaces tested for emissions shall be constructed according to the fireplace manufacturer's instructions.

2111.13.6 Outlet. The exterior air outlet is permitted to be located in the back or sides of the firebox chamber or within 24 inches (610 mm) of the firebox opening on or near the floor. The outlet shall be closable and designed to

prevent burning material from dropping into concealed combustible spaces.

SECTION 2112 MASONRY HEATERS

2112.1 Definition. A masonry heater is a heating appliance constructed of concrete or solid masonry, hereinafter referred to as "masonry," which is designed to absorb and store heat from a solid fuel fire built in the firebox by routing the exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox may include flow in a horizontal or downward direction before entering the chimney and which delivers heat by radiation from the masonry surface of the heater.

2112.2 Installation. Masonry heaters shall be installed in accordance with this section and comply with one of the following:

1. Masonry heaters shall comply with the requirements of ASTM E 1602; or
2. Masonry heaters shall be listed and labeled in accordance with UL 1482 and installed in accordance with the manufacturer's installation instructions.

2112.3 Footings and foundation. The firebox floor of a masonry heater shall be a minimum thickness of 4 inches (102 mm) of noncombustible material and be supported on a noncombustible footing and foundation in accordance with Section 2113.2.

2112.4 Seismic reinforcing. In structures assigned to Seismic Design Category D, E or F, masonry heaters shall be anchored to the masonry foundation in accordance with Section 2113.3. Seismic reinforcing shall not be required within the body of a masonry heater with a height that is equal to or less than 3.5 times its body width and where the masonry chimney serving the heater is not supported by the body of the heater. Where the masonry chimney shares a common wall with the facing of the masonry heater, the chimney portion of the structure shall be reinforced in accordance with Section 2113.

2112.5 Masonry heater clearance. Combustible materials shall not be placed within 36 inches (765 mm) of the outside surface of a masonry heater in accordance with NFPA 211, Section 8-7 (clearances for solid fuel-burning appliances), and the required space between the heater and combustible material shall be fully vented to permit the free flow of air around all heater surfaces.

Exceptions:

1. When the masonry heater wall thickness is at least 8 inches (203 mm) thick of solid masonry and the wall thickness of the heat exchange channels is at least 5 inches (127 mm) thick of solid masonry, combustible materials shall not be placed within 4 inches (102 mm) of the outside surface of a masonry heater. A clearance of at least 8 inches (203 mm) shall be provided between the gas-tight capping slab of the heater and a combustible ceiling.
2. Masonry heaters listed and labeled in accordance with UL 1482 and installed in accordance with the manufacturer's instructions.

SECTION 2113 MASONRY CHIMNEYS

2113.1 Definition. A masonry chimney is a chimney constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete, hereinafter referred to as "masonry." Masonry chimneys shall be constructed, anchored, supported and reinforced as required in this chapter.

2113.2 Footings and foundations. Footings for masonry chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and shall extend at least 6 inches (152 mm) beyond the face of the foundation or support wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

2113.3 Seismic reinforcing. Masonry or concrete chimneys shall be constructed, anchored, supported and reinforced as required in this chapter. In structures assigned to Seismic Design Category C or D, masonry and concrete chimneys shall be reinforced and anchored as detailed in Sections 2113.3.1, 2113.3.2 and 2113.4. In structures assigned to Seismic Design Category A or B, reinforcement and seismic anchorage is not required. In structures assigned to Seismic Design Category E or F, masonry and concrete chimneys shall be reinforced in accordance with the requirements of Sections 2101 through 2108.

2113.3.1 Vertical reinforcing. For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars anchored in the foundation shall be placed in the concrete between wythes of solid masonry or within the cells of hollow unit masonry and grouted in accordance with Section 2103.12. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys greater than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 inches (1016 mm) in width or fraction thereof.

2113.3.2 Horizontal reinforcing. Vertical reinforcement shall be placed enclosed within $\frac{1}{4}$ -inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) o.c. in concrete, or placed in the bed joints of unit masonry, at a minimum of every 18 inches (457 mm) of vertical height. Two such ties shall be provided at each bend in the vertical bars.

2113.4 Seismic anchorage. Masonry and concrete chimneys and foundations in structures assigned to Seismic Design Category C or D shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade, except where constructed completely within the exterior walls. Anchorage shall conform to the following requirements.

2113.4.1 Anchorage. Two $\frac{3}{16}$ -inch by 1-inch (4.8 mm by 25 mm) straps shall be embedded a minimum of 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to a minimum of four floor joists with two $\frac{1}{2}$ -inch (12.7 mm) bolts.

2113.5 Corbeling. Masonry chimneys shall not be corbeled more than half of the chimney's wall thickness from a wall or foundation, nor shall a chimney be corbeled from a wall or foundation that is less than 12 inches (305 mm) in thickness unless it projects equally on each side of the wall, except that on the second story of a two-story dwelling, corbeling of chimneys on the exterior of the enclosing walls is permitted to equal the wall thickness. The projection of a single course shall not exceed one-half the unit height or one-third of the unit bed depth, whichever is less.

2113.6 Changes in dimension. The chimney wall or chimney flue lining shall not change in size or shape within 6 inches (152 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

2113.7 Offsets. Where a masonry chimney is constructed with a fireclay flue liner surrounded by one wythe of masonry, the maximum offset shall be such that the centerline of the flue above the offset does not extend beyond the center of the chimney wall below the offset. Where the chimney offset is supported by masonry below the offset in an approved manner, the maximum offset limitations shall not apply. Each individual corbeled masonry course of the offset shall not exceed the projection limitations specified in Section 2113.5.

2113.8 Additional load. Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load. Masonry chimneys are permitted to be constructed as part of the masonry walls or concrete walls of the building.

2113.9 Termination. Chimneys shall extend at least 2 feet (610 mm) higher than any portion of the building within 10 feet (3048 mm), but shall not be less than 3 feet (914 mm) above the highest point where the chimney passes through the roof.

2113.9.1 Chimney caps. Masonry chimneys shall have a concrete, metal or stone cap, sloped to shed water, a drip edge and a caulked bond break around any flue liners in accordance with ASTM C 1283.

2113.9.2 Spark arrestors. [SFM] All chimneys attached to any appliance or fireplace that burns solid fuel shall be equipped with an approved spark arrester. The spark arrester shall meet all of the following requirements:

1. The net free area of the arrester shall not be less than four times the net free area of the outlet of the chimney flue it serves.
2. The arrester screen shall have heat and corrosion resistance equivalent to 12-gage wire, 19-gage galvanized steel or 24-gage stainless steel.
3. Openings shall not permit the passage of spheres having a diameter greater than $\frac{1}{2}$ inch (13 mm) nor block the passage of spheres having a diameter less than $\frac{3}{8}$ inch (11 mm).
4. The spark arrester shall be accessible for cleaning and the screen or chimney cap shall be removable to allow for cleaning of the chimney flue.

2113.9.3 Rain caps. Where a masonry or metal rain cap is installed on a masonry chimney, the net free area under the cap shall not be less than four times the net free area of the outlet of the chimney flue it serves.

2113.10 Wall thickness. Masonry chimney walls shall be constructed of concrete, solid masonry units or hollow masonry units grouted solid with not less than 4 inches (102 mm) nominal thickness.

2113.10.1 Masonry veneer chimneys. Where masonry is used as veneer for a framed chimney, through flashing and weep holes shall be provided as required by Chapter 14.

2113.11 Flue lining (material). Masonry chimneys shall be lined. The lining material shall be appropriate for the type of appliance connected, according to the terms of the appliance listing and the manufacturer's instructions.

2113.11.1 Residential-type appliances (general). Flue lining systems shall comply with one of the following:

1. Clay flue lining complying with the requirements of ASTM C 315.
2. Listed chimney lining systems complying with UL 1777.
3. Factory-built chimneys or chimney units listed for installation within masonry chimneys.
4. Other approved materials that will resist corrosion, erosion, softening or cracking from flue gases and condensate at temperatures up to 1,800°F (982°C).

2113.11.1.1 Flue linings for specific appliances. Flue linings other than those covered in Section 2113.11.1 intended for use with specific appliances shall comply with Sections 2113.11.1.2 through 2113.11.1.4 and Sections 2113.11.2 and 2113.11.3.

2113.11.1.2 Gas appliances. Flue lining systems for gas appliances shall be in accordance with the *California Mechanical Code*.

2113.11.1.3 Pellet fuel-burning appliances. Flue lining and vent systems for use in masonry chimneys with pellet fuel-burning appliances shall be limited to flue lining systems complying with Section 2113.11.1 and pellet vents listed for installation within masonry chimneys (see Section 2113.11.1.5 for marking).

2113.11.1.4 Oil-fired appliances approved for use with L-vent. Flue lining and vent systems for use in masonry chimneys with oil-fired appliances approved for use with Type L vent shall be limited to flue lining systems complying with Section 2113.11.1 and listed chimney liners complying with UL 641 (see Section 2113.11.1.5 for marking).

2113.11.1.5 Notice of usage. When a flue is relined with a material not complying with Section 2113.11.1, the chimney shall be plainly and permanently identified by a label attached to a wall, ceiling or other conspicuous location adjacent to where the connector enters the chimney. The label shall include the following message or equivalent language: "This chimney is for use only with (type or category of appliance) that burns (type of fuel). Do not connect other types of appliances."

2113.11.2 Concrete and masonry chimneys for medium-heat appliances.

2113.11.2.1 General. Concrete and masonry chimneys for medium-heat appliances shall comply with Sections 2113.1 through 2113.5.

2113.11.2.2 Construction. Chimneys for medium-heat appliances shall be constructed of solid masonry units or of concrete with walls a minimum of 8 inches (203 mm) thick, or with stone masonry a minimum of 12 inches (305 mm) thick.

2113.11.2.3 Lining. Concrete and masonry chimneys shall be lined with an approved medium-duty refractory brick a minimum of 4½ inches (114 mm) thick laid on the 4½-inch bed (114 mm) in an approved medium-duty refractory mortar. The lining shall start 2 feet (610 mm) or more below the lowest chimney connector entrance. Chimneys terminating 25 feet (7620 mm) or less above a chimney connector entrance shall be lined to the top.

2113.11.2.4 Multiple passageway. Concrete and masonry chimneys containing more than one passageway shall have the liners separated by a minimum 4-inch-thick (102 mm) concrete or solid masonry wall.

2113.11.2.5 Termination height. Concrete and masonry chimneys for medium-heat appliances shall extend a minimum of 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm).

2113.11.2.6 Clearance. A minimum clearance of 4 inches (102 mm) shall be provided between the exterior surfaces of a concrete or masonry chimney for medium-heat appliances and combustible material.

2113.11.3 Concrete and masonry chimneys for high-heat appliances.

2113.11.3.1 General. Concrete and masonry chimneys for high-heat appliances shall comply with Sections 2113.1 through 2113.5.

2113.11.3.2 Construction. Chimneys for high-heat appliances shall be constructed with double walls of solid masonry units or of concrete, each wall to be a minimum of 8 inches (203 mm) thick with a minimum airspace of 2 inches (51 mm) between the walls.

2113.11.3.3 Lining. The inside of the interior wall shall be lined with an approved high-duty refractory brick, a minimum of 4½ inches (114 mm) thick laid on the 4½-inch bed (114 mm) in an approved high-duty refractory mortar. The lining shall start at the base of the chimney and extend continuously to the top.

2113.11.3.4 Termination height. Concrete and masonry chimneys for high-heat appliances shall extend a minimum of 20 feet (6096 mm) higher than any portion of any building within 50 feet (15 240 mm).

2113.11.3.5 Clearance. Concrete and masonry chimneys for high-heat appliances shall have approved clearance from buildings and structures to prevent overheating combustible materials, permit inspection

and maintenance operations on the chimney and prevent danger of burns to persons.

2113.12 Clay flue lining (installation). Clay flue liners shall be installed in accordance with ASTM C 1283 and extend from a point not less than 8 inches (203 mm) below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber to a point above the enclosing walls. The lining shall be carried up vertically, with a maximum slope no greater than 30 degrees (0.52 rad) from the vertical.

Clay flue liners shall be laid in medium-duty nonwater-soluble refractory mortar conforming to ASTM C 199 with tight mortar joints left smooth on the inside and installed to maintain an air space or insulation not to exceed the thickness of the flue liner separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides. Only enough mortar shall be placed to make the joint and hold the liners in position.

2113.13 Additional requirements.

2113.13.1 Listed materials. Listed materials used as flue linings shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

2113.13.2 Space around lining. The space surrounding a chimney lining system or vent installed within a masonry chimney shall not be used to vent any other appliance.

Exception: This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's instructions.

2113.14 Multiple flues. When two or more flues are located in the same chimney, masonry wythes shall be built between adjacent flue linings. The masonry wythes shall be at least 4 inches (102 mm) thick and bonded into the walls of the chimney.

Exception: When venting only one appliance, two flues are permitted to adjoin each other in the same chimney with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered at least 4 inches (102 mm).

2113.15 Flue area (appliance). Chimney flues shall not be smaller in area than the area of the connector from the appliance. Chimney flues connected to more than one appliance shall not be less than the area of the largest connector plus 50 percent of the areas of additional chimney connectors.

Exceptions:

- Chimney flues serving oil-fired appliances sized in accordance with NFPA 31.
- Chimney flues serving gas-fired appliances sized in accordance with the *California Mechanical Code*.

2113.16 Flue area (masonry fireplace). Flue sizing for chimneys serving fireplaces shall be in accordance with Section 2113.16.1 or 2113.16.2.

2113.16.1 Minimum area. Round chimney flues shall have a minimum net cross-sectional area of at least $\frac{1}{12}$ of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of at least $\frac{1}{10}$ of the fireplace opening. Rectangular chimney flues with an aspect

ratio less than 2 to 1 shall have a minimum net cross-sectional area of at least $\frac{1}{10}$ of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of at least $\frac{1}{8}$ of the fireplace opening.

2113.16.2 Determination of minimum area. The minimum net cross-sectional area of the flue shall be determined in accordance with Figure 2113.16. A flue size providing at least the equivalent net cross-sectional area shall be used. Cross-sectional areas of clay flue linings are as provided in Tables 2113.16(1) and 2113.16(2) or as provided by the manufacturer or as measured in the field. The height of the chimney shall be measured from the firebox floor to the top of the chimney flue.

TABLE 2113.16(1)
NET CROSS-SECTIONAL AREA OF ROUND FLUE SIZES^a

| FLUE SIZE, INSIDE DIAMETER (inches) | CROSS-SECTIONAL AREA (square inches) |
|-------------------------------------|--------------------------------------|
| 6 | 28 |
| 7 | 38 |
| 8 | 50 |
| 10 | 78 |
| $10\frac{3}{4}$ | 90 |
| 12 | 113 |
| 15 | 176 |
| 18 | 254 |

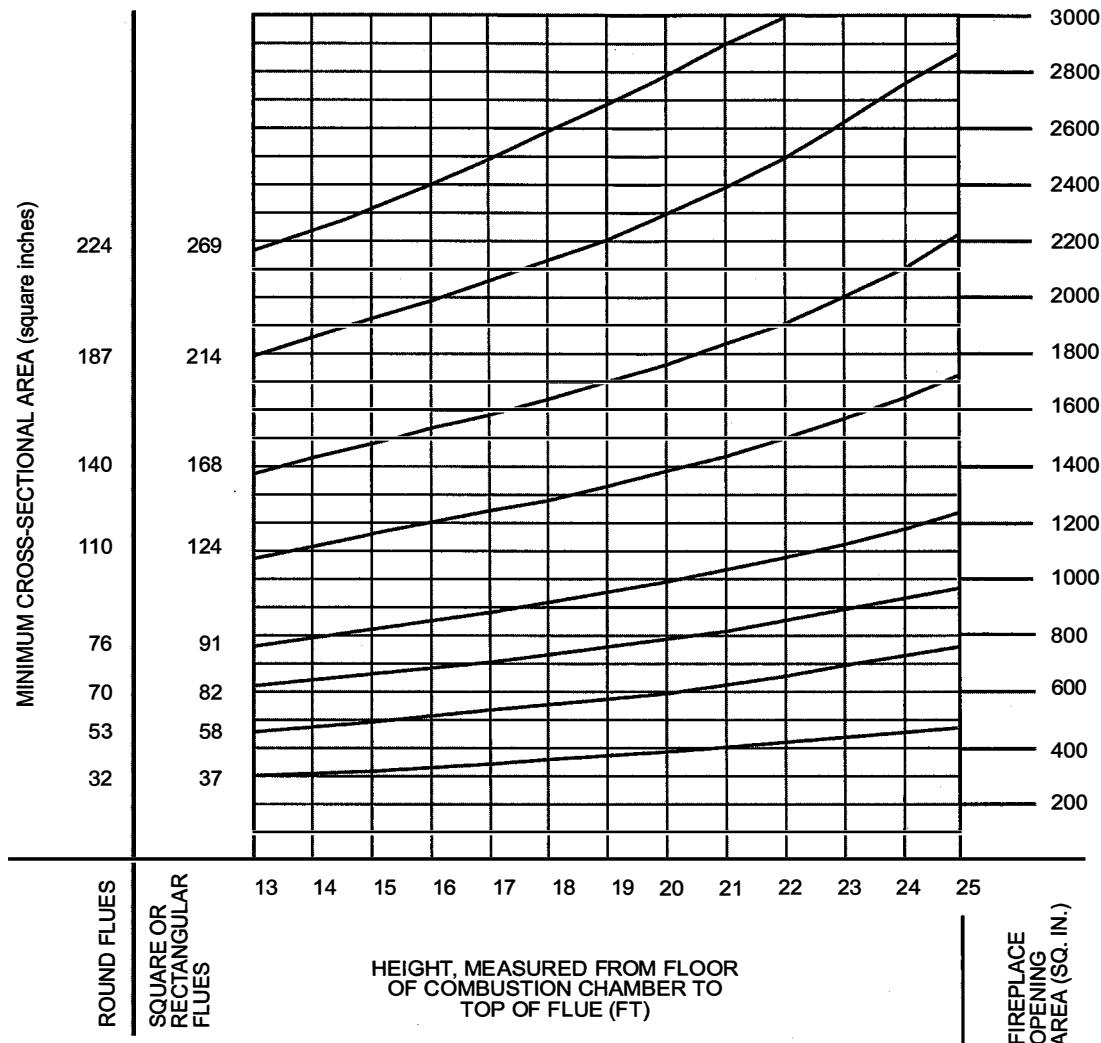
For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm².

a. Flue sizes are based on ASTM C 315.

TABLE 2113.16(2)
NET CROSS-SECTIONAL AREA OF SQUARE AND RECTANGULAR FLUE SIZES

| FLUE SIZE, OUTSIDE NOMINAL DIMENSIONS (inches) | CROSS-SECTIONAL AREA (square inches) |
|--|--------------------------------------|
| 4.5 × 8.5 | 23 |
| 4.5 × 13 | 34 |
| 8 × 8 | 42 |
| 8.5 × 8.5 | 49 |
| 8 × 12 | 67 |
| 8.5 × 13 | 76 |
| 12 × 12 | 102 |
| 8.5 × 18 | 101 |
| 13 × 13 | 127 |
| 12 × 16 | 131 |
| 13 × 18 | 173 |
| 16 × 16 | 181 |
| 16 × 20 | 222 |
| 18 × 18 | 233 |
| 20 × 20 | 298 |
| 20 × 24 | 335 |
| 24 × 24 | 431 |

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm².



For SI: 1 inch = 25.4 mm, 1 square inch = 645 mm²

**FIGURE 2113.16
FLUE SIZES FOR MASONRY CHIMNEYS**

2113.17 Inlet. Insets to masonry chimneys shall enter from the side. Insets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

2113.18 Masonry chimney cleanout openings. Cleanout openings shall be provided within 6 inches (152 mm) of the base of each flue within every masonry chimney. The upper edge of the cleanout shall be located at least 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be at least 6 inches (152 mm). The cleanout shall be provided with a noncombustible cover.

Exception: Chimney flues serving masonry fireplaces, where cleaning is possible through the fireplace opening.

2113.19 Chimney clearances. Any portion of a masonry chimney located in the interior of the building or within the exterior wall of the building shall have a minimum airspace clearance to combustibles of 2 inches (51 mm). Chimneys

located entirely outside the exterior walls of the building, including chimneys that pass through the soffit or cornice, shall have a minimum airspace clearance of 1 inch (25 mm). The airspace shall not be filled, except to provide fireblocking in accordance with Section 2113.20.

Exceptions:

1. Masonry chimneys equipped with a chimney lining system listed and labeled for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, are permitted to have combustible material in contact with their exterior surfaces.
2. Where masonry chimneys are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete wall less than 12 inches (305 mm) from the inside surface of the nearest flue lining.

3. Exposed combustible trim and the edges of sheathing materials, such as wood siding, are permitted to abut the masonry chimney sidewalls, in accordance with Figure 2113.19, provided such combustible trim or sheathing is a minimum of 12 inches (305 mm) from the inside surface of the nearest flue lining. Combustible material and trim shall not overlap the corners of the chimney by more than 1 inch (25 mm).

2113.20 Chimney fireblocking. All spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between wood joists, beams or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

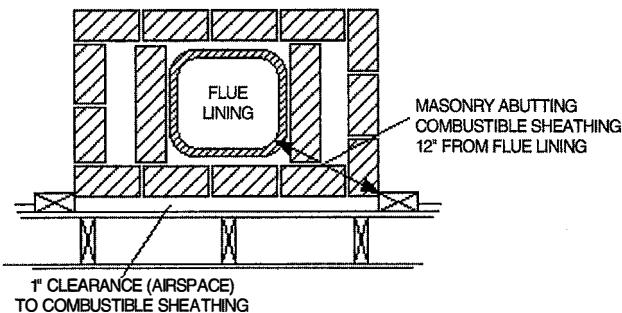


FIGURE 2113.19
ILLUSTRATION OF EXCEPTION THREE CHIMNEY
CLEARANCE PROVISION

SECTION 2114 ADDITIONAL REQUIREMENTS [DSA-SS/CC]

2114.1 General. In addition to the provisions of this chapter, the following requirements shall apply to community college buildings regulated by the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC).

2114.1.1 Prohibitions. The following design, systems and materials are not permitted by DSA:

1. Unreinforced masonry
2. Autoclaved aerated concrete (AAC) masonry
3. Empirical design of masonry
4. Ordinary reinforced masonry shear walls
5. Intermediate reinforced masonry shear walls
6. Prestressed masonry shear walls
7. Direct design of masonry

> **2114.2 Mortar.** Type S mortar conforming to ASTM C 270 shall be used for glass unit masonry.

2114.3 Additives and Admixtures.

2114.3.1 General. Additives and admixtures to mortar or grout shall not be used unless approved by the enforcement agency.

2114.3.2 Antifreeze compounds. Antifreeze liquids, chloride salts or other such substances shall not be used in mortar or grout.

2114.3.3 Air entrainment. Air-entraining substances shall not be used in mortar or grout unless tests are conducted to determine compliance with the requirements of this code.

2114.4 Tolerances. The maximum thickness of the initial bed joint in fully grouted masonry walls shall not exceed $1\frac{1}{4}$ in. (31.7 mm).

2114.5 Glass unit masonry. All mortar for glass unit masonry contact surfaces shall be treated to ensure adhesion between mortar and glass.

2114.6 Grouted masonry.

2114.6.1 General conditions. Prior to grouting, the grout space shall be clean so that all spaces to be filled with grout do not contain mortar projections greater than $\frac{1}{4}$ inch (6.4 mm), mortar droppings and other foreign material.

All cells shall be solidly filled with grout, except as provided in Section 2114.14.

Reinforcement and embedded items shall be clean, properly positioned and securely anchored against moving prior to grouting. Bolts shall be accurately set with templates or by approved equivalent means and held in place to prevent dislocation during grouting. Reinforcement, embedded items and bolts shall be solidly embedded in grout. Anchor bolts in the face shells of hollow masonry units shall be positioned to maintain a minimum of $\frac{1}{2}$ inch of grout between the bolt and the face shell.

The grouting of any section of wall shall be completed in one day with no interruptions greater than one hour. At the time of laying, all masonry units shall be free of dust and dirt.

Grout pours greater than 12 inches (300 mm) in height shall be consolidated by mechanical vibration during placement to fill the grout space before loss of plasticity, and reconsolidated by mechanical vibration to minimize voids due to water loss. Grout pours less than 12 inches in height may be puddled.

Between grout pours or where grouting has been stopped more than an hour, a horizontal construction joint shall be formed by stopping all wythes at the same elevation and with the grout stopping a minimum of $1\frac{1}{2}$ inches (38 mm) below a mortar joint, except at the top of the wall. Where bond beams occur, the grout pour shall be stopped a minimum of $\frac{1}{2}$ inch (12.7 mm) below the top of the masonry.

The construction documents shall completely describe grouting procedures, subject to approval of DSA.

2114.7 Aluminum equipment. Grout shall not be handled nor pumped utilizing aluminum equipment unless it can be demonstrated with the materials and equipment to be used that there will be no deleterious effect on the strength of the grout.

2114.8 Specified compressive strength. The specified compressive strength, f'_{m} , assumed in design shall be not less than 1,500 psi (10.34 MPa) for all masonry construction using materials and details of construction required herein. Testing of the constructed masonry shall be provided in accordance with Section 2114.9.3.

In no case shall the f'_{m} assumed in design exceed 3,000 psi (20.68 MPa).

2114.9 Additional testing requirements.

2114.9.1 Mortar and grout tests. At the beginning of all masonry work, at least one test sample of the mortar and grout shall be taken on three successive working days and at least at one-week intervals thereafter. They shall meet the minimum strength requirement given in Sections 2103.9 and 2103.13 for mortar and grout, respectively. Additional samples shall be taken whenever any change in materials or job conditions occur, or whenever in the judgment of the architect, structural engineer or the enforcement agency such tests are necessary to determine the quality of the material. When the prism test method of Section 2105.2.2.2 is used during construction, the tests in this section are not required.

Test specimens for mortar and grout shall be made as set forth in ASTM C 1586 and ASTM C 1019

2114.9.2 Prism test method.

2114.9.2.1 Number of prisms per test. Prior to the start of construction, three prisms shall be constructed and tested in accordance with ASTM C 1314. A set of three masonry prisms shall be built during construction in accordance with ASTM C 1314 for each 5,000 square feet (465 m^2) of wall area, but not less than one set of three prisms for the project. Each set of prisms shall equal or exceed f'_{m} .

2114.9.3 Masonry core testing. Not less than two cores shall be taken from each building for each 5,000 square feet (465 m^2) of the greater of the masonry wall area or the floor area or fraction thereof. The architect or structural engineer in responsible charge of the project or his / her representative or the inspector of record shall select the areas for sampling. Cores shall be a minimum of $3\frac{3}{4}$ " inches (76 mm) in diameter and shall be taken in such a manner as to exclude masonry unit webs and reinforcing steel. If vertical reinforcing steel is placed such that cores will include reinforcing steel, core testing may be waived by the design professional in responsible charge, as approved by the enforcement agency. The inspector of record shall observe the coring of the masonry walls.

Visual examination of all cores shall be made by a laboratory acceptable to the building official and the condition of the cores reported as required by the California Administrative Code. All cores taken shall be tested in shear. The shear test shall test both joints between the grout core and the outside wythes or face shell of the masonry. Shear testing apparatus shall be of a design approved by the enforcement agency. Core samples shall

not be soaked before testing. The average unit shear on the cross section of all the cores shall not be less than $2.5 \sqrt{f'_{m}}$ psi.

All cores shall be submitted to the laboratory, acceptable to the building official, for examination, regardless of whether the outside wythe or face shells separated during the cutting operation. The laboratory shall report the location where each core was taken, the findings of their visual examination of each core, and the results of the shear tests.

2114.10 Modifications to TMS 402/ACI 530/ASCE 5.

2114.10.1 Modify TMS 402/ACI 530/ASCE 5, Section 1.18 as follows:

- 1. Minimum reinforcement requirements for masonry walls.** The total area of reinforcement in reinforced masonry walls shall not be less than 0.003 times the sectional area of the wall. Neither the horizontal nor the vertical reinforcement shall be less than one third of the total. Horizontal and vertical reinforcement shall be spaced at not more than 24 inches (610 mm) center to center. The minimum reinforcing shall be No. 4, except that No. 3 bars may be used for ties and stirrups. Vertical wall reinforcement shall have dowels of equal size and equal matched spacing in all footings. Reinforcement shall be continuous around wall corners and through intersections. Only reinforcement which is continuous in the wall shall be considered in computing the minimum area of reinforcement. Reinforcement with splices conforming to TMS 402/ACI 530/ASCE 5 as modified by Sections 2107 and 2108 shall be considered as continuous reinforcement.

Horizontal reinforcement shall be provided in the top of footings, at the top of wall openings, at roof and floor levels, and at the top of parapet walls. For walls 12 inches (nominal) (305 mm) or more in thickness, horizontal and vertical reinforcement shall be equally divided into two layers, except where designed as retaining walls. Where reinforcement is added above the minimum requirements, such additional reinforcement need not be so divided.

In bearing walls of every type of reinforced masonry, there shall be trim reinforcement of not less than one No. 5 bar or two No. 4 bars on all sides of, and adjacent to, every opening which exceeds 16 inches (406 mm) in either direction, and such bars shall extend not less than 48 diameters, but in no case less than 24 inches (610 mm) beyond the corners of the opening. The bars required by this paragraph shall be in addition to the minimum reinforcement elsewhere required.

When the reinforcement in bearing walls is designed, placed and anchored in position as for columns, the allowable stresses shall be as for columns.

Joint reinforcement shall not be used as principal reinforcement in masonry designed by the strength design method.

2. **Minimum reinforcement for masonry columns.** The spacing of column ties shall be as follows: not greater than 8 bar diameters, 24 tie diameters, or one half the least dimension of the column for the full column height. Ties shall be at least $\frac{3}{8}$ inch (10 mm) in diameter and shall be embedded in grout. Top tie shall be within 2 inches (51 mm) of the top of the column or of the bottom of the horizontal bar in the supported beam.
3. **Anchor bolts.** Bent bar anchor bolts shall not be allowed. The maximum size anchor shall be $\frac{1}{2}$ -inch (13 mm) diameter for 6-inch (152 mm) nominal masonry, $\frac{3}{4}$ -inch (19 mm) diameter for 8-inch (203 mm) nominal masonry, $\frac{7}{8}$ -inch (22 mm) diameter for 10-inch (254 mm) nominal masonry, and 1-inch (25 mm) diameter for 12-inch (304.8 mm) nominal masonry.

2114.11 Additional requirements for allowable stress design.

2114.11.1 TMS 402/ACI 530/ASCE 5 [DSA-SS/CC]
Modify by adding Section 2.1.8 as follows:

2.1.8 – Walls and piers.

Thickness of walls. For thickness limitations of walls as specified in this chapter, nominal thickness shall be used. Stresses shall be determined on the basis of the net thickness of the masonry, with consideration for reduction, such as raked joints.

The thickness of masonry walls shall be designed so that allowable maximum stresses specified in this chapter are not exceeded. Also, no masonry wall shall exceed the height or length-to-thickness ratio or the minimum thickness as specified in this chapter and as set forth in Table 2114.11.1.

Piers. Every pier or wall section which width is less than three times its thickness shall be designed and constructed as required for columns if such pier is a structural member. Every pier or wall section which width is between three and five times its thickness or less than one half the height of adjacent openings shall have all horizontal steel in the form of ties except that in walls 12 inches (305 mm) or less in thickness such steel may be in the form of hair-pins.

2114.11.2 TMS 402/ACI 530/ASCE 5, Section 2.1.7.7.1.1, lap splices. Modify the requirements of Section 2107.2.1 by adding the following:

Lap splices need not be greater than 72 bar diameters.

**TABLE 2114.11.1
MINIMUM THICKNESS OF MASONRY WALLS^{1,2} [DSA-SS/CC]**

| TYPE OF MASONRY | MAXIMUM RATIO UNSUPPORTED HEIGHT OR LENGTH TO THICKNESS ^{2,3} | NOMINAL MINIMUM THICKNESS (inches) |
|-----------------------------------|--|------------------------------------|
| BEARING OR SHEAR WALLS: | | |
| 1. Stone masonry | 14 | 16 |
| 2. Reinforced grouted masonry | 25 | 6 |
| 3. Reinforced hollow unit masonry | 25 | 6 |
| NONBEARING WALLS: | | |
| 4. Exterior reinforced walls | 30 | 6 |
| 5. Interior partitions reinforced | 36 | 4 |

1. For walls of varying thickness, use the least thickness when determining the height or length to thickness ratio.
2. In determining the height or length to thickness ratio of a cantilevered wall, the dimension to be used shall be twice the dimension of the end of the wall from the lateral support.
3. Cantilevered walls not part of a building and not carrying applied vertical loads need not meet these minimum requirements but their design must comply with stress and overturning requirements

2114.12 Glass unit masonry construction. Masonry of glass blocks shall be permitted in nonload-bearing exterior or interior walls and shall conform to the requirements of Section 2114.14. Stresses in glass block shall not be utilized. Glass block may be solid or hollow and may contain inserts.

2114.13 Nonbearing walls. All nonbearing masonry walls shall be reinforced as specified in Section 2114.10.1.1. Fences and interior nonbearing nonshear walls may be of hollow-unit masonry construction grouted in cells containing vertical and horizontal reinforcement. Nonbearing walls may be used to carry a superimposed load of not more than 200 pounds per linear foot (2.92 kN/m).

1. Thickness. Every nonbearing masonry wall shall be so constructed and have a sufficient thickness to withstand all vertical loads and horizontal loads, but in no case shall the thickness of such walls be less than the values set forth in Table 2114.11.1.

Plaster shall not be considered as contributing to the thickness of a wall in computing the height-to-thickness ratio.

2. Anchorage. All nonbearing walls shall be anchored as required by Section 1604.8.2 and ASCE 7 Chapter 13. Suspended ceilings or other nonstructural elements shall not be used to provide anchorage for masonry walls.

2114.14 Masonry screen walls. Masonry units may be used in nonbearing decorative screen walls. Units may be laid up in panels with units on edge with the open pattern of the unit exposed in the completed wall.

1. Horizontal forces. The panels shall be capable of spanning between supports to resist the horizontal forces

- specified in Chapter 16. Wind loads shall be based on gross projected area of the block.
2. **Mortar joints.** Horizontal and vertical joints shall not be less than $\frac{1}{4}$ inch (6 mm) thick. All joints shall be completely filled with mortar and shall be "shoved joint" work. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with a minimum of 0.03 square inch (19 mm^2) of reinforcing steel and maximum spacing of 16 in. on center. Reinforcement may be embedded in mortar.
 3. **Reinforcement.** Joint reinforcement may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized. Ladder wire reinforcement shall not be spliced and shall be the widest that the mortar joint will accommodate, allowing $\frac{1}{2}$ inch (13 mm) of mortar cover.
 4. **Size of panels.** The maximum size of panels shall be 144 square feet (13.4 m^2), with the maximum dimension in either direction of 15 feet (4572 mm). The specified thickness of the units for exterior applications shall not be less than $3\frac{7}{8}$ in.
 5. **Panel support.** Each panel shall be supported on all edges by a structural member of concrete, masonry or steel. Supports at the top and ends of the panel shall be by means of confinement of the masonry by at least 1 inch (25 mm) into and between the flanges of a steel channel. The space between the end of the panel and the web of the channel shall be filled with resilient material. The use of equivalent configuration in other steel section or in masonry or concrete is acceptable.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 21A – MASONRY

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
 See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | X | | | X | | | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | X | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 2113A.9.2 | | X | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

CHAPTER 21A

MASONRY

SECTION 2101A GENERAL

2101A.1 Scope. This chapter shall govern the materials, design, construction and quality of masonry.

2101A.1.1 Application. *The scope of application of Chapter 21A is as follows:*

1. *Applications listed in Section 1.9.2.1 regulated by the Division of the State Architect-Structural Safety (DSA-SS). These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.*
2. *Applications listed in Sections 1.10.1, and 1.10.4 regulated by the Office of Statewide Health Planning and Development (OSHPD). These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 21 and any applicable amendments therein.

2101A.1.2 Amendments in this chapter. DSA-SS and OSHPD 1 & 4 adopt this chapter and all amendments.

Exception: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect-Structural Safety:
[DSA-SS] For applications listed in Section 1.9.2.1.*
2. *Office of Statewide Health Planning and Development:
[OSHPD 1] - For applications listed in Section 1.10.1.
[OSHPD 4] - For applications listed in Section 1.10.4.*

2101A.1.3 Prohibition: *The following design, systems, and materials are not permitted by DSA-SS and OSHPD:*

1. *Unreinforced masonry*
2. *Autoclaved aerated concrete (AAC) masonry*
3. *Empirical design of masonry*
4. *Adobe construction*
5. *Ordinary reinforced masonry shear walls*
6. *Intermediate reinforced masonry shear walls*
7. *Prestressed masonry shear walls*
8. *Direct design of masonry*

2101A.2 Design methods. Masonry shall comply with the provisions of one of the following design methods in this chapter as well as the requirements of Sections 2101A through 2104A. Masonry designed by the allowable stress design provisions of Section 2101A.2.1, or the strength design provisions of Section 2101A.2.2, shall comply with Section 2105A.

2101A.2.1 Allowable stress design. Masonry designed by the allowable stress design method shall comply with the provisions of Sections 2106A and 2107A.

2101A.2.2 Strength design. Masonry designed by the strength design method shall comply with the provisions of Sections 2106A and 2108A.

2101A.2.3 Prestressed masonry. *Not permitted by DSA and OSHPD.*

2101A.2.4 Empirical design. *Not permitted by DSA and OSHPD.*

2101A.2.5 Glass unit masonry. Glass unit masonry shall comply with the provisions of Section 2110A.

2101A.2.6 Masonry veneer. Masonry veneer shall comply with the provisions of Chapter 14.

2101A.2.7 Direct design. *Not permitted by DSA and OSHPD.*

2101A.3 Construction documents. The construction documents shall show all of the items required by this code including the following:

1. Specified size, grade, type and location of reinforcement, anchors and wall ties.
2. Reinforcing bars to be welded and welding procedure.
3. Size and location of structural elements.
4. Provisions for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature and moisture.
5. Loads used in the design of masonry.
6. Specified compressive strength of masonry at stated ages or stages of construction for which masonry is designed, except where specifically exempted by this code.
7. Details of anchorage of masonry to structural members, frames and other construction, including the type, size and location of connectors.
8. Size and permitted location of conduits, pipes and sleeves.
9. The minimum level of testing and inspection as defined in Chapter 17A, or an itemized testing and inspection program that meets or exceeds the requirements of Chapter 17A.

2101A.3.1 Fireplace drawings. The construction documents shall describe in sufficient detail the location, size and construction of masonry fireplaces. The thickness and characteristics of materials and the clearances from walls, partitions and ceilings shall be indicated.

SECTION 2102A DEFINITIONS AND NOTATIONS

2102A.1 General. The following terms are defined in Chapter 2, except those defined below which shall, for the purposes of this chapter, have the meanings shown herein:

AAC MASONRY.

ADOBE CONSTRUCTION.

Adobe, stabilized.

Adobe, unstabilized.

ANCHOR.

ARCHITECTURAL TERRA COTTA.

AREA.

Gross cross-sectional.

Net cross-sectional.

AUTOCLAVED AERATED CONCRETE (AAC).

BED JOINT.

BOND BEAM.

BRICK.

Calcium silicate (sand lime brick).

Clay or shale.

Concrete.

CAST STONE.

CELL.

CHIMNEY.

CHIMNEY TYPES.

High-heat appliance type.

Low-heat appliance type.

Masonry type.

Medium-heat appliance type.

CLEANOUT.

COLLAR JOINT.

COMPRESSIVE STRENGTH OF MASONRY.

DIMENSIONS.

Nominal.

Specified.

FIREPLACE.

FIREPLACE THROAT.

FOUNDATION PIER.

HEAD JOINT.

MASONRY.

Ashlar masonry.

Coursed ashlar.

Glass unit masonry.

Plain masonry.

Random ashlar.

Reinforced masonry.

Solid masonry.

Unreinforced (plain) masonry.

MASONRY UNIT.

Hollow.

Solid.

MORTAR.

MORTAR, SURFACE-BONDING.

PRESTRESSED MASONRY.

PRISM.

RUBBLE MASONRY.

Coursed rubble.

Random rubble.

Rough or ordinary rubble.

RUNNING BOND.

SHEAR WALL.

Detailed plain masonry shear wall.

Intermediate prestressed masonry shear wall.

Intermediate reinforced masonry shear wall.

Ordinary plain masonry shear wall.

Ordinary plain prestressed masonry shear wall.

Ordinary reinforced masonry shear wall.

Special prestressed masonry shear wall.

Special reinforced masonry shear wall.

SPECIFIED.

SPECIFIED COMPRESSIVE STRENGTH OF MASONRY, f'_{m} .

STACK BOND.

STONE MASONRY.

Ashlar stone masonry.

Rubble stone masonry.

STRENGTH.

Design strength.

Nominal strength.

Required strength.

THIN-BED MORTAR.

TIE, WALL.

TILE, STRUCTURAL CLAY.

CHAPTER 21A

MASONRY

SECTION 2101A GENERAL

2101A.1 Scope. This chapter shall govern the materials, design, construction and quality of masonry.

2101A.1.1 Application. *The scope of application of Chapter 21A is as follows:*

1. *Applications listed in Section 1.9.2.1 regulated by the Division of the State Architect-Structural Safety (DSA-SS). These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.*
2. *Applications listed in Sections 1.10.1, and 1.10.4 regulated by the Office of Statewide Health Planning and Development (OSHPD). These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 21 and any applicable amendments therein.

2101A.1.2 Amendments in this chapter. DSA-SS adopts this chapter and all amendments.

Exception: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect-Structural Safety:
[DSA-SS] For applications listed in Section 1.9.2.1.*
2. *Office of Statewide Health Planning and Development:
[OSHPD 1] - For applications listed in Section 1.10.1.
[OSHPD 4] - For applications listed in Section 1.10.4.*

2101A.1.3 Prohibition: The following design, systems, and materials are not permitted by DSA-SS and OSHPD:

1. *Unreinforced masonry*
2. *Autoclaved aerated concrete (AAC) masonry*
3. *Empirical design of masonry*
4. *Adobe construction*
5. *Ordinary reinforced masonry shear walls*
6. *Intermediate reinforced masonry shear walls*
7. *Prestressed masonry shear walls*
8. *Direct design of masonry*

2101A.2 Design methods. Masonry shall comply with the provisions of one of the following design methods in this chapter as well as the requirements of Sections 2101A through 2104A. Masonry designed by the allowable stress design provisions of Section 2101A.2.1, or the strength design provisions of Section 2101A.2.2, shall comply with Section 2105A.

2101A.2.1 Allowable stress design. Masonry designed by the allowable stress design method shall comply with the provisions of Sections 2106A and 2107A.

2101A.2.2 Strength design. Masonry designed by the strength design method shall comply with the provisions of Sections 2106A and 2108A.

2101A.2.3 Prestressed masonry. Not permitted by DSA and OSHPD.

2101A.2.4 Empirical design. Not permitted by DSA and OSHPD.

2101A.2.5 Glass unit masonry. Glass unit masonry shall comply with the provisions of Section 2110A.

2101A.2.6 Masonry veneer. Masonry veneer shall comply with the provisions of Chapter 14.

2101A.2.7 Direct design. Not permitted by DSA and OSHPD.

2101A.3 Construction documents. The construction documents shall show all of the items required by this code including the following:

1. Specified size, grade, type and location of reinforcement, anchors and wall ties.
2. Reinforcing bars to be welded and welding procedure.
3. Size and location of structural elements.
4. Provisions for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature and moisture.
5. Loads used in the design of masonry.
6. Specified compressive strength of masonry at stated ages or stages of construction for which masonry is designed, except where specifically exempted by this code.
7. Details of anchorage of masonry to structural members, frames and other construction, including the type, size and location of connectors.
8. Size and permitted location of conduits, pipes and sleeves.
9. The minimum level of testing and inspection as defined in Chapter 17A, or an itemized testing and inspection program that meets or exceeds the requirements of Chapter 17A.

2101A.3.1 Fireplace drawings. The construction documents shall describe in sufficient detail the location, size and construction of masonry fireplaces. The thickness and characteristics of materials and the clearances from walls, partitions and ceilings shall be indicated.

SECTION 2102A DEFINITIONS AND NOTATIONS

2102A.1 General. The following terms are defined in Chapter 2, except those defined below which shall, for the purposes of this chapter, have the meanings shown herein:

AAC MASONRY.

ADOBE CONSTRUCTION.

Adobe, stabilized.

Adobe, unstabilized.

ANCHOR.

ARCHITECTURAL TERRA COTTA.

AREA.

Gross cross-sectional.

Net cross-sectional.

AUTOCLAVED AERATED CONCRETE (AAC).

BED JOINT.

BOND BEAM.

BRICK.

Calcium silicate (sand lime brick).

Clay or shale.

Concrete.

CAST STONE.

CELL.

CHIMNEY.

CHIMNEY TYPES.

High-heat appliance type.

Low-heat appliance type.

Masonry type.

Medium-heat appliance type.

CLEANOUT.

COLLAR JOINT.

COMPRESSIVE STRENGTH OF MASONRY.

DIMENSIONS.

Nominal.

Specified.

FIREPLACE.

FIREPLACE THROAT.

FOUNDATION PIER.

HEAD JOINT.

MASONRY.

Ashlar masonry.

Coursed ashlar.

Glass unit masonry.

Plain masonry.

Random ashlar.

Reinforced masonry.

Solid masonry.

Unreinforced (plain) masonry.

MASONRY UNIT.

Hollow.

Solid.

MORTAR.

MORTAR, SURFACE-BONDING.

PRESTRESSED MASONRY.

PRISM.

RUBBLE MASONRY.

Coursed rubble.

Random rubble.

Rough or ordinary rubble.

RUNNING BOND.

SHEAR WALL.

Detailed plain masonry shear wall.

Intermediate prestressed masonry shear wall.

Intermediate reinforced masonry shear wall.

Ordinary plain masonry shear wall.

Ordinary plain prestressed masonry shear wall.

Ordinary reinforced masonry shear wall.

Special prestressed masonry shear wall.

Special reinforced masonry shear wall.

SPECIFIED.

SPECIFIED COMPRESSIVE STRENGTH OF MASONRY, f'_{m} .

STACK BOND.

STONE MASONRY.

Ashlar stone masonry.

Rubble stone masonry.

STRENGTH.

Design strength.

Nominal strength.

Required strength.

THIN-BED MORTAR.

TIE, WALL.

TILE, STRUCTURAL CLAY.

WALL.**Cavity wall.****Composite wall.****Dry-stacked, surface-bonded wall.**

Hollow-unit masonry wall. Type of construction made with hollow masonry units in which the units are laid and set in mortar, reinforced and grouted solid except as provided in Section 2114A.

Masonry-bonded hollow wall.**Parapet wall.****WYTHE.****NOTATIONS.** d_b = Diameter of reinforcement, inches (mm). F_s = Allowable tensile or compressive stress in reinforcement, psi (MPa). f_r = Modulus of rupture, psi (MPa). f'_{AAC} = Specified compressive strength of AAC masonry, the minimum compressive strength for a class of AAC masonry as specified in ASTM C 1386, psi (MPa). f'_{m} = Specified compressive strength of masonry at age of 28 days, psi (MPa). f'_{mi} = Specified compressive strength of masonry at the time of prestress transfer, psi (MPa). K = The lesser of the masonry cover, clear spacing between adjacent reinforcement, or five times d_b , inches (mm). L_s = Distance between supports, inches (mm). l_d = Required development length or lap length of reinforcement, inches (mm). P = The applied load at failure, pounds (N). S_t = Thickness of the test specimen measured parallel to the direction of load, inches (mm). S_w = Width of the test specimen measured parallel to the loading cylinder, inches (mm).

SECTION 2103A MASONRY CONSTRUCTION MATERIALS

2103A.1 Concrete masonry units. Concrete masonry units shall conform to the following standards: ASTM C 55 for concrete brick; ASTM C 73 for calcium silicate face brick; ASTM C 90 for load-bearing concrete masonry units or ASTM C 744 for prefaced concrete and calcium silicate masonry units.

2103A.2 Clay or shale masonry units. Clay or shale masonry units shall conform to the following standards: ASTM C 34 for structural clay load-bearing wall tile; ASTM C 56 for structural clay nonload-bearing wall tile; ASTM C

62 for building brick (solid masonry units made from clay or shale); ASTM C 1088 for solid units of thin veneer brick; ASTM C 126 for ceramic-glazed structural clay facing tile, facing brick and solid masonry units; ASTM C 212 for structural clay facing tile; ASTM C 216 for facing brick (solid masonry units made from clay or shale); ASTM C 652 for hollow brick (hollow masonry units made from clay or shale) or ASTM C 1405 for glazed brick (single-fired solid brick units).

Exception: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 or UL 263 and shall comply with the requirements of Table 602.

2103A.3 AAC masonry. Not permitted by DSA and OSHPD.

2103A.4 Stone masonry units. Stone masonry units shall conform to the following standards: ASTM C 503 for marble building stone (exterior); ASTM C 568 for limestone building stone; ASTM C 615 for granite building stone; ASTM C 616 for sandstone building stone; or ASTM C 629 for slate building stone.

2103A.5 Architectural cast stone. Architectural cast stone shall conform to ASTM C 1364.

2103A.6 Ceramic tile. Ceramic tile shall be as defined in, and shall conform to the requirements of, ANSI A137.1.

2103A.7 Glass unit masonry. Hollow glass units shall be partially evacuated and have a minimum average glass face thickness of $\frac{3}{16}$ inch (4.8 mm). Solid glass-block units shall be provided when required. The surfaces of units intended to be in contact with mortar shall be treated with a polyvinyl butyral coating or latex-based paint. Reclaimed units shall not be used.

2103A.8 Second-hand units. Second-hand masonry units shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old mortar shall be cleaned from the unit before reuse.

2103A.9 Mortar. Mortar for use in masonry construction shall conform to ASTM C 270 and Articles 2.1 and 2.6 A of TMS 602/ACI 530.1/ASCE 6, except for mortars listed in Section 2103A.10. Type S mortar conforming to ASTM C 270 shall be used for glass unit masonry.

2103A.10 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C 887. Surface bonding of concrete masonry units shall comply with ASTM C 946.

2103A.11 Mortars for ceramic wall and floor tile. Portland cement mortars for installing ceramic wall and floor tile shall comply with ANSI A108.1A and ANSI A108.1B and be of the compositions indicated in Table 2103A.11.

**TABLE 2103A.11
CERAMIC TILE MORTAR COMPOSITIONS**

| LOCATION | MORTAR | COMPOSITION |
|----------|-------------------------------|---|
| Walls | Scratchcoat | 1 cement; $\frac{1}{5}$ hydrated lime; 4 dry or 5 damp sand |
| | Setting bed and leveling coat | 1 cement; $\frac{1}{2}$ hydrated lime; 5 damp sand to 1 cement 1 hydrated lime, 7 damp sand |
| Floors | Setting bed | 1 cement; $\frac{1}{10}$ hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand |
| Ceilings | Scratchcoat and sand bed | 1 cement; $\frac{1}{2}$ hydrated lime; $2\frac{1}{2}$ dry sand or 3 damp sand |

2103A.11.1 Dry-set portland cement mortars. Premixed prepared portland cement mortars, which require only the addition of water and are used in the installation of ceramic tile, shall comply with ANSI A118.1. The shear bond strength for tile set in such mortar shall be as required in accordance with ANSI A118.1. Tile set in dry-set portland cement mortar shall be installed in accordance with ANSI A108.5.

2103A.11.2 Latex-modified portland cement mortar. Latex-modified portland cement thin-set mortars in which latex is added to dry-set mortar as a replacement for all or part of the gauging water that are used for the installation of ceramic tile shall comply with ANSI A118.4. Tile set in latex-modified portland cement shall be installed in accordance with ANSI A108.5.

2103A.11.3 Epoxy mortar. Ceramic tile set and grouted with chemical-resistant epoxy shall comply with ANSI A118.3. Tile set and grouted with epoxy shall be installed in accordance with ANSI A108.6.

2103A.11.4 Furan mortar and grout. Chemical-resistant furan mortar and grout that are used to install ceramic tile shall comply with ANSI A118.5. Tile set and grouted with furan shall be installed in accordance with ANSI A108.8.

2103A.11.5 Modified epoxy-emulsion mortar and grout. Modified epoxy-emulsion mortar and grout that are used to install ceramic tile shall comply with ANSI A118.8. Tile set and grouted with modified epoxy-emulsion mortar and grout shall be installed in accordance with ANSI A108.9.

2103A.11.6 Organic adhesives. Water-resistant organic adhesives used for the installation of ceramic tile shall comply with ANSI A136.1. The shear bond strength after water immersion shall not be less than 40 psi (275 kPa) for Type I adhesive and not less than 20 psi (138 kPa) for Type II adhesive when tested in accordance with ANSI A136.1. Tile set in organic adhesives shall be installed in accordance with ANSI A108.4.

2103A.11.7 Portland cement grouts. Portland cement grouts used for the installation of ceramic tile shall comply with ANSI A118.6. Portland cement grouts for tile work shall be installed in accordance with ANSI A108.10.

2103A.12 Mortar for AAC masonry. Not permitted by DSA and OSHPD.

2103A.13 Grout. Grout shall comply with Article 2.2 of TMS 602/ACI 530.1/ASCE 6.

2103A.13.1 Water. Water content shall be adjusted to provide proper workability and to enable proper placement under existing field conditions, without segregation.

2103A.13.2 Selecting proportions. Proportions of ingredients and any additives shall be based on laboratory or field experience with the grout ingredients and the masonry units to be used. Coarse grout proportioned by weight shall contain not less than 564 pounds of cementitious material per cubic yard (335 kg/m^3).

2103A.13.3 Aggregate. Coarse grout shall be used in grout spaces 2 inches (51 mm) or more in width and in all filled-cell masonry construction.

2103A.14 Metal reinforcement and accessories. Metal reinforcement and accessories shall conform to Article 2.4 of TMS 602/ACI 530.1/ASCE 6. Where unidentified reinforcement is approved for use, not less than three tension and three bending tests shall be made on representative specimens of the reinforcement from each shipment and grade of reinforcing steel proposed for use in the work.

2103A.15 Additives and admixtures.

2103A.15.1 General. Additives and admixtures to mortar or grout shall not be used unless approved by the enforcement agency.

2103A.15.2 Antifreeze compounds. Antifreeze liquids, chloride salts or other such substances shall not be used in mortar or grout.

2103A.15.3 Air entrainment. Air-entraining substances shall not be used in mortar or grout unless tests are conducted to determine compliance with the requirements of this code.

SECTION 2104A CONSTRUCTION

2104A.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104A.1.1 through 2104A.5 and with TMS 602/ACI 530.1/ASCE 6.

2104A.1.1 Tolerances. Masonry, except masonry veneer, shall be constructed within the tolerances specified in TMS 602/ACI 530.1/ASCE 6.

Exception: The maximum thickness of the initial bed joint in fully grouted masonry walls shall not exceed $1\frac{1}{4}$ inches (31.7 mm).

2104A.1.2 Placing mortar and units. Placement of mortar, grout, and clay, concrete, and glass, masonry units shall comply with TMS 602/ACI 530.1/ASCE 6. All mortar for glass unit masonry contact surfaces shall be treated to ensure adhesion between mortar and glass.

2104A.1.3 Installation of wall ties. Wall ties shall be installed in accordance with TMS 602/ACI 530.1/ASCE 6.

2104A.1.4 Chases and recesses. Chases and recesses shall be constructed as masonry units are laid. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on lintels.

2104A.1.5 Lintels. The design for lintels shall be in accordance with the masonry design provisions of either Section 2107A or 2108A.

2104A.1.6 Support on wood. Masonry shall not be supported on wood girders or other forms of wood construction except as permitted in Section 2304.12.

2104A.2 Corbeled masonry. Corbeled masonry shall comply with the requirements of Section 1.12 of TMS 402/ACI 530/ASCE 5.

2104A.2.1 Molded cornices. Unless structural support and anchorage are provided to resist the overturning moment, the center of gravity of projecting masonry or molded cornices shall lie within the middle one-third of the supporting wall. Terra cotta and metal cornices shall be provided with a structural frame of approved noncombustible material anchored in an approved manner.

2104A.3 Cold weather construction. The cold weather construction provisions of TMS 602/ACI 530.1/ASCE 6, Article 1.8 C, shall be implemented when the ambient temperature falls below 40°F (4°C).

2104A.4 Hot weather construction. The hot weather construction provisions of TMS 602/ACI 530.1/ASCE 6, Article 1.8 D, shall be implemented when the ambient air temperature exceeds 100°F (37.8°C), or 90°F (32.2°C) with a wind velocity greater than 8 mph (12.9 km/hr).

2104A.5 Grouted masonry.

2104A.5.1 General conditions. Grouted masonry shall be constructed in such a manner that all elements of the masonry act together as a structural element. At the time of laying, all masonry units shall be free of dust and dirt. Prior to grouting, the grout space shall be clean so that all spaces to be filled with grout do not contain mortar projections greater than $\frac{1}{4}$ inch (6.4 mm), mortar droppings and other foreign material. Grout shall be placed so that all spaces to be grouted do not contain voids.

Grout materials and water content shall be controlled to provide adequate fluidity for placement without segregation of the constituents, and shall be mixed thoroughly. Segregation of the grout materials and damage to the masonry shall be avoided during the grouting process.

Reinforcement and embedded items shall be clean, properly positioned and securely anchored against movement prior to grouting. Bolts shall be accurately set with templates or by approved equivalent means and held in place to prevent dislocation during grouting. Reinforcement, embedded items and bolts shall be solidly embedded in grout. Anchor bolts in the face shells of hollow masonry units shall be positioned to maintain a minimum of $\frac{1}{2}$ in. of grout between the bolt and the face shell.

The grouting of any section of wall shall be completed in one day with no interruptions greater than one hour.

Grout pours greater than 12 inches (300 mm) in height shall be consolidated by mechanical vibration during placement to fill the grout space before loss of plasticity, and reconsolidated by mechanical vibration to minimize voids due to water loss. Grout pours less than 12 inches in height may be puddled.

Between grout pours, or where grouting has been stopped more than an hour, a horizontal construction joint shall be formed by stopping all wythes at the same elevation and with the grout stopping a minimum of $1\frac{1}{2}$ inches (38 mm) below a mortar joint, except at the top of the wall. Where bond beams occur, the grout pour shall be stopped a minimum of $\frac{1}{2}$ inch (12.7 mm) below the top of the masonry.

Grout shall not be handled nor pumped utilizing aluminum equipment unless it can be demonstrated with the materials and equipment to be used that there will be no deleterious effect on the strength of the grout.

2104A.5.1.1 Reinforced grouted masonry.

2104A.5.1.1.1 General. Reinforced grouted masonry is that form of construction made with clay or shale brick or made with solid concrete building brick in which interior joints of masonry are filled by pouring grout around reinforcement therein as the work progresses.

2104A.5.1.1.2 Low-lift grouted construction. Requirements for construction shall be as follows:

1. All units in the two outer wythes shall be laid with full-shoved head joint and bed mortar joints. Masonry headers shall not project into the grout space.
2. The minimum grout space for low-lift grout masonry shall be $2\frac{1}{2}$ inches (64 mm). All reinforcement and wire ties shall be embedded in the grout. The thickness of the grout between masonry units and reinforcement shall be a minimum of one bar diameter.
3. One tier of a grouted reinforced masonry wall may be carried up 12 inches (305 mm) before grouting, but the other tier shall be laid up and grouted in lifts not to exceed one masonry unit in height. All grout shall be puddled with a mechanical vibrator or wood stick immediately after placing so as to completely fill all voids and to consolidate the grout. All vertical and horizontal steel shall be held firmly in place by a frame or suitable devices.
4. Tooothing of masonry walls is prohibited. Racking is to be held to a minimum.

2104A.5.1.1.3 High-lift grouted construction. Where high-lift grouting is used, the method shall

be subject to the approval of the enforcement agency. Requirements for construction shall be as follows:

1. All units in the two wythes shall be laid with full head and bed mortar joints.
2. The two wythes shall be bonded together with wall ties. Ties shall not be less than No. 9 wire in the form of rectangles 4 inches (102 mm) wide and 2 inches (51 mm) in length less than the overall wall thickness. Kinks, water drips, or deformations shall not be permitted in the ties. One tier of the wall shall be built up not more than 16 inches (406 mm) ahead of the other tier. Ties shall be laid not to exceed 24 inches (610 mm) on center horizontally and 16 inches (406 mm) on center vertically for running bond, and not more than 24 inches (610 mm) on center horizontally and 12 inches (305 mm) on center vertically for stack bond.
3. Cleanouts shall be provided for each pour by leaving out every other unit in the bottom tier of the section being poured or by cleanout openings in the foundation. The foundation or other horizontal construction joints shall be cleaned of all loose material and mortar droppings before each pour. The cleanouts shall be sealed after inspection and before grouting.
4. The grout space in high-lift grouted masonry shall be a minimum of $3\frac{1}{2}$ inches (89 mm). All reinforcing and wire ties shall be embedded in the grout. The thickness of the grout between masonry units and reinforcement shall be a minimum of one bar diameter.
5. Vertical grout barriers or dams of solid masonry shall be built across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be spaced not more than 30 feet (9144 mm) apart.
6. An approved admixture of a type that reduces early water loss and produces an expansive action shall be used in high-lift grout.
7. Grouting shall be done in a continuous pour in lifts not exceeding 4 feet (1219 mm). Grout shall be consolidated by mechanical vibration only, and shall be reconsolidated after excess moisture has been absorbed, but before plasticity is lost. The grouting of any section of a wall between control barriers shall be completed in one day, with no interruptions greater than one hour.

2104A.5.1.2 Reinforced hollow-unit masonry.

2104A.5.1.2.1 General. Reinforced hollow-unit masonry is that type of construction made with hollow-masonry units in which cells are continuously filled with grout, and in which reinforcement is embedded. All cells shall be solidly filled with grout in reinforced hollow-unit masonry, except as provided in Section 2114A.1. Construction shall be one of the two following methods: The low-lift method where the maximum height of construction laid before grouting is 4 feet (1220 mm), or the high-lift method where the full height of construction between horizontal cold joints is grouted in one operation. General requirements for construction shall be as follows:

1. Bond shall be provided by lapping units in successive vertical courses. Where stack bond is used in reinforced hollow-unit masonry, the open-end type of unit shall be used with vertical reinforcement spaced a maximum of 16 inches (406 mm) on center.
2. Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear unobstructed, continuous vertical cell measuring not less than 2 inches by 3 inches (51 mm by 76 mm), except the minimum cell dimension for high-lift grout shall be 3 inches (76 mm).
3. Grout shall be a workable mix suitable for placing without segregation and shall be thoroughly mixed. Grout shall be placed by pumping or an approved alternate method and shall be placed before initial set or hardening occurs. Grout shall be consolidated by mechanical vibration during placing and reconsolidated after excess moisture has been absorbed, but before workability is lost.
4. All reinforcement and wire ties shall be embedded in the grout. The space between masonry unit surfaces and reinforcement shall be a minimum of one bar diameter.
5. Horizontal reinforcement shall be placed in bond beam units with a minimum grout cover of 1 inch (25 mm) above steel for each grout pour. The depth of the bond beam channel below the top of the unit shall be a minimum of $1\frac{1}{2}$ inches (38 mm) and the width shall be 3 inches (76 mm) minimum.

2104A.5.1.2.2 Low-lift grouted construction. Units || shall be laid a maximum of 4 feet (1220 mm) before grouting. Grouting shall follow each 4 feet (1220 mm) of construction laid and shall be consolidated so as to completely fill all voids and embed all reinforcing steel. Horizontal reinforcement shall be fully embedded in grout in an uninterrupted pour.

2104A.5.1.2.3 High-lift grouted construction. || Where high-lift grouting is used, the method shall

be approved by the enforcement agency. Cleanout openings shall be provided in every cell at the bottom of each pour of grout. Alternatively, if the course at the bottom of the pour is constructed entirely of inverted open-end bond beam units, cleanout openings need only be provided for access to every reinforced cell at the bottom of each pour of grout. The cleanouts shall be sealed before grouting. An approved admixture that reduces early water loss and produces an expansive action shall be used in the grout.

SECTION 2105A QUALITY ASSURANCE

2105A.1 General. A quality assurance program shall be used to ensure that the constructed masonry is in compliance with the construction documents.

The quality assurance program shall comply with the inspection and testing requirements of Chapter 17A.

2105A.2 Acceptance relative to strength requirements. Where required by Chapter 17A, verification of the strength of masonry shall be in accordance with Sections 2105A.2.1 and 2105A.2.2.

2105A.2.1 Compliance with f'_m . Compressive strength of masonry shall be considered satisfactory if the compressive strength of each masonry wythe and grouted collar joint equals or exceeds the value of f'_m for clay and concrete masonry and requirements of Section 2105A.2.2 are satisfied. For partially grouted clay and concrete masonry, the compressive strength of both the grouted and ungrouted masonry shall equal or exceed the applicable f'_m . The specified compressive strength, f'_m , assumed in design shall be 1,500 psi (10.34 MPa) for all masonry construction using materials and details of construction required herein. Testing of the constructed masonry shall be provided in accordance with Section 2105A.4 [OSHPD 1 & 4] or 2105A.5 [DSA-SS].

Exception: [DSA-SS] Subject to the approval of the enforcement agency, higher values of f'_m may be used in the design of reinforced grouted masonry and reinforced hollow-unit masonry. The approval shall be based on prism test results submitted by the architect or engineer which demonstrate the ability of the proposed construction to meet prescribed performance criteria for strength and stiffness. The design shall take into account the mortar joint depth. In no case shall the f'_m assumed in design exceed 3,000 psi (20.7 MPa).

Where an f'_m greater than 1,500 psi (10.34 MPa) is approved, the architect or structural engineer shall establish a method of quality control of the masonry construction acceptable to the enforcement agency which shall be described in the contract specifications. Compliance with the requirements for the specified compressive strength of masonry f'_m shall be provided in accordance with Section 2105A.2.2.1 or 2105A.2.2.2. Substantiation for the specified compressive strength prior to the start of construction shall be

obtained in accordance with Section 2105A.2.2.2. Testing of the constructed masonry shall be provided in accordance with Section 2105A.5.

Exception: [OSHPD 1 & 4] Subject to the approval of the enforcement agency, higher values of f'_m may be used in the design of reinforced grouted masonry and reinforced hollow-unit masonry. The approval shall be based on prism test results submitted by the architect or engineer which demonstrate the ability of the proposed construction to meet prescribed performance criteria for strength and stiffness. The design shall assume that the reinforcement will be placed in a location that will produce the largest stresses within the tolerances allowed in Section 2104A.1.1 and shall take into account the mortar joint depth. In no case shall the f'_m assumed in design exceed 3,000 psi (20.7 MPa).

Where an f'_m greater than 1,500 psi (10.34 MPa) is approved, the architect or structural engineer shall establish a method of quality control of the masonry construction acceptable to the enforcement agency which shall be described in the contract specifications. Compliance with the requirements for the specified strength of constructed masonry shall be provided in accordance with Sections 2105A.2.2.2 and 2105A.4. Substantiation for the specified compressive strength prior to the start of construction shall be obtained in accordance with Sections 2105A.2.2.2.2 and 2105A.2.2.1.4.

2105A.2.2 Determination of compressive strength. The compressive strength for each wythe shall be determined by the unit strength method or by the prism test method as specified herein.

2105A.2.2.1 Unit strength method. The determination of compressive strength by the unit strength method shall be in accordance with Section 2105A.2.2.1.1 for clay masonry and Section 2105A.2.2.1.2 for concrete masonry.

2105A.2.2.1.1 Clay masonry. The compressive strength of masonry shall be determined based on the strength of the units and the type of mortar specified using Table 2105A.2.2.1.1, provided:

1. Units are sampled and tested to verify compliance with ASTM C 62, ASTM C 216 or ASTM C 652.
2. Thickness of bed joints does not exceed $\frac{5}{8}$ inch (15.9 mm).
3. For grouted masonry, the grout meets one of the following requirements:
 - 3.1. Grout conforms to Article 2.2 of TMS 602/ACI 530.1/ASCE 6.
 - 3.2. Minimum grout compressive strength equals or exceeds f'_m but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

TABLE 2105A.2.2.1.1
COMPRESSIVE STRENGTH OF CLAY MASONRY

| NET AREA COMPRESSIVE STRENGTH OF CLAY MASONRY UNITS (psi) | | NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi) |
|---|---------------|--|
| Type M or S mortar | Type N mortar | |
| 1,700 | 2,100 | 1,000 |
| 3,350 | 4,150 | 1,500 |
| 4,950 | 6,200 | 2,000 |
| 6,600 | 8,250 | 2,500 |
| 8,250 | 10,300 | 3,000 |
| 9,900 | — | 3,500 |
| 11,500 | — | 4,000 |

For SI: 1 pound per square inch = 0.00689 MPa.

2105A.2.2.1.2 Concrete masonry. The compressive strength of masonry shall be determined based on the strength of the unit and type of mortar specified using Table 2105A.2.2.1.2, provided:

1. Units are sampled and tested to verify compliance with ASTM C 55 or ASTM C 90.
2. Thickness of bed joints does not exceed $\frac{5}{8}$ inch (15.9 mm).
3. For grouted masonry, the grout meets one of the following requirements:
 - 3.1. Grout conforms to Article 2.2 of TMS 602/ACI 530.1/ASCE 6.
 - 3.2. Minimum grout compressive strength equals or exceeds f'_m but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

TABLE 2105A.2.2.1.2
COMPRESSIVE STRENGTH OF CONCRETE MASONRY

| NET AREA COMPRESSIVE STRENGTH OF CONCRETE MASONRY UNITS (psi) | | NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi) ^a |
|---|---------------|---|
| Type M or S mortar | Type N mortar | |
| 1,250 | 1,300 | 1,000 |
| 1,900 | 2,150 | 1,500 |
| 2,800 | 3,050 | 2,000 |
| 3,750 | 4,050 | 2,500 |
| 4,800 | 5,250 | 3,000 |

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa.

a. For units less than 4 inches in height, 85 percent of the values listed.

2105A.2.2.1.3 AAC masonry. Not permitted by the DSA.

2105A.2.2.1.4 Mortar and grout tests. These tests are to establish whether the masonry components meet the specified component strengths. At the beginning of all masonry work, at least one test sample of the mortar and grout shall be taken on three successive working days and at least at one-week intervals thereafter. They shall meet the minimum strength requirement given in Sections 2103A.9 and 2103A.13 for mortar and grout, respectively. Addi-

tional samples shall be taken whenever any change in materials or job conditions occur, or whenever in the judgment of the architect, structural engineer or the enforcement agency such tests are necessary to determine the quality of the material. When the prism test method of Section 2105A.2.2.2 is used during construction, the tests in this section are not required.

Test specimens for mortar and grout shall be made as set forth in ASTM C 1586 and ASTM C 1019

2105A.2.2.2 Prism test method. The determination of compressive strength by the prism test method shall be in accordance with Sections 2105A.2.2.1 and 2105A.2.2.2.2.

2105A.2.2.2.1 General. The compressive strength of clay and concrete masonry shall be determined by the prism test method *prior to the start of construction and during construction*:

1. Where specified in the construction documents.
2. Where masonry does not meet the requirements for application of the unit strength method in Section 2105A.2.2.1.
3. Where required by Section 2105A.2.1.

2105A.2.2.2.2 Number of prisms per test. Prior to the start of construction, a prism test shall consist of five prisms constructed and tested in accordance with ASTM C 1314. A set of three masonry prisms shall be built during construction in accordance with ASTM C 1314 for each 5,000 square feet (465 m²) of wall area, but not less than one set of three prisms for the project. Each set of prisms shall equal or exceed f'_m .

2105A.3 Testing prisms from constructed masonry. When approved by the building official, acceptance of masonry that does not meet the requirements of Section 2105A.2.2.1, 2105A.2.2.2, 2105A.4, 2105A.5 or 2105A.2.2.1.4 shall be permitted to be based on tests of prisms cut from the masonry construction in accordance with Sections 2105A.3.1, 2105A.3.2 and 2105A.3.3.

2105A.3.1 Prism sampling and removal. A set of three masonry prisms that are at least 28 days old shall be saw cut from the masonry for each 5,000 square feet (465 m²) of the wall area that is in question but not less than one set of three masonry prisms for the project. The length, width and height dimensions of the prisms shall comply with the requirements of ASTM C 1314. Transporting, preparation and testing of prisms shall be in accordance with ASTM C 1314.

2105A.3.2 Compressive strength calculations. The compressive strength of prisms shall be the value calculated in accordance ASTM C 1314, except that the net cross-sectional area of the prism shall be based on the net mortar bedded area.

2105A.3.3 Compliance. Compliance with the requirement for the specified compressive strength of masonry, f'_m , shall be considered satisfied provided the modified compressive strength equals or exceeds the specified f'_m . Additional testing of specimens cut from locations in question shall be permitted.

2105A.4 Masonry core testing. [OSHPD 1 & 4] Not less than two cores shall be taken from each building for each 5,000 square feet (465 m^2) of the greater of the masonry wall area or the floor area or fraction thereof. The architect or structural engineer in responsible charge of the project or his or her representative or the inspector of record shall select the areas for sampling. Cores shall be a minimum of $3\frac{3}{4}$ inches (76 mm) in diameter and shall be taken in such a manner as to exclude masonry unit webs and reinforcing steel. The inspector of record or testing agency shall inspect the coring of the masonry walls.

Visual examination of all cores shall be made by a laboratory acceptable to the building official and the condition of the cores reported as required by the California Administrative Code. One half of the number of cores taken shall be tested in shear. The shear test shall test both joints between the grout core and the outside wythes or face shells of the masonry. Shear testing apparatus shall be of a design approved by the enforcement agency. Core samples shall not be soaked before testing. The unit shear on the cross section of the core shall not be less than $2.5 \text{ f'}_m \text{ psi}$.

All cores shall be submitted to the laboratory, acceptable to the building official, for examination regardless of whether the core specimens failed during the cutting operation. The laboratory shall report the location where each core was taken, the findings of their visual examination of each core, identify which cores were selected for shear testing and the results of the shear tests.

> **2105A.5 [DSA-SS] Masonry core testing.** Not less than two cores shall be taken from each building for each 5,000 square feet (465 m^2) of the greater of the masonry wall area or the floor area or fraction thereof. The architect or structural engineer in responsible charge of the project or his/her representative or the inspector of record shall select the areas for sampling. Cores shall be a minimum of $3\frac{3}{4}$ inches (76 mm) in diameter and shall be taken in such a manner as to exclude masonry unit webs and reinforcing steel. If vertical reinforcing steel is placed such that cores will include reinforcing steel, core testing may be waived by the design professional in responsible charge, as approved by the enforcement agency. The inspector of record shall observe the coring of the masonry walls.

Visual examination of all cores shall be made by a laboratory acceptable to the building official and the condition of the cores reported as required by the California Administrative Code. All cores taken shall be tested in shear. The shear test shall test both joints between the grout core and the outside wythes or face shell of the masonry. Shear testing apparatus shall be of a design approved by the enforcement agency. Core samples shall not be soaked before testing. The average unit shear on the cross section of all the cores shall not be less than $2.5 \text{ f'}_m \text{ psi}$.

All cores shall be submitted to the laboratory, acceptable to the building official, for examination, regardless of whether the outside wythe or face shells separated during the cutting operation. The laboratory shall report the location where each core was taken, the findings of their visual examination of each core, and the results of the shear tests.

SECTION 2106A SEISMIC DESIGN

2106A.1 Seismic design requirements for masonry. Masonry structures and components shall comply with the requirements in Section 1.18 of TMS 402/ACI 530/ASCE 5 depending on the structure's seismic design category.

2106A.1.1 Modifications to TMS 402/ACI 530/ASCE 5.

Modify TMS 402/ACI 530/ASCE 5/Section 1.18 as follows:

1. Minimum reinforcement requirements for masonry walls. The total area of reinforcement in reinforced masonry walls shall not be less than 0.003 times the sectional area of the wall. Neither the horizontal nor the vertical reinforcement shall be less than one third of the total. Horizontal and vertical reinforcement shall be spaced at not more than 24 inches (610 mm) center to center. The minimum reinforcing shall be No. 4, except that No. 3 bars may be used for ties and stirrups. Vertical wall reinforcement shall have dowels of equal size and equal matched spacing in all footings. Reinforcement shall be continuous around wall corners and through intersections. Only reinforcement which is continuous in the wall shall be considered in computing the minimum area of reinforcement. Reinforcement with splices conforming to TMS 402/ACI 530/ASCE 5 as modified by Section 2107A and 2108A shall be considered as continuous reinforcement.

Horizontal reinforcement shall be provided in the top of footings, at the top of wall openings, at roof and floor levels, and at the top of parapet walls. For walls 12 inches (nominal) (305 mm) or more in thickness, horizontal and vertical reinforcement shall be equally divided into two layers, except where designed as retaining walls. Where reinforcement is added above the minimum requirements, such additional reinforcement need not be so divided.

In bearing walls of every type of reinforced masonry, there shall be trim reinforcement of not less than one No. 5 bar or two No. 4 bars on all sides of, and adjacent to, every opening which exceeds 16 inches (406 mm) in either direction, and such bars shall extend not less than 48 diameters, but in no case less than 24 inches (610 mm) beyond the corners of the opening. The bars required by this paragraph shall be in addition to the minimum reinforcement elsewhere required.

When the reinforcement in bearing walls is designed, placed and anchored in position as for columns, the allowable stresses shall be as for columns.

Joint reinforcement shall not be used as principal reinforcement in masonry designed by the strength design method.

2. **Minimum reinforcement for masonry columns.** The spacing of column ties shall be as follows: not greater than 8 bar diameters, 24 tie diameters, or one half the least dimension of the column for the full column height. Ties shall be at least $\frac{3}{8}$ -inch (10 mm) diameter and shall be embedded in grout. Top tie shall be within 2 inches (51 mm) of the top of the column or of the bottom of the horizontal bar in the supported beam.
3. **Lateral support.** Lateral support of masonry may be provided by cross walls, columns, pilasters, counterforts or buttresses where spanning horizontally or by floors, beams, girts or roofs where spanning vertically. Where walls are supported laterally by vertical elements, the stiffness of each vertical element shall exceed that of the tributary area of the wall.
4. **Anchor bolts.** Bent bar anchor bolts shall not be allowed. The maximum size anchor shall be $\frac{1}{2}$ -inch (13 mm) diameter for 6-inch (152 mm) nominal masonry, $\frac{3}{4}$ -inch (19 mm) diameter for 8-inch (203 mm) nominal masonry, $\frac{7}{8}$ -inch (22 mm) diameter for 10-inch (254 mm) nominal masonry, and 1-inch (25 mm) diameter for 12-inch (304.8 mm) nominal masonry.

SECTION 2107A ALLOWABLE STRESS DESIGN

2107A.1 General. The design of masonry structures using allowable stress design shall comply with Section 2106A and the requirements of Chapters 1 and 2 of TMS 402/ACI 530/ASCE 5 except as modified by Sections 2107A.2 through 2107A.6.

2107A.2 TMS 402/ACI 530/ASCE 5, Section 2.1.7.7.1.1, lap splices. In lieu of Section 2.1.7.7.1.1, it shall be permitted to design lap splices in accordance with Section 2107A.2.1.

2107A.2.1 Lap splices. The minimum length of lap splices for reinforcing bars in tension or compression, l_d , shall be

$$l_d = 0.002d_b f_s \quad (\text{Equation 21A-1})$$

For SI: $l_d = 0.29d_b f_s$

but not less than 12 inches (305 mm). In no case shall the length of the lapped splice be less than 40 bar diameters, and need not be greater than 72 bar diameters.

where:

d_b =Diameter of reinforcement, inches (mm).

f_s = Computed stress in reinforcement due to design loads, psi (MPa).

In regions of moment where the design tensile stresses in the reinforcement are greater than 80 percent of the allowable steel tension stress, F_s , the lap length of splices shall be increased not less than 50 percent of the minimum required length. Other equivalent means of stress transfer to accomplish the same 50 percent increase shall be permitted. Where epoxy coated bars are used, lap length shall be increased by 50 percent.

2107A.3 TMS 402/ACI 530/ASCE 5, Section 2.1.7.7, splices of reinforcement. Modify Section 2.1.7.7 as follows:

2.1.7.7 Splices of reinforcement. Lap splices, welded splices or mechanical splices are permitted in accordance with the provisions of this section. All welding shall conform to AWS D1.4. Welded splices shall be of ASTM A 706 steel reinforcement. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section 2.1.7.7.3.

2107A.4 TMS 402/ACI 530/ASCE 5, Section 2.3.7, maximum bar size. Add the following to Chapter 2:

2.3.7 Maximum bar size. The bar diameter shall not exceed one-eighth of the nominal wall thickness and shall not exceed one-quarter of the least dimension of the cell, course or collar joint in which it is placed.

2107A.5 TMS 402/ACI 530/ASCE 5. Modify by adding Section 2.1.8, as follows:

2.1.8 - Walls and Piers.

Thickness of Walls. For thickness limitations of walls as specified in this chapter, nominal thickness shall be used. Stresses shall be determined on the basis of the net thickness of the masonry, with consideration for reduction, such as raked joints.

The thickness of masonry walls shall be designed so that allowable maximum stresses specified in this chapter are not exceeded. Also, no masonry wall shall exceed the height or length-to-thickness ratio or the minimum thickness as specified in this chapter and as set forth in Table 2107A.5, below.

Piers. Every pier or wall section which width is less than three times its thickness shall be designed and constructed as required for columns if such pier is a structural member. Every pier or wall section which width is between three and five times its thickness or less than one half the height of adjacent openings shall have all horizontal steel in the form of ties except that in walls 12 inches (305 mm) or less in thickness such steel may be in the form of hairpins.

2107A.6 [OSHPD 1 & 4] Modify TMS402/ACI 530/ASCE 5, Section 2.3.4.4 by the following:

All reinforced masonry components that are subjected to in-plane forces shall have a maximum reinforcement ratio, ρ_{max} , not greater than that computed by Equation 2-23.

**TABLE 2107A.5
MINIMUM THICKNESS OF MASONRY WALLS^{1,2}**

| TYPE OF MASONRY | MAXIMUM RATIO UNSUPPORTED HEIGHT OR LENGTH TO THICKNESS ^{3,4} | NOMINAL MINIMUM THICKNESS (inches) |
|-----------------------------------|--|------------------------------------|
| BEARING OR SHEAR WALLS: | | |
| 1. Stone masonry | 14 | 16 |
| 2. Reinforced grouted masonry | 25 | 6 |
| 3. Reinforced hollow-unit masonry | 25 | 6 |
| NONBEARING WALLS: | | |
| 4. Exterior reinforced walls | 30 | 6 |
| 5. Interior partitions reinforced | 36 | 4 |

1. For walls of varying thickness, use the least thickness when determining the height or length to thickness ratio.
2. In determining the height or length to thickness ratio of a cantilevered wall, the dimension to be used shall be twice the dimension of the end of the wall from the lateral support.
3. Cantilevered walls not part of a building and not carrying applied vertical loads need not meet these minimum requirements but their design must comply with stress and overturning requirements.

SECTION 2108A STRENGTH DESIGN OF MASONRY

2108A.1 General. The design of masonry structures using strength design shall comply with Section 2106A and the requirements of Chapters 1 and 3 of TMS 402/ACI 530/ASCE 5, except as modified by Sections 2108A.2 through 2108A.3.

2108A.2 TMS 402/ACI 530/ASCE 5, Section 3.3.3.3 development. Modify the second paragraph of Section 3.3.3.3 as follows:

The required development length of reinforcement shall be determined by Equation (3-16), but shall not be less than 12 inches (305 mm) and need not be greater than $72 d_b$.

2108A.3 TMS 402/ACI 530/ASCE 5, Section 3.3.3.4, splices. Modify items (b) and (c) of Section 3.3.3.4 as follows:

3.3.3.4 (c). A welded splice shall have the bars butted and welded to develop at least 125 percent of the yield strength, f_y , of the bar in tension or compression, as required. Welded splices shall be of ASTM A 706 steel reinforcement. Welded splices shall not be permitted in plastic hinge zones of intermediate or special reinforced walls or special moment frames of masonry.

3.3.3.4 (d). Mechanical splices shall be classified as Type 1 or 2 according to Section 21.2.6.1 of ACI-318. Type 1 mechanical splices shall not be used within a plastic hinge zone or within a beam-column joint of intermediate or special reinforced masonry shear walls or special moment frames. Type 2 mechanical splices are permitted in any location within a member.

SECTION 2109A EMPIRICAL DESIGN OF MASONRY *Not permitted by OSHPD and DSA.*

SECTION 2110A GLASS UNIT MASONRY

2110A.1 General. Masonry of glass blocks shall be permitted in nonload-bearing exterior or interior walls and shall conform to the requirements of Section 2115A. Stresses in glass block shall not be utilized. Glass block may be solid or hollow and may contain inserts.

SECTION 2111A MASONRY FIREPLACES

2111A.1 Definition. A masonry fireplace is a fireplace constructed of concrete or masonry. Masonry fireplaces shall be constructed in accordance with this section.

2111A.2 Footings and foundations. Footings for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and shall extend at least 6 inches (153 mm) beyond the face of the fireplace or foundation wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

2111A.2.1 Ash dump cleanout. Cleanout openings, located within foundation walls below fireboxes, when provided, shall be equipped with ferrous metal or masonry doors and frames constructed to remain tightly closed, except when in use. Cleanouts shall be accessible and located so that ash removal will not create a hazard to combustible materials.

2111A.3 Seismic reinforcing. In structures assigned to Seismic Design Category A or B, reinforcement and seismic anchorage are not required. Masonry or concrete fireplaces shall be constructed, anchored, supported and reinforced as required in this chapter. In structures assigned to Seismic Design Category C or D, masonry and concrete fireplaces shall be reinforced and anchored as detailed in Sections 2111A.3.1, 2111A.3.2, 2111A.4 and 2111A.4.1 for chimneys serving fireplaces. In structures assigned to Seismic Design Category E or F, masonry and concrete chimneys shall be reinforced in accordance with the requirements of Sections 2101A through 2108A.

2111A.3.1 Vertical reinforcing. For fireplaces with chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete between wythes of solid masonry or within the cells of hollow unit masonry and grouted in accordance with Section 2103A.12. For fireplaces with chimneys greater than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 inches (1016 mm) in width or fraction thereof.

2111A.3.2 Horizontal reinforcing. Vertical reinforcement shall be placed enclosed within $\frac{1}{4}$ -inch (6.4 mm) ties or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) on center in concrete; or placed in the bed joints of unit masonry at a minimum of every 18 inches (457 mm) of vertical height. Two

such ties shall be provided at each bend in the vertical bars.

2111A.4 Seismic anchorage. Masonry and concrete chimneys in structures assigned to Seismic Design Category C or D shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade, except where constructed completely within the exterior walls. Anchorage shall conform to the following requirements.

2111A.4.1 Anchorage. Two $\frac{3}{16}$ -inch by 1-inch (4.8 mm by 25.4 mm) straps shall be embedded a minimum of 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to a minimum of four floor joists with two $\frac{1}{2}$ -inch (12.7 mm) bolts.

2111A.5 Firebox walls. Masonry fireboxes shall be constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete. When a lining of firebrick at least 2 inches (51 mm) in thickness or other approved lining is provided, the minimum thickness of back and sidewalls shall each be 8 inches (203 mm) of solid masonry, including the lining. The width of joints between firebricks shall not be greater than $\frac{1}{4}$ inch (6.4 mm). When no lining is provided, the total minimum thickness of back and sidewalls shall be 10 inches (254 mm) of solid masonry. Firebrick shall conform to ASTM C 27 or ASTM C 1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C 199.

2111A.5.1 Steel fireplace units. Steel fireplace units are permitted to be installed with solid masonry to form a masonry fireplace provided they are installed according to either the requirements of their listing or the requirements of this section. Steel fireplace units incorporating a steel firebox lining shall be constructed with steel not less than $\frac{1}{4}$ inch (6.4 mm) in thickness, and an air-circulating chamber which is ducted to the interior of the building. The firebox lining shall be encased with solid masonry to provide a total thickness at the back and sides of not less than 8 inches (203 mm), of which not less than 4 inches (102 mm) shall be of solid masonry or concrete. Circulating air ducts employed with steel fireplace units shall be constructed of metal or masonry.

2111A.6 Firebox dimensions. The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall not be less than 8 inches (203 mm) above the fireplace opening. The throat opening shall not be less than 4 inches (102 mm) in depth. The cross-sectional area of the passageway above the firebox, including the throat, damper and smoke chamber, shall not be less than the cross-sectional area of the flue.

Exception: Rumford fireplaces shall be permitted provided that the depth of the fireplace is at least 12 inches (305 mm) and at least one-third of the width of the fireplace opening, and the throat is at least 12 inches (305 mm) above the lintel, and at least $\frac{1}{20}$ the cross-sectional area of the fireplace opening.

2111A.7 Lintel and throat. Masonry over a fireplace opening shall be supported by a lintel of noncombustible material. The minimum required bearing length on each end of the fireplace opening shall be 4 inches (102 mm). The fireplace

throat or damper shall be located a minimum of 8 inches (203 mm) above the top of the fireplace opening.

2111A.7.1 Damper. Masonry fireplaces shall be equipped with a ferrous metal damper located at least 8 inches (203 mm) above the top of the fireplace opening. Dampers shall be installed in the fireplace or at the top of the flue venting the fireplace, and shall be operable from the room containing the fireplace. Damper controls shall be permitted to be located in the fireplace.

2111A.8 Smoke chamber walls. Smoke chamber walls shall be constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete. The total minimum thickness of front, back and sidewalls shall be 8 inches (203 mm) of solid masonry. The inside surface shall be parged smooth with refractory mortar conforming to ASTM C 199. When a lining of firebrick at least 2 inches (51 mm) thick, or a lining of vitrified clay at least $\frac{5}{8}$ inch (15.9 mm) thick, is provided, the total minimum thickness of front, back and sidewalls shall be 6 inches (152 mm) of solid masonry, including the lining. Firebrick shall conform to ASTM C 1261 and shall be laid with refractory mortar conforming to ASTM C 199. Vitrified clay linings shall conform to ASTM C 315.

2111A.8.1 Smoke chamber dimensions. The inside height of the smoke chamber from the fireplace throat to the beginning of the flue shall not be greater than the inside width of the fireplace opening. The inside surface of the smoke chamber shall not be inclined more than 45 degrees (0.76 rad) from vertical when prefabricated smoke chamber linings are used or when the smoke chamber walls are rolled or sloped rather than corbeled. When the inside surface of the smoke chamber is formed by corbeled masonry, the walls shall not be corbeled more than 30 degrees (0.52 rad) from vertical.

2111A.9 Hearth and hearth extension. Masonry fireplace hearths and hearth extensions shall be constructed of concrete or masonry, supported by noncombustible materials, and reinforced to carry their own weight and all imposed loads. No combustible material shall remain against the underside of hearths or hearth extensions after construction.

2111A.9.1 Hearth thickness. The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

2111A.9.2 Hearth extension thickness. The minimum thickness of hearth extensions shall be 2 inches (51 mm).

Exception: When the bottom of the firebox opening is raised at least 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than $\frac{3}{8}$ -inch-thick (9.5 mm) brick, concrete, stone, tile or other approved noncombustible material is permitted.

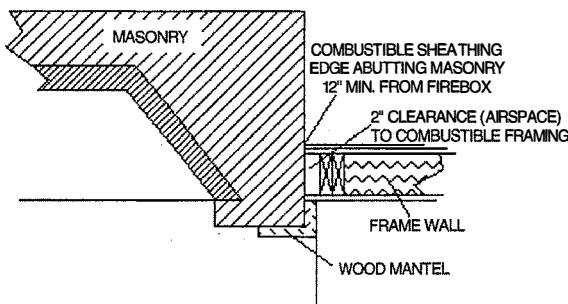
2111A.10 Hearth extension dimensions. Hearth extensions shall extend at least 16 inches (406 mm) in front of, and at least 8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m²) or larger, the hearth extension shall extend at least 20 inches (508 mm) in front of, and at least 12 inches (305 mm) beyond, each side of the fireplace opening.

2111A.11 Fireplace clearance. Any portion of a masonry fireplace located in the interior of a building or within the

exterior wall of a building shall have a clearance to combustibles of not less than 2 inches (51 mm) from the front faces and sides of masonry fireplaces and not less than 4 inches (102 mm) from the back faces of masonry fireplaces. The air-space shall not be filled, except to provide fireblocking in accordance with Section 2111A.12.

Exceptions:

1. Masonry fireplaces listed and labeled for use in contact with combustibles in accordance with UL 127 and installed in accordance with the manufacturer's installation instructions are permitted to have combustible material in contact with their exterior surfaces.
2. When masonry fireplaces are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete walls less than 12 inches (306 mm) from the inside surface of the nearest firebox lining.
3. Exposed combustible trim and the edges of sheathing materials, such as wood siding, flooring and drywall, are permitted to abut the masonry fireplace sidewalls and hearth extension, in accordance with Figure 2111A.11, provided such combustible trim or sheathing is a minimum of 12 inches (306 mm) from the inside surface of the nearest firebox lining.
4. Exposed combustible mantels or trim is permitted to be placed directly on the masonry fireplace front surrounding the fireplace opening, provided such combustible materials shall not be placed within 6 inches (153 mm) of a fireplace opening. Combustible material directly above and within 12 inches (305 mm) of the fireplace opening shall not project more than $\frac{1}{8}$ inch (3.2 mm) for each 1-inch (25 mm) distance from such opening. Combustible materials located along the sides of the fireplace opening that project more than $1\frac{1}{2}$ inches (38 mm) from the face of the fireplace shall have an additional clearance equal to the projection.



For SI: 1 inch = 25.4 mm

FIGURE 2111A.11
ILLUSTRATION OF EXCEPTION TO
FIREPLACE CLEARANCE PROVISIONS

2111A.12 Fireplace fireblocking. All spaces between fireplaces and floors and ceilings through which fireplaces pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between wood joists, beams or headers shall be to a depth of 1 inch (25 mm) and shall only be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

2111A.13 Exterior air. Factory-built or masonry fireplaces covered in this section shall be equipped with an exterior air supply to ensure proper fuel combustion unless the room is mechanically ventilated and controlled so that the indoor pressure is neutral or positive.

2111A.13.1 Factory-built fireplaces. Exterior combustion air ducts for factory-built fireplaces shall be listed components of the fireplace, and installed according to the fireplace manufacturer's instructions.

2111A.13.2 Masonry fireplaces. Listed combustion air ducts for masonry fireplaces shall be installed according to the terms of their listing and manufacturer's instructions.

2111A.13.3 Exterior air intake. The exterior air intake shall be capable of providing all combustion air from the exterior of the dwelling. The exterior air intake shall not be located within a garage, attic, basement or crawl space of the dwelling nor shall the air intake be located at an elevation higher than the firebox. The exterior air intake shall be covered with a corrosion-resistant screen of $\frac{1}{4}$ -inch (6.4 mm) mesh.

2111A.13.4 Clearance. Unlisted combustion air ducts shall be installed with a minimum 1-inch (25 mm) clearance to combustibles for all parts of the duct within 5 feet (1524 mm) of the duct outlet.

2111A.13.5 Passageway. The combustion air passageway shall be a minimum of 6 square inches (3870 mm^2) and not more than 55 square inches (0.035 m^2), except that combustion air systems for listed fireplaces or for fireplaces tested for emissions shall be constructed according to the fireplace manufacturer's instructions.

2111A.13.6 Outlet. The exterior air outlet is permitted to be located in the back or sides of the firebox chamber or within 24 inches (610 mm) of the firebox opening on or near the floor. The outlet shall be closable and designed to prevent burning material from dropping into concealed combustible spaces.

SECTION 2112A

MASONRY HEATERS

2112A.1 Definition. A masonry heater is a heating appliance constructed of concrete or solid masonry, hereinafter referred to as "masonry," which is designed to absorb and store heat from a solid fuel fire built in the firebox by routing the exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox may include flow in a horizontal or downward direction before entering the chimney and which delivers heat by radiation from the masonry surface of the heater.

2112A.2 Installation. Masonry heaters shall be installed in accordance with this section and comply with one of the following:

1. Masonry heaters shall comply with the requirements of ASTM E 1602; or
2. Masonry heaters shall be listed and labeled in accordance with UL 1482 and installed in accordance with the manufacturer's installation instructions.

2112A.3 Footings and foundation. The firebox floor of a masonry heater shall be a minimum thickness of 4 inches (102 mm) of noncombustible material and be supported on a noncombustible footing and foundation in accordance with Section 2113.2.

2112A.4 Seismic reinforcing. In structures assigned to Seismic Design Category D, E and F, masonry heaters shall be anchored to the masonry foundation in accordance with Section 2113A.3. Seismic reinforcing shall not be required within the body of a masonry heater with a height that is equal to or less than 3.5 times its body width and where the masonry chimney serving the heater is not supported by the body of the heater. Where the masonry chimney shares a common wall with the facing of the masonry heater, the chimney portion of the structure shall be reinforced in accordance with Section 2113A.

2112A.5 Masonry heater clearance. Combustible materials shall not be placed within 36 inches (765 mm) of the outside surface of a masonry heater in accordance with NFPA 211, Section 8-7 (clearances for solid fuel-burning appliances), and the required space between the heater and combustible material shall be fully vented to permit the free flow of air around all heater surfaces.

Exceptions:

1. When the masonry heater wall thickness is at least 8 inches (203 mm) thick of solid masonry and the wall thickness of the heat exchange channels is at least 5 inches (127 mm) thick of solid masonry, combustible materials shall not be placed within 4 inches (102 mm) of the outside surface of a masonry heater. A clearance of at least 8 inches (203 mm) shall be provided between the gas-tight capping slab of the heater and a combustible ceiling.
2. Masonry heaters listed and labeled in accordance with UL 1482 and installed in accordance with the manufacturer's instructions.

SECTION 2113A MASONRY CHIMNEYS

2113A.1 Definition. A masonry chimney is a chimney constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete, hereinafter referred to as "masonry." Masonry chimneys shall be constructed, anchored, supported and reinforced as required in this chapter.

2113A.2 Footings and foundations. Footings for masonry chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and shall extend at least 6 inches (152 mm) beyond the face of the foundation or support

wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

2113A.3 Seismic reinforcing. Masonry or concrete chimneys shall be constructed, anchored, supported and reinforced as required in this chapter. In structures assigned to Seismic Design Category C or D, masonry and concrete chimneys shall be reinforced and anchored as detailed in Sections 2113A.3.1, 2113A.3.2 and 2113A.4. In structures assigned to Seismic Design Category A or B, reinforcement and seismic anchorage is not required. In structures assigned to Seismic Design Category E or F, masonry and concrete chimneys shall be reinforced in accordance with the requirements of Sections 2101A through 2108A.

2113A.3.1 Vertical reinforcing. For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars anchored in the foundation shall be placed in the concrete between wythes of solid masonry or within the cells of hollow unit masonry and grouted in accordance with Section 2103A.12. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys greater than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 inches (1016 mm) in width or fraction thereof.

2113A.3.2 Horizontal reinforcing. Vertical reinforcement shall be placed enclosed within $\frac{1}{4}$ -inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) o.c. in concrete, or placed in the bed joints of unit masonry, at a minimum of every 18 inches (457 mm) of vertical height. Two such ties shall be provided at each bend in the vertical bars.

2113A.4 Seismic anchorage. Masonry and concrete chimneys and foundations in structures assigned to Seismic Design Category C or D shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade, except where constructed completely within the exterior walls. Anchorage shall conform to the following requirements.

2113A.4.1 Anchorage. Two $\frac{3}{16}$ -inch by 1-inch (4.8 mm by 25 mm) straps shall be embedded a minimum of 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to a minimum of four floor joists with two $\frac{1}{2}$ -inch (12.7 mm) bolts.

2113A.5 Corbeling. Masonry chimneys shall not be corbeled more than half of the chimney's wall thickness from a wall or foundation, nor shall a chimney be corbeled from a wall or foundation that is less than 12 inches (305 mm) in thickness unless it projects equally on each side of the wall, except that on the second story of a two-story dwelling, corbeling of chimneys on the exterior of the enclosing walls is permitted to equal the wall thickness. The projection of a single course shall not exceed one-half the unit height or one-third of the unit bed depth, whichever is less.

2113A.6 Changes in dimension. The chimney wall or chimney flue lining shall not change in size or shape within 6 inches (152 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

2113A.7 Offsets. Where a masonry chimney is constructed with a fireclay flue liner surrounded by one wythe of masonry, the maximum offset shall be such that the centerline of the flue above the offset does not extend beyond the center of the chimney wall below the offset. Where the chimney offset is supported by masonry below the offset in an approved manner, the maximum offset limitations shall not apply. Each individual corbeled masonry course of the offset shall not exceed the projection limitations specified in Section 2113A.5.

2113A.8 Additional load. Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load. Masonry chimneys are permitted to be constructed as part of the masonry walls or concrete walls of the building.

2113A.9 Termination. Chimneys shall extend at least 2 feet (610 mm) higher than any portion of the building within 10 feet (3048 mm), but shall not be less than 3 feet (914 mm) above the highest point where the chimney passes through the roof.

2113A.9.1 Chimney caps. Masonry chimneys shall have a concrete, metal or stone cap, sloped to shed water, a drip edge and a caulked bond break around any flue liners in accordance with ASTM C 1283.

2113A.9.2 Spark arrestors. *[SFM] All chimneys attached to any appliance or fireplace that burns solid fuel shall be equipped with an approved spark arrester.* The spark arrester shall meet all of the following requirements:

1. *The net free area of the spark arrester shall not be less than four times the net free area of the outlet of the chimney flue it serves.*
2. *The spark arrester screen shall have heat and corrosion resistance equivalent to 12-gage wire, 19-gage galvanized wire or 24-gage stainless steel.*
3. *Openings shall not permit the passage of spheres having a diameter larger than $\frac{1}{2}$ inch (12.7 mm) and shall not block the passage of spheres having a diameter of less than $\frac{3}{8}$ inch (9.5 mm).*
4. *The spark arrester shall be accessible for cleaning and the screen or chimney cap shall be removable to allow for cleaning of the chimney flue.*

2113A.9.3 Rain caps. Where a masonry or metal rain cap is installed on a masonry chimney, the net free area under the cap shall not be less than four times the net free area of the outlet of the chimney flue it serves.

2113A.10 Wall thickness. Masonry chimney walls shall be constructed of concrete, solid masonry units or hollow masonry units grouted solid with not less than 4 inches (102 mm) nominal thickness.

2113A.10.1 Masonry veneer chimneys. Where masonry is used as veneer for a framed chimney, through flashing

and weep holes shall be provided as required by Chapter 14.

2113A.11 Flue lining (material). Masonry chimneys shall be lined. The lining material shall be appropriate for the type of appliance connected, according to the terms of the appliance listing and the manufacturer's instructions.

2113A.11.1 Residential-type appliances (general). Flue lining systems shall comply with one of the following:

1. Clay flue lining complying with the requirements of ASTM C 315.
2. Listed chimney lining systems complying with UL 1777.
3. Factory-built chimneys or chimney units listed for installation within masonry chimneys.
4. Other approved materials that will resist corrosion, erosion, softening or cracking from flue gases and condensate at temperatures up to 1,800°F (982°C).

2113A.11.1.1 Flue linings for specific appliances. Flue linings other than those covered in Section 2113A.11.1 intended for use with specific appliances shall comply with Sections 2113A.11.1.2 through 2113A.11.1.4 and Sections 2113A.11.2 and 2113A.11.3.

2113A.11.1.2 Gas appliances. Flue lining systems for gas appliances shall be in accordance with the *International Fuel Gas Code*.

2113A.11.1.3 Pellet fuel-burning appliances. Flue lining and vent systems for use in masonry chimneys with pellet fuel-burning appliances shall be limited to flue lining systems complying with Section 2113A.11.1 and pellet vents listed for installation within masonry chimneys (see Section 2113A.11.1.5 for marking).

2113A.11.1.4 Oil-fired appliances approved for use with L-vent. Flue lining and vent systems for use in masonry chimneys with oil-fired appliances approved for use with Type L vent shall be limited to flue lining systems complying with Section 2113A.11.1 and listed chimney liners complying with UL 641 (see Section 2113A.11.1.5 for marking).

2113A.11.1.5 Notice of usage. When a flue is relined with a material not complying with Section 2113A.11.1, the chimney shall be plainly and permanently identified by a label attached to a wall, ceiling or other conspicuous location adjacent to where the connector enters the chimney. The label shall include the following message or equivalent language: "This chimney is for use only with (type or category of appliance) that burns (type of fuel). Do not connect other types of appliances."

2113A.11.2 Concrete and masonry chimneys for medium-heat appliances.

2113A.11.2.1 General. Concrete and masonry chimneys for medium-heat appliances shall comply with Sections 2113A.1 through 2113A.5.

2113A.11.2.2 Construction. Chimneys for medium-heat appliances shall be constructed of solid masonry units or of concrete with walls a minimum of 8 inches

(203 mm) thick, or with stone masonry a minimum of 12 inches (305 mm) thick.

2113A.11.2.3 Lining. Concrete and masonry chimneys shall be lined with an approved medium-duty refractory brick a minimum of $4\frac{1}{2}$ inches (114 mm) thick laid on the $4\frac{1}{2}$ -inch bed (114 mm) in an approved medium-duty refractory mortar. The lining shall start 2 feet (610 mm) or more below the lowest chimney connector entrance. Chimneys terminating 25 feet (7620 mm) or less above a chimney connector entrance shall be lined to the top.

2113A.11.2.4 Multiple passageway. Concrete and masonry chimneys containing more than one passageway shall have the liners separated by a minimum 4-inch-thick (102 mm) concrete or solid masonry wall.

2113A.11.2.5 Termination height. Concrete and masonry chimneys for medium-heat appliances shall extend a minimum of 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm).

2113A.11.2.6 Clearance. A minimum clearance of 4 inches (102 mm) shall be provided between the exterior surfaces of a concrete or masonry chimney for medium-heat appliances and combustible material.

2113A.11.3 Concrete and masonry chimneys for high-heat appliances.

2113A.11.3.1 General. Concrete and masonry chimneys for high-heat appliances shall comply with Sections 2113A.1 through 2113A.5.

2113A.11.3.2 Construction. Chimneys for high-heat appliances shall be constructed with double walls of solid masonry units or of concrete, each wall to be a minimum of 8 inches (203 mm) thick with a minimum airspace of 2 inches (51 mm) between the walls.

2113A.11.3.3 Lining. The inside of the interior wall shall be lined with an approved high-duty refractory brick, a minimum of $4\frac{1}{2}$ inches (114 mm) thick laid on the $4\frac{1}{2}$ -inch bed (114 mm) in an approved high-duty refractory mortar. The lining shall start at the base of the chimney and extend continuously to the top.

2113A.11.3.4 Termination height. Concrete and masonry chimneys for high-heat appliances shall extend a minimum of 20 feet (6096 mm) higher than any portion of any building within 50 feet (15 240 mm).

2113A.11.3.5 Clearance. Concrete and masonry chimneys for high-heat appliances shall have approved clearance from buildings and structures to prevent overheating combustible materials, permit inspection and maintenance operations on the chimney and prevent danger of burns to persons.

2113A.12 Clay flue lining (installation). Clay flue liners shall be installed in accordance with ASTM C 1283 and extend from a point not less than 8 inches (203 mm) below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber to a point above the enclosing walls. The lining shall be carried up vertically, with a maximum slope no greater than 30 degrees (0.52 rad) from the vertical.

Clay flue liners shall be laid in medium-duty nonwatersoluble refractory mortar conforming to ASTM C 199 with tight mortar joints left smooth on the inside and installed to maintain an air space or insulation not to exceed the thickness of the flue liner separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides. Only enough mortar shall be placed to make the joint and hold the liners in position.

2113A.13 Additional requirements.

2113A.13.1 Listed materials. Listed materials used as flue linings shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

2113A.13.2 Space around lining. The space surrounding a chimney lining system or vent installed within a masonry chimney shall not be used to vent any other appliance.

Exception: This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's instructions.

2113A.14 Multiple flues. When two or more flues are located in the same chimney, masonry wythes shall be built between adjacent flue linings. The masonry wythes shall be at least 4 inches (102 mm) thick and bonded into the walls of the chimney.

Exception: When venting only one appliance, two flues are permitted to adjoin each other in the same chimney with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered at least 4 inches (102 mm).

2113A.15 Flue area (appliance). Chimney flues shall not be smaller in area than the area of the connector from the appliance. Chimney flues connected to more than one appliance shall not be less than the area of the largest connector plus 50 percent of the areas of additional chimney connectors.

Exceptions:

1. Chimney flues serving oil-fired appliances sized in accordance with NFPA 31.
2. Chimney flues serving gas-fired appliances sized in accordance with the *International Fuel Gas Code*.

2113A.16 Flue area (masonry fireplace). Flue sizing for chimneys serving fireplaces shall be in accordance with Section 2113A.16.1 or 2113A.16.2.

2113A.16.1 Minimum area. Round chimney flues shall have a minimum net cross-sectional area of at least $\frac{1}{12}$ of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of at least $\frac{1}{10}$ of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of at least $\frac{1}{10}$ of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of at least $\frac{1}{8}$ of the fireplace opening.

2113A.16.2 Determination of minimum area. The minimum net cross-sectional area of the flue shall be determined in accordance with Figure 2113A.16. A flue size providing at least the equivalent net cross-sectional area

shall be used. Cross-sectional areas of clay flue linings are as provided in Tables 2113A.16(1) and 2113A.16(2) or as provided by the manufacturer or as measured in the field. The height of the chimney shall be measured from the firebox floor to the top of the chimney flue.

TABLE 2113A.16(1)
NET CROSS-SECTIONAL AREA OF ROUND FLUE SIZES^a

| FLUE SIZE, INSIDE DIAMETER (inches) | CROSS-SECTIONAL AREA (square inches) |
|--|---|
| 6 | 28 |
| 7 | 38 |
| 8 | 50 |
| 10 | 78 |
| 10 ^{3/4} | 90 |
| 12 | 113 |
| 15 | 176 |
| 18 | 254 |

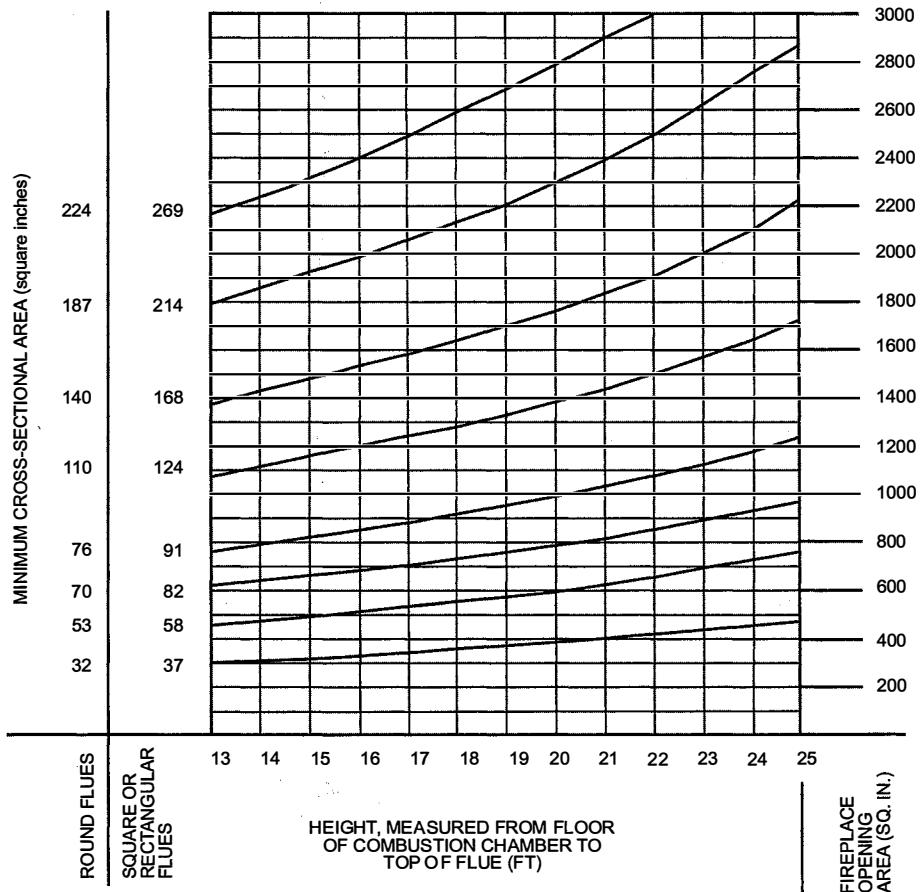
For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm².

a. Flue sizes are based on ASTM C 315.

TABLE 2113A.16(2)
**NET CROSS-SECTIONAL AREA OF SQUARE AND
RECTANGULAR FLUE SIZES^a**

| FLUE SIZE, OUTSIDE NOMINAL DIMENSIONS (inches) | CROSS-SECTIONAL AREA (square inches) |
|---|---|
| 4.5 × 8.5 | 23 |
| 4.5 × 13 | 34 |
| 8 × 8 | 42 |
| 8.5 × 8.5 | 49 |
| 8 × 12 | 67 |
| 8.5 × 13 | 76 |
| 12 × 12 | 102 |
| 8.5 × 18 | 101 |
| 13 × 13 | 127 |
| 12 × 16 | 131 |
| 13 × 18 | 173 |
| 16 × 16 | 181 |
| 16 × 20 | 222 |
| 18 × 18 | 233 |
| 20 × 20 | 298 |
| 20 × 24 | 335 |
| 24 × 24 | 431 |

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm².



For SI: 1 inch = 25.4 mm, 1 square inch = 645 mm².

FIGURE 2113A.16
FLUE SIZES FOR MASONRY CHIMNEYS

2113A.17 Inlet. Inlets to masonry chimneys shall enter from the side. Inlets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

2113A.18 Masonry chimney cleanout openings. Cleanout openings shall be provided within 6 inches (152 mm) of the base of each flue within every masonry chimney. The upper edge of the cleanout shall be located at least 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be at least 6 inches (152 mm). The cleanout shall be provided with a noncombustible cover.

Exception: Chimney flues serving masonry fireplaces, where cleaning is possible through the fireplace opening.

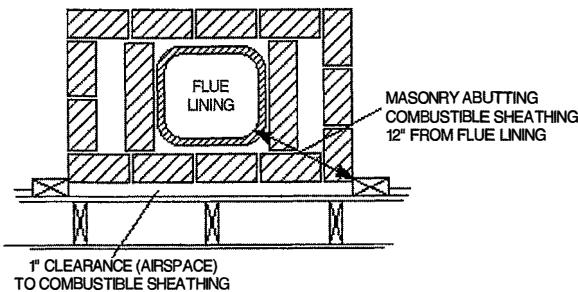
2113A.19 Chimney clearances. Any portion of a masonry chimney located in the interior of the building or within the exterior wall of the building shall have a minimum airspace clearance to combustibles of 2 inches (51 mm). Chimneys located entirely outside the exterior walls of the building, including chimneys that pass through the soffit or cornice, shall have a minimum airspace clearance of 1 inch (25 mm). The airspace shall not be filled, except to provide fireblocking in accordance with Section 2113A.20.

Exceptions:

1. Masonry chimneys equipped with a chimney lining system listed and labeled for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, are permitted to have combustible material in contact with their exterior surfaces.
2. Where masonry chimneys are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete wall less than 12 inches (305 mm) from the inside surface of the nearest flue lining.
3. Exposed combustible trim and the edges of sheathing materials, such as wood siding, are permitted to abut the masonry chimney sidewalls, in accordance with Figure 2113A.19, provided such combustible trim or sheathing is a minimum of 12 inches (305 mm) from the inside surface of the nearest flue lining. Combustible material and trim shall not overlap the corners of the chimney by more than 1 inch (25 mm).

2113A.20 Chimney fireblocking All spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between wood joists, beams or headers shall be self-supporting or to a depth of 1 inch (25 mm) and shall only be placed on strips of metal

or metal lath laid across the spaces between combustible material and the chimney.



For SI: 1 inch = 25.4 mm.

FIGURE 2113A.19
ILLUSTRATION OF EXCEPTION THREE
CHIMNEY CLEARANCE PROVISIONS

SECTION 2114A NONBEARING WALLS

2114A.1 General. All nonbearing masonry walls shall be reinforced as specified in Section 2106A.1.1.1. Fences and interior nonbearing nonshear walls may be of hollow-unit masonry construction grouted in cells containing vertical and horizontal reinforcement. Nonbearing walls may be used to carry a superimposed load of not more than 200 pounds per linear foot (2.92 kN/m).

1. Thickness. Every nonbearing masonry wall shall be constructed and have a sufficient thickness to withstand all vertical loads and horizontal loads, but in no case shall the thickness of such walls be less than the values set forth in Table 2107A.5.

Plaster shall not be considered as contributing to the thickness of a wall in computing the height-to-thickness ratio.

2. Anchorage. All nonbearing walls shall be anchored as required by Section 1604A.8.2 and ASCE 7 Chapter 13. Suspended ceilings or other nonstructural elements shall not be used to provide anchorage for masonry walls.

SECTION 2115A MASONRY SCREEN WALLS

2115A.1 General. Masonry units may be used in nonbearing decorative screen walls. Units may be laid up in panels with units on edge with the open pattern of the unit exposed in the completed wall.

1. Horizontal forces. The panels shall be capable of spanning between supports to resist the horizontal forces

specified in Chapter 16A. Wind loads shall be based on the gross projected area of the block.

2. **Mortar joints.** Horizontal and vertical joints shall not be less than $\frac{1}{4}$ inch (6 mm) thick. All joints shall be completely filled with mortar and shall be "shoved joint" work. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with a minimum of 0.03 square inch (19 mm^2) of reinforcing steel and maximum spacing of 16 inches on center. Reinforcement may be embedded in mortar.
3. **Reinforcement.** Joint reinforcement may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized. Ladder wire reinforcement shall not be spliced and shall be the widest that the mortar joint will accommodate, allowing $\frac{1}{2}$ inch (13 mm) of mortar cover.
4. **Size of panels.** The maximum size of panels shall be 144 square feet (13.4 m^2), with the maximum dimension in either direction of 15 feet (4572 mm). The specified thickness of the units for exterior applications shall not be less than $3\frac{1}{8}$ inches.
5. **Panel support.** Each panel shall be supported on all edges by a structural member of concrete, masonry or steel. Supports at the top and ends of the panel shall be by means of confinement of the masonry by at least 1 inch (25 mm) into and between the flanges of a steel channel. The space between the end of the panel and the web of the channel shall be filled with resilient material. The use of an equivalent configuration in other steel sections or in masonry or concrete is acceptable.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 22 – STEEL

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | X | X | | | | | | X | X | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | X | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 2201.1.1 | | | | | | | | | X | | | | | | | | | | | |
| 2201.1.2 | | | | | | | | | X | | | | | | | | | | | |
| 2201.1.3 | | | | | | | | | X | | | | | | | | | | | |
| 2201.1.4 | | | | | | | | | X | | | | | | | | | | | |
| 2212 | | | | | | | | | X | | | | | | | | | | | |
| 2212.1 | | | | | | | | | X | | | | | | | | | | | |
| 2212.1.1 | | | | | | | | | X | | | | | | | | | | | |
| 2212.2 | | | | | | | | | X | | | | | | | | | | | |
| 2212.3 | | | | | | | | | X | | | | | | | | | | | |
| 2212.4 | | | | | | | | | X | | | | | | | | | | | |
| 2212.5 | | | | | | | | | X | | | | | | | | | | | |
| 2212.6 | | | | | | | | | X | | | | | | | | | | | |

CHAPTER 22

STEEL

SECTION 2201 GENERAL

2201.1 Scope. The provisions of this chapter govern the quality, design, fabrication and erection of steel used structurally in buildings or structures.

2201.1.1 Application. [DSA-SS/CC] *The scope of application of Chapter 22 is as follows:*

Community college buildings regulated by the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC), as listed in Section 1.9.2.2.

2201.1.2 Identification of amendments. [DSA-SS/CC]

Division of the State Architect-Structural Safety/Community Colleges amendments appear in this chapter preceded with the appropriate acronym, as follows:

[DSA-SS/CC] - For community college buildings listed in Section 1.9.2.2

2201.1.3 Reference to other chapters. [DSA-SS/CC] *Where reference within this chapter is made to sections in Chapter 17 the provisions in Chapter 17A, shall apply instead.*

2201.1.4 Amendments. [DSA-SS/CC] *See Section 2212 for additional requirements.*

SECTION 2202 DEFINITIONS

2202.1 Definitions. The following terms are defined in Chapter 2:

STEEL CONSTRUCTION, COLD-FORMED.

STEEL JOIST.

STEEL MEMBER, STRUCTURAL.

SECTION 2203 IDENTIFICATION AND PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

2203.1 Identification. Identification of structural steel members shall comply with the requirements contained in AISC 360. Identification of cold-formed steel members shall comply with the requirements contained in AISI S100. Identification of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S200. Other steel furnished for structural load-carrying purposes shall be properly identified for conformity to the ordered grade in accordance with the specified ASTM standard or other specification and the provisions of this chapter. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards.

2203.2 Protection. Painting of structural steel members shall comply with the requirements contained in AISC 360. Paint-

ing of open-web steel joists and joist girders shall comply with the requirements of SJI CJ-1.0, SJI JG-1.1, SJI K-1.1 and SJI LH/DLH-1.1. Individual structural members and assembled panels of cold-formed steel construction shall be protected against corrosion in accordance with the requirements contained in AISI S100. Protection of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S200.

SECTION 2204 CONNECTIONS

2204.1 Welding. The details of design, workmanship and technique for welding, inspection of welding and qualification of welding operators shall conform to the requirements of the specifications listed in Sections 2205, 2206, 2207, 2208, 2210 and 2211. Special inspection of welding shall be provided where required by Section 1705.

2204.2 Bolting. The design, installation and inspection of bolts shall be in accordance with the requirements of the specifications listed in Sections 2205, 2206, 2207, 2210 and 2211. Special inspection of the installation of high-strength bolts shall be provided where required by Section 1705.

2204.2.1 Anchor rods. Anchor rods shall be set in accordance with the construction documents. The protrusion of the threaded ends through the connected material shall fully engage the threads of the nuts, but shall not be greater than the length of the threads on the bolts.

SECTION 2205 STRUCTURAL STEEL

2205.1 General. The design, fabrication and erection of structural steel for buildings and structures shall be in accordance with AISC 360. Where required, the seismic design of structural steel structures shall be in accordance with the additional provisions of Section 2205.2.

2205.2 Seismic requirements for structural steel structures. The design of structural steel structures to resist seismic forces shall be in accordance with the provisions of Section 2205.2.1 or 2205.2.2, as applicable.

2205.2.1 Seismic Design Category B or C. Structural steel structures assigned to Seismic Design Category B or C shall be of any construction permitted in Section 2205. Where a response modification coefficient, R, in accordance with ASCE 7, Table 12.2-1 is used for the design of structural steel structures assigned to Seismic Design Category B or C, the structures shall be designed and detailed in accordance with the requirements of AISC 341.

Exception: The response modification coefficient, R, designated for "Steel systems not specifically detailed for seismic resistance, excluding cantilever column sys-

tems" in ASCE 7, Table 12.2-1 shall be permitted for systems designed and detailed in accordance with AISC 360, and need not be designed and detailed in accordance with AISC 341.

2205.2.2 Seismic Design Category D, E or F. Structural steel structures assigned to Seismic Design Category D, E or F shall be designed and detailed in accordance with AISC 341, except as permitted in ASCE 7, Table 15.4-1.

SECTION 2206 COMPOSITE STRUCTURAL STEEL AND CONCRETE STRUCTURES

2206.1 General. Systems of structural steel acting compositely with reinforced concrete shall be designed in accordance with AISC 360 and ACI 318, excluding ACI 318 Chapter 22. Where required, the seismic design of composite steel and concrete systems shall be in accordance with the additional provisions of Section 2206.2.

2206.2 Seismic requirements for composite structural steel and concrete construction. Where a response modification coefficient, R , in accordance with ASCE 7, Table 12.2-1 is used for the design of systems of structural steel acting compositely with reinforced concrete, the structures shall be designed and detailed in accordance with the requirements of AISC 341.

SECTION 2207 STEEL JOISTS

2207.1 General. The design, manufacture and use of open web steel joists and joist girders shall be in accordance with one of the following Steel Joist Institute (SJI) specifications:

1. SJI CJ-1.0
2. SJI K-1.1
3. SJI LH/DLH-1.1
4. SJI JG-1.1

Where required, the seismic design of buildings shall be in accordance with the additional provisions of Section 2205.2 or 2211.6.

2207.2 Design. The registered design professional shall indicate on the construction documents the steel joist and/or steel joist girder designations from the specifications listed in Section 2207.1 and shall indicate the requirements for joist and joist girder design, layout, end supports, anchorage, non-SJI standard bridging, bridging termination connections and bearing connection design to resist uplift and lateral loads. These documents shall indicate special requirements as follows:

1. Special loads including:
 - 1.1. Concentrated loads;
 - 1.2. Nonuniform loads;
 - 1.3. Net uplift loads;
 - 1.4. Axial loads;
 - 1.5. End moments; and

1.6. Connection forces.

2. Special considerations including:

- 2.1. Profiles for nonstandard joist and joist girder configurations (standard joist and joist girder configurations are as indicated in the SJI catalog);
- 2.2. Oversized or other nonstandard web openings; and
- 2.3. Extended ends.

3. Deflection criteria for live and total loads for non-SJI standard joists.

2207.3 Calculations. The steel joist and joist girder manufacturer shall design the steel joists and/or steel joist girders in accordance with the current SJI specifications and load tables to support the load requirements of Section 2207.2. The registered design professional may require submission of the steel joist and joist girder calculations as prepared by a registered design professional responsible for the product design. If requested by the registered design professional, the steel joist manufacturer shall submit design calculations with a cover letter bearing the seal and signature of the joist manufacturer's registered design professional. In addition to standard calculations under this seal and signature, submittal of the following shall be included:

1. Non-SJI standard bridging details (e.g. for cantilevered conditions, net uplift, etc.).
2. Connection details for:
 - 2.1. Non-SJI standard connections (e.g. flush-framed or framed connections);
 - 2.2. Field splices; and
 - 2.3. Joist headers.

2207.4 Steel joist drawings. Steel joist placement plans shall be provided to show the steel joist products as specified on the construction documents and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2207.2. Steel placement plans shall include, at a minimum, the following:

1. Listing of all applicable loads as stated in Section 2207.2 and used in the design of the steel joists and joist girders as specified in the construction documents.
2. Profiles for nonstandard joist and joist girder configurations (standard joist and joist girder configurations are as indicated in the SJI catalog).
3. Connection requirements for:
 - 3.1. Joist supports;
 - 3.2. Joist girder supports;
 - 3.3. Field splices; and
 - 3.4. Bridging attachments.
4. Deflection criteria for live and total loads for non-SJI standard joists.
5. Size, location and connections for all bridging.
6. Joist headers.

Steel joist placement plans do not require the seal and signature of the joist manufacturer's registered design professional.

2207.5 Certification. At completion of manufacture, the steel joist manufacturer shall submit a certificate of compliance in accordance with Section 1704.2.5.2 stating that work was performed in accordance with approved construction documents and with SJI standard specifications.

SECTION 2208 STEEL CABLE STRUCTURES

2208.1 General. The design, fabrication and erection including related connections, and protective coatings of steel cables for buildings shall be in accordance with ASCE 19.

2208.2 Seismic requirements for steel cable. The design strength of steel cables shall be determined by the provisions of ASCE 19 except as modified by these provisions.

1. A load factor of 1.1 shall be applied to the prestress force included in T_3 and T_4 as defined in Section 3.12.
2. In Section 3.2.1, Item (c) shall be replaced with "1.5 T_3 " and Item (d) shall be replaced with "1.5 T_4 ."

SECTION 2209 STEEL STORAGE RACKS

2209.1 Storage racks. The design, testing and utilization of industrial steel storage racks made of cold-formed or hot-rolled steel structural members, shall be in accordance with RMI/ANSI MH 16.1. Where required by ASCE 7, the seismic design of storage racks shall be in accordance with the provisions of Section 15.5.3 of ASCE 7, except that the mapped acceleration parameters, S_s and S_p , shall be determined in accordance with Section 1613.3.1.

SECTION 2210 COLD-FORMED STEEL

2210.1 General. The design of cold-formed carbon and low-alloy steel structural members shall be in accordance with AISI S100. The design of cold-formed stainless-steel structural members shall be in accordance with ASCE 8. Cold-formed steel light-frame construction shall also comply with Section 2211. Where required, the seismic design of cold-formed steel structures shall be in accordance with the additional provisions of Section 2210.2.

2210.1.1 Steel decks. The design and construction of cold-formed steel decks shall be in accordance with this section.

2210.1.1.1 Noncomposite steel floor decks. Noncomposite steel floor decks shall be permitted to be designed and constructed in accordance with ANSI/SDI-NC1.0.

2210.1.1.2 Steel roof deck. Steel roof decks shall be permitted to be designed and constructed in accordance with ANSI/SDI-RD1.0.

2210.2 Seismic requirements for cold-formed steel structures. Where a response modification coefficient, R , in accordance with ASCE 7, Table 12.2-1 is used for the design of

cold-formed steel structures, the structures shall be designed and detailed in accordance with the requirements of AISI S100, ASCE 8, and, for cold-formed steel special-bolted moment frames, AISI S110.

SECTION 2211 COLD-FORMED STEEL LIGHT-FRAME CONSTRUCTION

2211.1 General. The design and installation of structural members and nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is between 0.0179 inches (0.455 mm) and 0.1180 inches (2.997 mm) shall be in accordance with AISI S200 and Sections 2211.2 through 2211.7, as applicable.

2211.2 Header design. Headers, including box and back-to-back headers, and double and single L-headers shall be designed in accordance with AISI S212 or AISI S100.

2211.3 Truss design. Cold-formed steel trusses shall be designed in accordance with AISI S214, Sections 2211.3.1 through 2211.3.4 and accepted engineering practice.

2211.3.1 Truss design drawings. The truss design drawings shall conform to the requirements of Section B2.3 of AISI S214 and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent individual truss member restraint/bracing in accordance with Section B6(a) or B 6(c) of AISI S214 where these methods are utilized to provide restraint/bracing.

2211.3.2 Deferred submittals. AISI S214 Section B4.2 shall be deleted.

2211.3.3 Trusses spanning 60 feet or greater. The owner shall contract with a registered design professional for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater. Special inspection of trusses over 60 feet (18 288 mm) in length shall conform to Section 1705.

2211.3.4 Truss quality assurance. Trusses not part of a manufacturing process that provides requirements for quality control done under the supervision of a third-party quality control agency, shall be manufactured in compliance with Sections 1704.2.5 and 1705.2, as applicable.

2211.4 Wall stud design. Wall studs shall be designed in accordance with either AISI S211 or AISI S100.

2211.5 Floor and roof system design. Framing for floor and roof systems in buildings shall be designed in accordance with either AISI S210 or AISI S100.

2211.6 Lateral design. Light-frame shear walls, diagonal strap bracing that is part of a structural wall and diaphragms used to resist wind, seismic and other in-plane lateral loads shall be designed in accordance with AISI S213.

2211.7 Prescriptive framing. Detached one- and two-family dwellings and townhouses, less than or equal to three stories above grade plane, shall be permitted to be constructed in accordance with AISI S230 subject to the limitations therein.

SECTION 2212 ADDITIONAL REQUIREMENTS [DSA-SS/CC]

2212.1 Connections.

2212.1.1 Column base plate. When shear and/or tensile forces are intended to be transferred between column base plates and anchor bolts, provision shall be made in the design to eliminate the effects of oversized holes permitted in base plates by AISC 360 by use of shear lugs and/or welded shear transfer plates or other means acceptable to the enforcement agency, when the oversized holes are larger than the anchor bolt by more than $\frac{1}{8}$ inch (3.2 mm). When welded shear transfer plates and shear lugs or other means acceptable to the enforcement agency are not used, the anchor bolts shall be checked for the induced bending stresses in combination with the shear stresses.

2212.2 Modifications to AISC 341.

2212.2.1 Section D1.

Add Section D1.6 as follows:

6. Diaphragm bracing systems. The required strength of diagonal bracing members used as the diaphragm shall be determined from either of the following:

- (1) The load effect resulting from the diaphragm analysis per the applicable building code provided the members satisfy all of the following requirements:
 1. Diagonal bracing members comply with Section D1.1 for moderately ductile members.
 2. Each diagonal bracing member resists no more than 30 percent of the diaphragm shear at each line of resistance.
 3. Diagonal bracing members shall not support gravity loads other than self-weight.
- (2) The load effect required for collectors using the load combinations stipulated in the applicable building code.

2212.2.2 Section D2. Modify Section D2.6c(b)(ii) as follows:

- (ii) the moment calculated using the load combinations of the applicable building code, including the amplified seismic load, provided the connection or other mechanism within the column base is designed to have the ductility necessary to accommodate the column base rotation resulting from the design story drift.

2212.2.3 Section D2. Add Section D2.9 as follows:

9. Diaphragm bracing systems. The required strength of the connections of diagonal bracing members used as the diaphragm shall be the load effect required for collectors using the load combinations stipulated in the applicable building code.

2212.2.4 Section F2. Modify Section F2.3 Exception (2)(a) as follows:

- (a) The maximum of the forces determined using load combination stipulated by the applicable building code including the amplified seismic load, applied to the building frame model in which all compression

braces have been removed and those determined with no compression braces removed per D1.4a(2).

2212.2.5 Section F2. Modify Section F2.4a by adding the following:

Where each framing bay on a line of resistance does not have opposing diagonal braces within the same column bay, then the collector forces along that line shall be designed considering the redistribution of seismic forces to other bays as a result of the post buckled redistribution of loads using the analysis requirements of Section F2.3. The collector shall not be designed for a load less than that stipulated by the applicable building code:

2212.3 Seismic requirements for composite structural steel and concrete construction. In addition to the requirements of Section 2206.2, steel and concrete composite special moment frame with the approved moment connections in accordance with AISC 358 Chapter 10 shall be permitted provided:

1. Beams are provided with reduced beam sections (RBS).
2. Columns shall be hollow structural sections (HSS) and completely filled with structural concrete having unit weight not less than 110 pounds per cubic foot (17 kN/m³). Concrete shall have 28-day compressive strength not less than 4,000 psi (28 MPa).
3. Web extension to beam web two sided fillet weld webs are sized to develop expected strength of the beam web and shall not be less than a $\frac{1}{4}$ inch fillet weld,
4. The high strength bolt design shall consider interaction between shear and tension as required by AISC 360, and
5. The HSS shall not be less than $\frac{1}{2}$ inch.

2212.4 Steel joists.

2212.4.1 Design approval. Joist and joist girder design calculations and profiles with member sizes and connection details, and joist placement plans shall be provided to the enforcement agency and approved prior to joist fabrication, in accordance with Title 24, Part 1. Joist and joist girder design calculations and profiles with member sizes and connection details shall bear the signature and stamp or seal of the registered engineer or licensed architect responsible for the joist design. Alterations to the approved joist and joist girder design calculations and profiles with member sizes and connection details, or to fabricated joists are subject to the approval of the enforcement agency.

2212.4.2 Joist chord bracing. The chords of all joists shall be laterally supported at all points where the chords change direction.

2212.5 Cold-formed steel light-frame construction.

2212.5.1 Trusses.

2212.5.1.1 Analysis submittals. Complete engineering analysis and truss design drawings shall accompany the construction documents submitted to the enforcement agency for approval. When load testing is required the test report shall be submitted with the

truss design drawings and engineering analysis to the enforcement agency.

2212.5.1.2 Deferred submittals. AISI S214 Section B4.2 shall not be deleted.

2212.5.2 Anchorage for shear. Cold formed steel stud foundation plates or sills shall be bolted or fastened to the foundation or foundation wall in accordance with Section 2304.3.4, Item 2.

2212.5.3 Limitations on shear wall assemblies. Shear wall assemblies per Section C2.2.3 of AISI-S213 are not permitted within the seismic force-resisting system of buildings or structures assigned to Occupancy Category II, III, IV, or buildings designed to be relocatable.

2212.6 Testing.

2212.6.1 Tests of high-strength bolts, nuts and washers. High-strength bolts, nuts and washers shall be sampled and tested by an approved independent testing laboratory for conformance with the requirements of Section 2205.

2212.6.2 Tests of end-welded studs. End-welded studs shall be sampled and tested per the requirements of the AWS D1.1.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE CHAPTER 22A – STEEL

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | X | | | X | | | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |

CHAPTER 22A

STEEL

SECTION 2201A GENERAL

2201A.1 Scope. The provisions of this chapter govern the quality, design, fabrication and erection of steel used structurally in buildings or structures.

2201A.1.1 Application. *The scope of application of Chapter 22A is as follows:*

1. *Structures regulated by the Division of the State Architect-Structural Safety (DSA-SS), which include those applications listed in Section 1.9.2.1. These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.*
2. *Structures regulated by the Office of Statewide Health Planning and Development (OSHPD), which include those applications listed in Sections 1.10.1, and 1.10.4. These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers.*

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 22 and any applicable amendments therein.

2201A.1.2 Identification of amendments. DSA-SS and OSHPD adopt this chapter and all amendments.

Exception: Amendments adopted by only one agency appear in this chapter preceded with the appropriate acronym of the adopting agency, as follows:

1. *Division of the State Architect-Structural Safety: [DSA-SS] For applications listed in Section 1.9.2.1.*
2. *Office of Statewide Health Planning and Development:
[OSHPD 1] - For applications listed in Section 1.10.1.
[OSHPD 4] - For applications listed in Section 1.10.4*

SECTION 2202A DEFINITIONS

2202A.1 Definitions. The following terms are defined in Chapter 2.

STEEL CONSTRUCTION, COLD-FORMED.

STEEL JOIST.

STEEL MEMBER, STRUCTURAL.

SECTION 2203A IDENTIFICATION AND PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

2203A.1 Identification. Identification of structural steel members shall comply with the requirements contained in AISC 360. Identification of cold-formed steel members shall comply with the requirements contained in AISI S100. Identification of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S200. Other steel furnished for structural load-carrying purposes shall be properly identified for conformity to the ordered grade in accordance with the specified ASTM standard or other specification and the provisions of this chapter. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards.

2203A.2 Protection. Painting of structural steel members shall comply with the requirements contained in AISC 360. Painting of open-web steel joists and joist girders shall comply with the requirements of SJI CJ-1.0, SJI JG-1.1, SJI K-1.1 and SJI LH/DLH-1.1. Individual structural members and assembled panels of cold-formed steel construction shall be protected against corrosion in accordance with the requirements contained in AISI S100. Protection of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S200.

SECTION 2204A CONNECTIONS

2204A.1 Welding. The details of design, workmanship and technique for welding, inspection of welding and qualification of welding operators shall conform to the requirements of the specifications listed in Sections 2205A, 2206A, 2207A, 2208A, 2210A and 2211A. Special inspection of welding shall be provided where required by Section 1705A.

2204A.2 Bolting. The design, installation and inspection of bolts shall be in accordance with the requirements of the specifications listed in Sections 2205A, 2206A, 2207A, 2210A and 2211A. Special inspection of the installation of high-strength bolts shall be provided where required by Section 1705A.

2204A.2.1 Anchor rods. Anchor rods shall be set in accordance with the construction documents. The protrusion of the threaded ends through the connected material shall fully engage the threads of the nuts, but shall not be greater than the length of the threads on the bolts.

2204A.2.2 Column base plate. When shear and/or tensile forces are intended to be transferred between column base plates and anchor bolts, provisions shall be made in the design to eliminate the effects of oversized holes permitted in base plates by AISC 360 by use of shear lugs and/or welded shear transfer plates or other means acceptable to

the enforcement agency, when the oversized holes are larger than the anchor bolt by more than $\frac{1}{8}$ inch (3.2 mm). When welded shear transfer plates and shear lugs or other means acceptable to the enforcement agency are not used, the anchor bolts shall be checked for the induced bending stresses in combination with the shear stresses.

SECTION 2205A STRUCTURAL STEEL

2205A.1 General. The design, fabrication and erection of structural steel for buildings and structures shall be in accordance with AISC 360. Where required, the seismic design of structural steel structures shall be in accordance with the additional provisions of Section 2205A.2.

2205A.2 Seismic requirements for structural steel structures. The design of structural steel structures to resist seismic forces shall be in accordance with the provisions of Section 2205A.2.2, as applicable.

> **2205A.2.1 Seismic Design Category B or C.** Not permitted by DSA-SS and OSHPD.

2205A.2.2 Seismic Design Category D, E or F. Structural steel structures assigned to Seismic Design Category D, E or F shall be designed and detailed in accordance with AISC 341.

2205A.3 Modifications to AISC 341. [DSA-SS]

2205A.3.1 Section D1. Add Section D1.6 as follows:

6. Diaphragm bracing systems. The required strength of diagonal bracing members used as the diaphragm shall be determined from either of the following:

(1) The load effect resulting from the diaphragm analysis per the applicable building code provided the members satisfy all of the following requirements:

1. Diagonal bracing members comply with Section D1.1 for moderately ductile members.
2. Each diagonal bracing member resists no more than 30 percent of the diaphragm shear at each line of resistance.
3. Diagonal bracing members shall not support gravity loads other than self-weight.

(2) The load effect required for collectors using the load combinations stipulated in the applicable building code.

2205A.3.2 Section D2. Modify Section D2.6c(b)(ii) as follows:

(ii) the moment calculated using the load combinations of the applicable building code, including the amplified seismic load, provided the connection or other mechanism within the column base is designed to have the ductility necessary to accommodate the column base rotation resulting from the design story drift.

2205A.3.3 Section D2. Add Section D2.9 as follows:

9. Diaphragm bracing systems. The required strength of the connections of diagonal bracing members used

as the diaphragm shall be the load effect required for collectors using the load combinations stipulated in the applicable building code.

2205A.3.4 Section F2. Modify Section F2.3 Exception (2)(a) as follows:

(a) The maximum of the forces determined using load combination stipulated by the applicable building code including the amplified seismic load, applied to the building frame model in which all compression braces have been removed and those determined with no compression braces removed per D1.4a(2).

2205A.3.5 Section F2. Modify Section F2.4a by adding the following:

Where each framing bay on a line of resistance does not have opposing diagonal braces within the same column bay, then the collector forces along that line shall be designed considering the redistribution of seismic forces to other bays as a result of the post-buckled redistribution of loads using the analysis requirements of Section F2.3. The collector shall not be designed for a load less than that stipulated by the applicable building code.

2205A.4 Modifications to AISC 341. [OSHPD 1 and 4]

2205A.4.1 Glossary. Modify glossary by adding the following:

Inelastic Rotation: The permanent or plastic portion of the rotation angle between a beam and the column, or between a link and the column of the test specimen, measured in radians. The inelastic rotation shall be computed based upon an analysis of the test specimen deformations. Sources of inelastic rotation include yielding of members and connectors, yielding of connection elements and slip between members and connection elements. For beam-to-column moment connections in special moment frames, the inelastic rotation is represented by the plastic chord rotation angle calculated as the plastic deflection of the beam or girder, at the center of its span divided by the distance between the center of the beam span and the centerline of the panel zone of the beam-column connection. For link-to-column connections in eccentrically braced frames, inelastic rotation shall be computed based upon the assumption that inelastic action is concentrated at a single point located at the intersection of the centerline of the link with the face of the column.

2205A.4.2 Section E3. Replace Section E3.6b Item 1 by the following:

(1) The connection shall be capable of sustaining an interstory drift angle of at least 0.04 radians and an inelastic rotation of 0.03 radians.

2205A.4.3 Section E3. Replace Section E3.6c Item # a by the following:

(a) Use of SMF connections designed in accordance with ANSI/AISC 358 shall be as modified in Section 2205A.4.

2205A.4.4 Section F2. Special concentrically braced frames (SCBF) modifications

5b. Diagonal braces, Add a new section as follows.

(4) The use of rectangular or square HSS are not permitted for bracing members, unless filled solid with cement grout having a minimum compressive strength of 3000 psi at 28 days. The effects of composite action in the filled composite brace shall be considered in the sectional properties of the system where it results in the more severe loading condition or detailing.

2205A.4.5 Section F3. Modify Section F3.6e Item 2 as follows:

Exception is not permitted.

2205A.4.6 Section K2. Replace Section K2.3b as follows:

The size of the beam or link used in the test specimen shall be within the following limits:

1. At least one of the test beams or links shall be no less than 100 percent of the depth of the prototype beam or link. For the remaining specimens, the depth of the test beam or link shall be no less than 90 percent of the depth of the prototype beam or link.
2. At least one of the test beams or links shall be no less than 100 percent of the weight per foot of the prototype beam or link. For the remaining specimens, the weight per foot of the test beam or link shall be no less than 75 percent of the weight per foot of the prototype beam or link.

The size of the column used in the test specimen shall properly represent the inelastic action in the column, as per the requirements in Section K2.3a. In addition, the depth of the test column shall be no less than 90 percent of the depth of the prototype column.

Extrapolation beyond the limitations stated in this section shall be permitted subject to peer review and approval by the enforcement agency.

2205A.4.7 Section K2. Modify Section K2.8 by the following:

The test specimen must sustain the required interstory drift angle, or link rotation angle, and inelastic rotation for at least two complete loading cycles.

2205A.5 Modifications to AISC 358. [OSHPD 1 and 4]

2205A.5.1.2. Design Requirements, 2.1 Special and Intermediate Moment Frame Connection Types, Table 2-1 Prequalified Moment Connections modifications.

The prequalified bolted moment connections are not permitted in buildings.

Exceptions:

1. Erection bolts are permitted.
2. The approved moment connection in accordance with AISC 358 Chapter 10 as permitted by the exception to Section 2206A.2.

SECTION 2206A COMPOSITE STRUCTURAL STEEL AND CONCRETE STRUCTURES

2206A.1 General. Systems of structural steel acting compositely with reinforced concrete shall be designed in accordance with AISC 360 and ACI 318, excluding ACI 318 Chapter 22. Where required, the seismic design of composite steel and concrete systems shall be in accordance with the additional provisions of Section 2206A.2.

2206A.2 Seismic requirements for composite structural steel and concrete construction. Where a response modification coefficient, R , in accordance with ASCE 7, Table 12.2-1 is used for the design of systems of structural steel acting compositely with reinforced concrete, the structures shall be designed and detailed in accordance with the requirements of AISC 341 and shall be considered as an alternative system.

Exception: Steel and concrete composite special moment frame with the approved moment connections in accordance with AISC 358 Chapter 10 shall be permitted, provided:

1. Beams are provided with reduced beam sections (RBS),
2. Columns shall be hollow structural sections (HSS) and completely filled with structural concrete having unit weight not less than 110 pounds per cubic foot (17 kN/m^3). Concrete shall have 28-day compressive strength not less than 4,000 psi (28 MPa).
3. Web extension to beam web two sided fillet welds are sized to develop expected strength of the beam web and shall not be less than a $\frac{1}{4}$ inch fillet weld,
4. The high-strength bolt design shall consider interaction between shear and tension as required by AISC 360, and
5. The HSS shall not be less than $\frac{1}{2}$ inch.

SECTION 2207A STEEL JOISTS

2207A.1 General. The design, manufacture and use of open web steel joists and joist girders shall be in accordance with one of the following Steel Joist Institute (SJI) specifications:

1. SJI CJ-1.0
2. SJI K-1.1
3. SJI LH/DLH-1.1
4. SJI JG-1.1

Where required, the seismic design of buildings shall be in accordance with the additional provisions of Section 2205A.2 or 2210A.5.

2207A.2 Design. The registered design professional shall indicate on the construction documents the steel joist and/or

steel joist girder designations from the specifications listed in Section 2207A.1 and shall indicate the requirements for joist and joist girder design, layout, end supports, anchorage, non-SJI standard bridging, bridging termination connections and bearing connection design to resist uplift and lateral loads. These documents shall indicate special requirements as follows:

1. Special loads including:

- 1.1. Concentrated loads;
- 1.2. Nonuniform loads;
- 1.3. Net uplift loads;
- 1.4. Axial loads;
- 1.5. End moments; and
- 1.6. Connection forces.

2. Special considerations including:

- 2.1. Profiles for nonstandard joist and joist girder configurations (standard joist and joist girder configurations are as indicated in the SJI catalog);
- 2.2. Oversized or other nonstandard web openings; and
- 2.3. Extended ends.

3. Deflection criteria for live and total loads for non-SJI standard joists.

2207A.3 Calculations. The steel joist and joist girder manufacturer shall design the steel joists and/or steel joist girders in accordance with the current SJI specifications and load tables to support the load requirements of Section 2207A.2. The registered design professional may require submission of the steel joist and joist girder calculations as prepared by a registered design professional responsible for the product design. If requested by the registered design professional, the steel joist manufacturer shall submit design calculations with a cover letter bearing the seal and signature of the joist manufacturer's registered design professional. In addition to standard calculations under this seal and signature, submittal of the following shall be included:

1. Non-SJI standard bridging details (e.g. for cantilevered conditions, net uplift, etc.).
2. Connection details for:
 - 2.1. Non-SJI standard connections (e.g. flush-framed or framed connections);
 - 2.2. Field splices; and
 - 2.3. Joist headers.

2207A.4 Steel joist drawings. Steel joist placement plans shall be provided to show the steel joist products as specified on the construction documents and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2207A.2. Steel placement plans shall include, at a minimum, the following:

1. Listing of all applicable loads as stated in Section 2207A.2 and used in the design of the steel joists and joist girders as specified in the construction documents.

2. Profiles for nonstandard joist and joist girder configurations (standard joist and joist girder configurations are as indicated in the SJI catalog).

3. Connection requirements for:

- 3.1. Joist supports;
- 3.2. Joist girder supports;
- 3.3. Field splices; and
- 3.4. Bridging attachments.

4. Deflection criteria for live and total loads for non-SJI standard joists.

5. Size, location and connections for all bridging.

6. Joist headers.

2207A.4.1 Design approval. [DSA-SS] *Joist and joist girder design calculations and profiles with member sizes and connection details, and joist placement plans shall be provided to the enforcement agency and approved prior to joist fabrication, in accordance with the California Administrative Code (Title 24, Part 1). Joist and joist girder design calculations and profiles with member sizes and connection details shall bear the signature and stamp or seal of the registered engineer or licensed architect responsible for the joist design. Alterations to the approved joist and joist girder design calculations and profiles with member sizes and connection details, or to fabricated joists are subject to the approval of the enforcement agency.*

2207A.5 Certification. At completion of manufacture, the steel joist manufacturer shall submit a certificate of compliance in accordance with Section 1704A.2.2 stating that work was performed in accordance with approved construction documents and with SJI standard specifications.

2207A.6 Joist chord bracing. *The chords of all joists shall be laterally supported at all points where the chords change direction.*

SECTION 2208A STEEL CABLE STRUCTURES

2208A.1 General. The design, fabrication and erection including related connections, and protective coatings of steel cables for buildings shall be in accordance with ASCE 19.

SECTION 2209A STEEL STORAGE RACKS

2209A.1 Storage racks. The design, testing and utilization of industrial steel storage racks made of cold-formed or hot-rolled steel structural members, shall be in accordance with RMI/ANSI MH 16.1. Where required by ASCE 7, the seismic design of storage racks shall be in accordance with the provisions of Section 15.5.3 of ASCE 7, except that the mapped acceleration parameters, S_s and S_{J_s} , shall be determined in accordance with Section 1613A.3.1.

SECTION 2210A COLD-FORMED STEEL

2210A.1 General. The design of cold-formed carbon and low-alloy steel structural members shall be in accordance with AISI S100. The design of cold-formed stainless-steel structural members shall be in accordance with ASCE 8. Cold-formed steel light-frame construction shall also comply with Section 2211A. Where required, the seismic design of cold-formed steel structures shall be in accordance with the additional provisions of Section 2210A.2.

2210A.1.1 Steel decks. The design and construction of cold-formed steel decks shall be in accordance with this section.

2210A.1.1.1 Noncomposite steel floor decks. Non-composite steel floor decks shall be permitted to be designed and constructed in accordance with ANSI/SDI-NC1.0.

2210A.1.1.2 Steel roof deck. Steel roof decks shall be permitted to be designed and constructed in accordance with ANSI/SDI-RD1.0. *The base material thickness of steel deck shall not be less than 0.0359 inch (0.9 mm) (20 gage).*

Exception: [DSA-SS] For single-story open structures, the minimum deck thickness may be waived if the steel roof deck need not be used as the diaphragm and there are no suspended hangers or bracing for nonstructural components attached to the deck.

2210A.1.1.3 Composite slabs on steel decks. Composite slabs of concrete and steel deck shall be permitted to be designed and constructed in accordance with ANSI/SDI-C.

2210A.2 Seismic requirements for cold-formed steel structures. Where a response modification coefficient, R , in accordance with ASCE 7, Table 12.2-1 is used for the design of cold-formed steel structures, the structures shall be designed and detailed in accordance with the requirements of AISI S100 and ASCE 8.

Complete engineering analysis and truss design drawings shall accompany the construction documents submitted to the enforcement agency for approval. When load testing is required, the test report shall be submitted with the truss design drawings and engineering analysis to the enforcement agency.

2211A.3.1 Truss design drawings. The truss design drawings shall conform to the requirements of Section B2.3 of AISI S214 and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent individual truss member restraint/bracing in accordance with Section B of AISI S214 where these methods are utilized to provide restraint/bracing.

2211A.3.2 Deferred submittals. Not permitted by DSA-SS and OSHPD.

2211A.3.3 Trusses spanning 60 feet or greater. The owner shall contract with a registered design professional for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater. Special inspection of trusses over 60 feet (18 288 mm) in length shall conform to Section 1705A.

2211A.3.4 Truss quality assurance. Trusses not part of a manufacturing process that provides requirements for quality control done under the supervision of a third-party quality control agency, shall be manufactured in compliance with Sections 1704A.2.5 and 1705A.3, as applicable.

2211A.4 Wall stud design. Wall studs shall be designed in accordance with either AISI S211 or AISI S100.

Cold formed steel stud foundation plates or sills shall be bolted or fastened to the foundation or foundation wall in accordance with Section 2304.3.4, Item 2.

2211A.5 Floor and roof system design. Framing for floor and roof systems in buildings shall be designed in accordance with either AISI S210 or AISI S100.

2211A.6 Lateral design. Light-frame shear walls, diagonal strap bracing that is part of a structural wall and diaphragms used to resist wind, seismic and other in-plane lateral loads shall be designed in accordance with AISI S213.

Shear wall assemblies per Section C2.2.3 of AISI-S213 are not permitted within the seismic force-resisting system of buildings.

2211A.7 Prescriptive framing. Not permitted by DSA-SS and OSHPD.

SECTION 2211A COLD-FORMED STEEL LIGHT-FRAME CONSTRUCTION

2211A.1 General. The design and installation of structural members and nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is between 0.0179 inches (0.455 mm) and 0.1180 inches (2.997 mm) shall be in accordance with AISI S200 and Sections 2211A.2 through 2211A.7, as applicable.

2211A.2 Header design. Headers, including box and back-to-back headers, and double and single L-headers shall be designed in accordance with AISI S212 or AISI S100.

2211A.3 Truss design. Cold-formed steel trusses shall be designed in accordance with AISI S214, Sections 2211A.3.1 through 2211A.3.4 and accepted engineering practice.

SECTION 2212A [DSA-SS] LIGHT MODULAR STEEL MOMENT FRAMES FOR PUBLIC ELEMENTARY AND SECONDARY SCHOOLS, AND COMMUNITY COLLEGES

2212A.1 General.

2212A.1.1 Configuration. Light modular steel moment frame buildings shall be constructed of factory-assembled modules comprising a single-story moment-resisting space frame supporting a floor and roof. Individual modules

shall not exceed a width of 14 feet (4.25 m) nor a length of 72 feet (22 m). All connections of beams to corner columns shall be designed as moment-resisting in accordance with the criteria of Section 2212A.2. Modules may be stacked to form multistory structures not exceeding 35 feet or two stories in height. When stacked modules are evaluated separately, seismic forces on each module shall be distributed in accordance with Section 12.8.3 of ASCE 7, considering the modules in the stacked condition. See Section 2212A.2.5 of this code.

2212A.1.2 Design, fabrication and erection. The design, fabrication and erection of light modular steel moment-frame buildings shall be in accordance with the AISC Specification for Structural Steel Buildings (ANSI/AISC 360) and the AISI North American Specification for the Design of Cold Formed Structural Members (AISI/COS/NASPEC), as applicable, and the requirements of this section. The maximum dead load of the roof and elevated floor shall not exceed 25 psf and 50 psf (1197 Pa and 2394 Pa), respectively. The maximum dead load of the exterior walls shall not exceed 45 psf (2155 Pa).

2212A.2 Seismic requirements. In addition to the other requirements of this code, the design, materials and workmanship of light modular steel moment frames shall comply with the requirements of this section. The response modification coefficient R shall be equal to $3\frac{1}{2}$. C_d and Ω_0 shall be equal to 3.0.

2212A.2.1 Base materials. Beams, columns and connection materials shall be limited to those materials permitted under the AISC Specification for Structural Members (ANSI/AISC 360) and the AISI North American Specification for the Design of Cold Formed Structural Members (AISI/COS/NASPEC).

2212A.2.2 Beam-to-column strength ratio. At each moment-resisting connection the following shall apply:

$$\frac{\sum S_{bi} F_{ybi}}{\sum S_{cj} F_{ycj}} \geq 1.4 \quad (\text{Equation 22A-1})$$

where:

F_{ybi} = The specified yield stress of beam "i."

F_{ycj} = The specified yield stress of column "j."

S_{bi} = The flexural section modulus of each beam "i" that is moment connected to the column "j" at the connection.

S_{cj} = The flexural section modulus of each column "j" that is moment connected to the beam "i" at the connection.

Exceptions:

1. Beam-to-column connections at the floor level beams of first or second-story modules need not comply with this requirement.
2. Beam-to-column strength ratios less than 1.4 are allowed if proven to be acceptable by analysis or testing.

2212A.2.3 Welding. Weld filler metals shall be capable of producing weld metal with a minimum Charpy V-Notch toughness of 20 ft-lb at 0°F. Where beam bottom flanges attach to columns with complete joint penetration groove welds and weld backing is used at the bottom surface of the beam flange, such backing shall be removed and the root pass back-gouged, repaired and reinforced with a minimum $\frac{3}{16}$ inch (5 mm) fillet weld.

2212A.2.4 Connection design. Connections of beams to columns shall have the design strength to resist the maximum seismic load effect, E_m , calculated in accordance with Section 12.4.3 of ASCE 7.

2212A.2.5 Multistory assemblies. Analysis of multistory assemblies shall be permitted to consider the stacked modules as a single assembly, with restraint conditions between the stacked units that represent the actual method of attachment. Alternatively, it shall be permitted to analyze the individual modules of stacked assemblies independently, with lateral and vertical reactions from modules above applied as concentrated loads at the top of the supporting module.

SECTION 2213A TESTING AND FIELD VERIFICATION

2213A.1 Tests of high-strength bolts, nuts and washers. High-strength bolts, nuts and washers shall be sampled and tested by an approved independent testing laboratory for conformance with the requirements of applicable ASTM standards.

[OSHPD 1 and 4] A minimum of three samples per lot, as defined in the ASTM standards for bolts [and not nuts and washers], shall be tested for tensile properties, but need not exceed three samples per 400 bolts.

2213A.2 Tests of end-welded studs. End-welded studs shall be tested per the requirements of the AWS D1.1, Sections 7.7 and 7.8.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE CHAPTER 23 – WOOD

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | X | | X | X | | | X | X | X | X | | X | | | | | | | | |
| Adopt only those sections that are listed below | | X | | | | | | | | | | | | | | | | | X | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 2301.1 | | | X | X | | | | | | | | | | | | | | | | |
| 2301.1.1 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2301.1.2 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2301.1.3 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2301.1.3.1 | | | | | | | X | | X | X | | X | | | | | | | | |
| 2301.1.3.2 | | | | | | | | X | | | | | | | | | | | | |
| 2301.2, Item 4, Exception | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2303.1.3.1 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2303.2 – 2303.2.9 | | X | | | | | | | | | | | | | | | | | | |
| 2303.4.1.4.1, Exception 3 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2303.4.3.1 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2304.3.1.1 | | X | X | | | | | | | | | | | | | | | | | |
| 2304.3.4 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2304.4.1 | | | | | | | X | X | | | | | | | | | | | | |
| 2304.4.4.1 | | | | | | | | | X | X | | X | | | | | | | | |
| 2304.5 | | | | | | | X | X | | | | | | | | | | | | |
| 2304.6.1, Exception | | | | | | | X | | X | | | X | | | | | | | | |
| 2304.9.1.1 | | | | | | | X | | X | X | | X | | | | | | | | |
| 2304.11.2.1.1 | | | | | | | | | | | | | | | | | | | X | |
| 2304.11.2.2, Exception | | | | | | | | X | X | X | X | | X | | | | | | | |
| 2304.11.2.4.1 | | | | | | | | X | | X | X | | X | | | | | | | |
| 2304.11.2.8 | | | | | | | | | | | | | | | | | | | X | |
| 2305.1.2 | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2305.2, Exception | | | | | | | X | | X | X | | X | | | | | | | | |
| 2305.3, Exception | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2306.2, Exception | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2306.3, Exception | | | | | | | X | X | X | X | | X | | | | | | | | |
| 2308.1 | | | | | | | | | | | | | | | | | | | | |
| 2308.2, Item 8 | | | | | | | X | X | | X | | | | | | | | | | |

CHAPTER 23

WOOD

SECTION 2301 GENERAL

2301.1 Scope. The provisions of this chapter shall govern the materials, design, construction and quality of wood members and their fasteners.

[HCD 1] For limited-density owner-built rural dwellings, owner-produced or used materials and appliances may be utilized unless found not to be of sufficient strength or durability to perform the intended function; owner-produced or used lumber, or shakes and shingles may be utilized unless found to contain dry rot, excessive splitting or other defects obviously rendering the material unfit in strength or durability for the intended purpose.

2301.1.1 Application. [DSA-SS, DSA-SS/CC & OSHPD 1, 2, & 4] The scope of application of Chapter 23 is as follows:

1. Applications listed in Sections 1.9.2.1 and 1.9.2.2, regulated by the Division of the State Architect-Structural Safety (DSA-SS, and DSA-SS/CC). These applications include public elementary and secondary schools, community colleges and state-owned or state-leased essential services buildings.
2. Applications listed in Section 1.10, regulated by the Office of Statewide Health Planning and Development (OSHPD). These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers.

Exception: For applications listed in Section 1.10.3 (Licensed Clinics), the provisions of this chapter without OSHPD amendments identified in accordance with Section 2301.1.2 shall apply.

2301.1.2 Identification of amendments. [DSA-SS, DSA-SS/CC & OSHPD 1, 2 & 4] Amendments appear in this chapter preceded with the appropriate acronym, as follows:

1. *Division of the State Architect - Structural Safety:*
[DSA-SS] - For applications listed in Section 1.9.2.1.
[DSA-SS/CC] - For applications listed in Section 1.9.2.2
2. *Office of Statewide Health Planning and Development:*
[OSHPD 1] - For applications listed in Section 1.10.1.
[OSHPD 2] - For applications listed in Section 1.10.2.
[OSHPD 4] - For applications listed in Section 1.10.4.

2301.1.3 Reference to other chapters.

2301.1.3.1 [DSA-SS and OSHPD 1 & 4] Where reference within this chapter is made to sections in Chapters 16, 17, 18, 19, 21, 22, and 34, the provisions in Chapters 16A, 17A, 18A, 19A, 21A, 22A, and 34A respectively shall apply instead.

Exception: For DSA-SS, the requirements of Chapter 34 shall apply instead of Chapter 34A

2301.1.3.2 [DSA-SS/CC] Where reference within this chapter is made to sections in Chapters 17 and 18, the provisions in Chapters 17A and 18A respectively shall apply instead.

2301.2 General design requirements. The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:

1. Allowable stress design in accordance with Sections 2304, 2305 and 2306.
 2. Load and resistance factor design in accordance with Sections 2304, 2305 and 2307.
 3. Conventional light-frame construction in accordance with Sections 2304 and 2308.
- Exception:** Buildings designed in accordance with the provisions of the AF&PA WFCM shall be deemed to meet the requirements of the provisions of Section 2308.
4. The design and construction of log structures shall be in accordance with the provisions of ICC 400.

Exception: [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] Log structures are not permitted by DSA and OSHPD.

2301.3 Nominal sizes. For the purposes of this chapter, where dimensions of lumber are specified, they shall be deemed to be nominal dimensions unless specifically designated as actual dimensions (see Section 2304.2).

SECTION 2302 DEFINITIONS

2302.1 Definitions. The following terms are defined in Chapter 2:

ACCREDITATION BODY.

BRACED WALL LINE.

BRACED WALL PANEL.

COLLECTOR.

CONVENTIONAL LIGHT-FRAME CONSTRUCTION.

CRIPPLE WALL.

DIAPHRAGM, UNBLOCKED.

DRAG STRUT.

FIBERBOARD.

GLUED BUILT-UP MEMBER.**GRADE (LUMBER).****HARDBOARD.****NAILING, BOUNDARY.****NAILING, EDGE.****NAILING, FIELD.****NATURALLY DURABLE WOOD.***Decay resistant.**Termite resistant.***NOMINAL SIZE (LUMBER).****PARTICLEBOARD.****PERFORMANCE CATEGORY.****PREFABRICATED WOOD I-JOIST.****SHEAR WALL.****Shear wall, perforated.****Shear wall segment, perforated.****STRUCTURAL COMPOSITE LUMBER.****Laminated strand lumber (LSL).****Laminated veneer lumber (LVL).****Oriented strand lumber (OSL).****Parallel strand lumber (PSL).****STRUCTURAL GLUED-LAMINATED TIMBER.****SUBDIAPHRAGM.****TIE-DOWN (HOLD-DOWN).****TREATED WOOD.****Fire-retardant-treated wood.****Preservative-treated wood.****WOOD SHEAR PANEL.****WOOD STRUCTURAL PANEL.****Composite panels.****Oriented strand board (OSB).****Plywood.**

SECTION 2303

MINIMUM STANDARDS AND QUALITY

2303.1 General. Structural sawn lumber; end-jointed lumber; prefabricated wood I-joists; structural glued-laminated timber; wood structural panels, fiberboard sheathing (when used structurally); hardboard siding (when used structurally); particleboard; preservative-treated wood; structural log members; structural composite lumber; round timber poles and piles; fire-retardant-treated wood; hardwood plywood; wood trusses; joist hangers; nails; and staples shall conform to the applicable provisions of this section.

2303.1.1 Sawn lumber. Sawn lumber used for load-supporting purposes, including end-jointed or edge-glued lumber, machine stress-rated or machine-evaluated lum-

ber, shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with DOC PS 20 or equivalent. Grading practices and identification shall comply with rules published by an agency approved in accordance with the procedures of DOC PS 20 or equivalent procedures.

2303.1.1.1 Certificate of inspection. In lieu of a grade mark on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section is permitted to be accepted for precut, remanufactured or rough-sawn lumber and for sizes larger than 3 inches (76 mm) nominal thickness.

2303.1.1.2 End-jointed lumber. Approved end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required to have a fire-resistance rating shall have the designation "Heat Resistant Adhesive" or "HRA" included in its grade mark.

2303.1.2 Prefabricated wood I-joists. Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D 5055.

2303.1.3 Structural glued-laminated timber. Glued-laminated timbers shall be manufactured and identified as required in ANSI/AITC A 190.1 and ASTM D 3737.

2303.1.3.1 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] The construction documents shall indicate the following:

1. Dry or wet service conditions.
2. Laminating combinations and stress requirements.
3. Species group.
4. Preservative material and retention, when preservative treatment is required.
5. Provisions for protection during shipping and field handling, such as sealing and wrapping in accordance with AITC 111.

When mechanical reinforcement such as radial tension reinforcement is required, such reinforcement shall comply with AITC 404 and shall be detailed accordingly in the construction documents. Construction documents shall specify that the moisture content of laminations at the time of manufacture shall not exceed 12 percent for dry conditions of use.

The design of fasteners and connections shall comply with AITC 117, Section I, Item 6 (Connection Design), and NDS Appendix E.

Refer to Section 1705A.5.4 for special inspection requirements during fabrication of structural glued laminated timbers.

Exception: [OSHPD 2] Special inspection shall be per Chapter 17 instead of 17A.

2303.1.4 Wood structural panels. Wood structural panels, when used structurally (including those used for siding, roof and wall sheathing, subflooring, diaphragms and built-up members), shall conform to the requirements for their type in DOC PS 1, DOC PS 2 or ANSI/APA PRP 210. Each panel or member shall be identified for grade, bond classification, and Performance Category by the trademarks of an approved testing and grading agency. The Performance Category value shall be used as the “nominal panel thickness” or “panel thickness” whenever referenced in this code. Wood structural panel components shall be designed and fabricated in accordance with the applicable standards listed in Section 2306.1 and identified by the trademarks of an approved testing and inspection agency indicating conformance to the applicable standard. In addition, wood structural panels when permanently exposed in outdoor applications shall be of Exterior type, except that wood structural panel roof sheathing exposed to the outdoors on the underside is permitted to be Exposure 1 type.

2303.1.5 Fiberboard. Fiberboard for its various uses shall conform to ASTM C 208. Fiberboard sheathing, when used structurally, shall be identified by an approved agency as conforming to ASTM C 208.

2303.1.5.1 Jointing. To ensure tight-fitting assemblies, edges shall be manufactured with square, shiplapped, beveled, tongue-and-groove or U-shaped joints.

2303.1.5.2 Roof insulation. Where used as roof insulation in all types of construction, fiberboard shall be protected with an approved roof covering.

2303.1.5.3 Wall insulation. Where installed and fire-blocked to comply with Chapter 7, fiberboards are permitted as wall insulation in all types of construction. In fire walls and fire barriers, unless treated to comply with Section 803.1 for Class A materials, the boards shall be cemented directly to the concrete, masonry or other noncombustible base and shall be protected with an approved noncombustible veneer anchored to the base without intervening airspaces.

2303.1.5.3.1 Protection. Fiberboard wall insulation applied on the exterior of foundation walls shall be protected below ground level with a bituminous coating.

2303.1.6 Hardboard. Hardboard siding used structurally shall be identified by an approved agency conforming to CPA/ANSI A135.6. Hardboard underlayment shall meet the strength requirements of $\frac{7}{32}$ -inch (5.6 mm) or $\frac{1}{4}$ -inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished hardboard paneling shall meet the requirements of CPA/ANSI A135.5. Other basic hardboard products shall meet the requirements of CPA/ANSI A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations.

2303.1.7 Particleboard. Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade mark or certificate of inspection issued by an approved agency. Particleboard shall not be utilized for

applications other than indicated in this section unless the particleboard complies with the provisions of Section 2306.3.

2303.1.7.1 Floor underlayment. Particleboard floor underlayment shall conform to Type PBU of ANSI A208.1. Type PBU underlayment shall not be less than $\frac{1}{4}$ -inch (6.4 mm) thick and shall be installed in accordance with the instructions of the Composite Panel Association.

2303.1.8 Preservative-treated wood. Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.11 to be preservative treated shall conform to the requirements of the applicable AWPA Standard U1 and M4 for the species, product, preservative and end use. Preservatives shall be listed in Section 4 of AWPA U1. Lumber and plywood used in wood foundation systems shall conform to Chapter 18.

2303.1.8.1 Identification. Wood required by Section 2304.11 to be preservative treated shall bear the quality mark of an inspection agency that maintains continuing supervision, testing and inspection over the quality of the preservative-treated wood. Inspection agencies for preservative-treated wood shall be listed by an accreditation body that complies with the requirements of the American Lumber Standards Treated Wood Program, or equivalent. The quality mark shall be on a stamp or label affixed to the preservative-treated wood, and shall include the following information:

1. Identification of treating manufacturer.
2. Type of preservative used.
3. Minimum preservative retention (pcf).
4. End use for which the product is treated.
5. AWPA standard to which the product was treated.
6. Identity of the accredited inspection agency.

2303.1.8.2 Moisture content. Where preservative-treated wood is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19 percent or less before being covered with insulation, interior wall finish, floor covering or other materials.

2303.1.9 Structural composite lumber. Structural capacities for structural composite lumber shall be established and monitored in accordance with ASTM D 5456.

2303.1.10 Structural log members. Stress grading of structural log members of nonrectangular shape, as typically used in log buildings, shall be in accordance with ASTM D 3957. Such structural log members shall be identified by the grade mark of an approved lumber grading or inspection agency. In lieu of a grade mark on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section shall be permitted.

2303.1.11 Round timber poles and piles. Round timber poles and piles shall comply with ASTM D 3200 and ASTM D 25, respectively.

2303.2 Fire-retardant-treated wood. Fire-retardant-treated wood is any wood product which, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E 84 or UL 723, a listed flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. Additionally, the flame front shall not progress more than $10\frac{1}{2}$ feet (3200 mm) beyond the centerline of the burners at any time during the test.

2303.2.1 Pressure process. For wood products impregnated with chemicals by a pressure process, the process shall be performed in closed vessels under pressures not less than 50 pounds per square inch gauge (psig) (345 kPa).

2303.2.2 Other means during manufacture. For wood products produced by other means during manufacture, the treatment shall be an integral part of the manufacturing process of the wood product. The treatment shall provide permanent protection to all surfaces of the wood product.

2303.2.3 Testing. For wood products produced by other means during manufacture, other than a pressure process, all sides of the wood product shall be tested in accordance with and produce the results required in Section 2303.2. Wood structural panels shall be permitted to test only the front and back faces.

2303.2.4 Labeling. Fire-retardant-treated lumber and wood structural panels shall be labeled. The label shall contain the following items:

1. The identification mark of an approved agency in accordance with Section 1703.5.
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread and smoke-developed index.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with Sections 2303.2.2 through 2303.2.5.
8. For fire-retardant-treated wood exposed to weather, damp or wet locations, include the words "No increase in the listed classification when subjected to the Standard Rain Test" (ASTM D 2898).

2303.2.5 Strength adjustments. Design values for untreated lumber and wood structural panels, as specified in Section 2303.1, shall be adjusted for fire-retardant-treated wood. Adjustments to design values shall be based on an approved method of investigation that takes into consideration the effects of the anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and redrying procedures.

2303.2.5.1 Wood structural panels. The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated soft-

wood plywood shall be determined in accordance with ASTM D 5516. The test data developed by ASTM D 5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D 6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for its treatment.

2303.2.5.2 Lumber. For each species of wood that is treated, the effects of the treatment, the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D 5664. The test data developed by ASTM D 5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D 6841. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (27°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

2303.2.6 Exposure to weather, damp or wet locations. Where fire-retardant-treated wood is exposed to weather, or damp or wet locations, it shall be identified as "Exterior" to indicate there is no increase in the listed flame spread index as defined in Section 2303.2 when subjected to ASTM D 2898.

2303.2.7 Interior applications. Interior fire-retardant-treated wood shall have moisture content of not over 28 percent when tested in accordance with ASTM D 3201 procedures at 92-percent relative humidity. Interior fire-retardant-treated wood shall be tested in accordance with Section 2303.2.5.1 or 2303.2.5.2. Interior fire-retardant-treated wood designated as Type A shall be tested in accordance with the provisions of this section.

2303.2.8 Moisture content. Fire-retardant-treated wood shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for wood structural panels before use. For wood kiln dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in Section 2303.2.5.1 for plywood and 2303.2.5.2 for lumber.

2303.2.9 Type I and II construction applications. See Section 603.1 for limitations on the use of fire-retardant-treated wood in buildings of Type I or II construction.

2303.3 Hardwood and plywood. Hardwood and decorative plywood shall be manufactured and identified as required in HPVA HP-1.

2303.4 Trusses. Wood trusses shall comply with Sections 2303.4.1 through 2303.4.7.

2303.4.1 Design. Wood trusses shall be designed in accordance with the provisions of this code and accepted engineering practice. Members are permitted to be joined by nails, glue, bolts, timber connectors, metal connector plates or other approved framing devices.

2303.4.1.1 Truss design drawings. The written, graphic and pictorial depiction of each individual truss shall be provided to the building official for approval prior to installation. Truss design drawings shall also be provided with the shipment of trusses delivered to the job site. Truss design drawings shall include, at a minimum, the information specified below:

1. Slope or depth, span and spacing;
2. Location of all joints and support locations;
3. Number of plies if greater than one;
4. Required bearing widths;
5. Design loads as applicable, including:
 - 5.1. Top chord live load;
 - 5.2. Top chord dead load;
 - 5.3. Bottom chord live load;
 - 5.4. Bottom chord dead load;
 - 5.5. Additional loads and locations; and
 - 5.6. Environmental design criteria and loads (wind, rain, snow, seismic, etc.).
6. Other lateral loads, including drag strut loads;
7. Adjustments to wood member and metal connector plate design value for conditions of use;
8. Maximum reaction force and direction, including maximum uplift reaction forces where applicable;
9. Metal-connector-plate type, size and thickness or gage, and the dimensioned location of each metal connector plate except where symmetrically located relative to the joint interface;
10. Size, species and grade for each wood member;
11. Truss-to-truss connections and truss field assembly requirements;
12. Calculated span-to-deflection ratio and maximum vertical and horizontal deflection for live and total load as applicable;
13. Maximum axial tension and compression forces in the truss members; and
14. Required permanent individual truss member restraint location and the method and details of restraint/bracing to be used in accordance with Section 2303.4.1.2.

2303.4.1.2 Permanent individual truss member restraint. Where permanent restraint of truss members is required on the truss design drawings, it shall be accomplished by one of the following methods:

1. Permanent individual truss member restraint/bracing shall be installed using standard industry lateral restraint/bracing details in accordance with generally accepted engineering practice. Locations for lateral restraint shall be identified on the truss design drawing.

2. The trusses shall be designed so that the buckling of any individual truss member is resisted internally by the individual truss through suitable means (i.e., buckling reinforcement by T-reinforcement or L-reinforcement, proprietary reinforcement, etc.). The buckling reinforcement of individual members of the trusses shall be installed as shown on the truss design drawing or on supplemental truss member buckling reinforcement details provided by the truss designer.
3. A project-specific permanent individual truss member restraint/bracing design shall be permitted to be specified by any registered design professional.

2303.4.1.3 Trusses spanning 60 feet or greater. The owner shall contract with any qualified registered design professional for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for all trusses with clear spans 60 feet (18 288 mm) or greater.

2303.4.1.4 Truss designer. The individual or organization responsible for the design of trusses.

2303.4.1.4.1 Truss design drawings. Where required by the registered design professional, the building official or the statutes of the jurisdiction in which the project is to be constructed, each individual truss design drawing shall bear the seal and signature of the truss designer.

Exceptions:

1. Where a cover sheet and truss index sheet are combined into a single sheet and attached to the set of truss design drawings, the single cover/truss index sheet is the only document required to be signed and sealed by the truss designer.
2. When a cover sheet and a truss index sheet are separately provided and attached to the set of truss design drawings, the cover sheet and the truss index sheet are the only documents required to be signed and sealed by the truss designer.
3. [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] Exceptions 1 and 2 are not permitted by DSA and OSHPD.

2303.4.2 Truss placement diagram. The truss manufacturer shall provide a truss placement diagram that identifies the proposed location for each individually designated truss and references the corresponding truss design drawing. The truss placement diagram shall be provided as part of the truss submittal package, and with the shipment of trusses delivered to the job site. Truss placement diagrams that serve only as a guide for installation and do not deviate from the permit submittal drawings shall not be required to bear the seal or signature of the truss designer.

2303.4.3 Truss submittal package. The truss submittal package provided by the truss manufacturer shall consist of each individual truss design drawing, the truss place-

ment diagram, the permanent individual truss member restraint/bracing method and details and any other structural details germane to the trusses; and, as applicable, the cover/truss index sheet.

2303.4.3.1 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] In addition to Sections 2303.4.1 and 2303.4.2, the following requirements apply:

1. **Construction documents.** The construction documents prepared by the registered engineer or licensed architect for the project shall indicate all requirements for the truss design, including:

1.1 Deflection criteria.

1.2 Connection details to structural and non-structural elements (e.g. non-bearing partitions).

2. **Requirements for approval.** The truss design drawings and engineering analysis shall be provided to the enforcement agency and approved prior to truss fabrication, in accordance with the California Administrative Code (Title 24, Part 1). Alterations to the approved truss design drawings or manufactured trusses are subject to the approval of the enforcement agency.-

3. **Special inspection during truss manufacture.** Refer to Section 1705A.5.5 for special inspection requirements during the manufacture of open-web trusses.

2303.4.4 Anchorage. The design for the transfer of loads and anchorage of each truss to the supporting structure is the responsibility of the registered design professional.

2303.4.5 Alterations to trusses. Truss members and components shall not be cut, notched, drilled, spliced or otherwise altered in any way without written concurrence and approval of a registered design professional. Alterations resulting in the addition of loads to any member (e.g., HVAC equipment, piping, additional roofing or insulation, etc.) shall not be permitted without verification that the truss is capable of supporting such additional loading.

2303.4.6 TPI 1 specifications. In addition to Sections 2303.4.1 through 2303.4.5, the design, manufacture and quality assurance of metal-plate-connected wood trusses shall be in accordance with TPI 1. Job-site inspections shall be in compliance with Section 110.4, as applicable.

2303.4.7 Truss quality assurance. Trusses not part of a manufacturing process in accordance with either Section 2303.4.6 or a referenced standard, which provides requirements for quality control done under the supervision of a third-party quality control agency, shall be manufactured in compliance with Sections 1704.2.5 and 1705.5, as applicable.

2303.5 Test standard for joist hangers. For the required test standards for joist hangers see Section 1711.1.

2303.6 Nails and staples. Nails and staples shall conform to requirements of ASTM F 1667. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as follows: 80 kips per square inch (ksi) (551

MPa) for shank diameters larger than 0.177 inch (4.50 mm) but not larger than 0.254 inch (6.45 mm), 90 ksi (620 MPa) for shank diameters larger than 0.142 inch (3.61 mm) but not larger than 0.177 inch (4.50 mm) and 100 ksi (689 MPa) for shank diameters of at least 0.099 inch (2.51 mm) but not larger than 0.142 inch (3.61 mm).

2303.7 Shrinkage. Consideration shall be given in design to the possible effect of cross-grain dimensional changes considered vertically which may occur in lumber fabricated in a green condition.

SECTION 2304 GENERAL CONSTRUCTION REQUIREMENTS

2304.1 General. The provisions of this section apply to design methods specified in Section 2301.2.

2304.2 Size of structural members. Computations to determine the required sizes of members shall be based on the net dimensions (actual sizes) and not nominal sizes.

2304.3 Wall framing. The framing of exterior and interior walls shall be in accordance with the provisions specified in Section 2308 unless a specific design is furnished.

2304.3.1 Bottom plates. Studs shall have full bearing on a 2-inch-thick (actual 1 $\frac{1}{2}$ -inch, 38 mm) or larger plate or sill having a width at least equal to the width of the studs.

2304.3.1.1 [HCD 1] Rodent proofing. Annular spaces around pipes, electric cables, conduits or other openings in bottom/sole plates at exterior walls shall be protected against the passage of rodents by closing such openings in accordance with the California Green Building Standards Code (CALGreen), Chapter 4, Division 4.4.

2304.3.2 Framing over openings. Headers, double joists, trusses or other approved assemblies that are of adequate size to transfer loads to the vertical members shall be provided over window and door openings in load-bearing walls and partitions.

2304.3.3 Shrinkage. Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems, or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

2304.3.4 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] The following additional requirements apply:

1. Engineering analysis shall be furnished that demonstrates compliance of wall framing elements and connections with Section 2301.2, Item 1 or 2.

2. Construction documents shall include detailing of sill plate anchorage to supporting masonry or con-

crete for all exterior and interior bearing, nonbearing and shear walls. Unless specifically designed in accordance with Item 1 above, sills under exterior walls, bearing walls and shear walls shall be bolted to masonry or concrete with $\frac{5}{8}$ inch diameter by 12-inch (16 mm by 305 mm) bolts spaced not more than four (4) feet (1219 mm) on center, with a minimum of two (2) bolts for each piece of sill plate. Anchor bolts shall have a 4 inch minimum and a 12-inch maximum clearance to the end of the sill plate, and 7-inch minimum embedment into concrete or masonry.

Unless specifically designed in accordance with Item 1 above, sill plates under nonbearing interior partitions on concrete floor slabs shall be anchored at not more than four (4) feet (1219 mm) on center to resist a minimum allowable stress shear of 100 pounds per linear foot (1.4 kN/m) acting either parallel or perpendicular to the wall.

3. Construction documents shall include detailing and limitations for notches and bored holes in wall studs, plates and sills.

2304.4 Floor and roof framing. The framing of wood-joisted floors and wood framed roofs shall be in accordance with the provisions specified in Section 2308 unless a specific design is furnished.

2304.4.1 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] The following additional requirements apply:

1. Engineering analysis shall be furnished that demonstrates compliance of floor, roof and ceiling framing elements and connections with Section 2301.2, Items 1 or 2.
2. Construction documents shall include detailing and limitations for notches and bored holes in floor and roof framing members.

2304.5 Framing around flues and chimneys. Combustible framing shall be a minimum of 2 inches (51 mm), but shall not be less than the distance specified in Sections 2111 and 2113 and the *California Mechanical Code*, from flues, chim-

neys and fireplaces, and 6 inches (152 mm) away from flue openings.

2304.6 Wall sheathing. Except as provided for in Section 1405 for weatherboarding or where stucco construction that complies with Section 2510 is installed, enclosed buildings shall be sheathed with one of the materials of the nominal thickness specified in Table 2304.6 or any other approved material of equivalent strength or durability.

2304.6.1 Wood structural panel sheathing. Where wood structural panel sheathing is used as the exposed finish on the outside of exterior walls, it shall have an exterior exposure durability classification. Where wood structural panel sheathing is used elsewhere, but not as the exposed finish, it shall be of a type manufactured with exterior glue (Exposure 1 or Exterior). Wood structural panel wall sheathing or siding used as structural sheathing shall be capable of resisting wind pressures in accordance with Section 1609. Maximum wind speeds for wood structural panel sheathing used to resist wind pressures shall be in accordance with Table 2304.6.1 for enclosed buildings with a mean roof height not greater than 30 feet (9144 mm) and a topographic factor (K_z) of 1.0.

Exception: [DSA-SS and OSHPD 1 & 4] Wind pressure shall be calculated in accordance with Section 1609A.

2304.6.2 Interior paneling. Softwood wood structural panels used for interior paneling shall conform to the provisions of Chapter 8 and shall be installed in accordance with Table 2304.9.1. Panels shall comply with DOC PS 1, DOC PS 2 or ANSI/APA PRP 210. Prefinished hardboard paneling shall meet the requirements of CPA/ANSI A135.5. Hardwood plywood shall conform to HPVA HP-1.

2304.7 Floor and roof sheathing. Structural floor sheathing and structural roof sheathing shall comply with Sections 2304.7.1 and 2304.7.2, respectively.

2304.7.1 Structural floor sheathing. Structural floor sheathing shall be designed in accordance with the general provisions of this code and the special provisions in this section.

Floor sheathing conforming to the provisions of Table 2304.7(1), 2304.7(2), 2304.7(3) or 2304.7(4) shall be deemed to meet the requirements of this section.

TABLE 2304.6
MINIMUM THICKNESS OF WALL SHEATHING

| SHEATHING TYPE | MINIMUM THICKNESS | MAXIMUM WALL STUD SPACING |
|---|---|---------------------------|
| Wood boards | $\frac{5}{8}$ inch | 24 inches on center |
| Fiberboard | $\frac{1}{2}$ inch | 16 inches on center |
| Wood structural panel | In accordance with Tables 2308.9.3(2) and 2308.9.3(3) | — |
| M-S "Exterior Glue" and M-2 "Exterior Glue" Particleboard | In accordance with Section 2306.3 and Table 2308.9.3(4) | — |
| Gypsum sheathing | $\frac{1}{2}$ inch | 16 inches on center |
| Gypsum wallboard | $\frac{1}{2}$ inch | 24 inches on center |
| Reinforced cement mortar | 1 inch | 24 inches on center |

For SI: 1 inch = 25.4 mm.

WOOD

**TABLE 2304.6.1
MAXIMUM NOMINAL DESIGN WIND SPEED, V_{asd} , PERMITTED FOR
WOOD STRUCTURAL PANEL WALL SHEATHING USED TO RESIST WIND PRESSURES^{a, b, c}**

| MINIMUM NAIL | | MINIMUM WOOD STRUCTURAL PANEL SPAN RATING | MINIMUM NOMINAL PANEL THICKNESS (inches) | MAXIMUM WALL STUD SPACING (inches) | PANEL NAIL SPACING | | MAXIMUM NOMINAL DESIGN WIND SPEED, V_{asd} (MPH) | | | | | |
|------------------------------|----------------------|---|--|------------------------------------|---------------------|---------------------|--|-----|-----|--|--|--|
| Size | Penetration (inches) | | | | Edges (inches o.c.) | Field (inches o.c.) | Wind exposure category | | | | | |
| | | | | | B | C | D | | | | | |
| 6d common (2.0" x 0.113") | 1.5 | 24/0 | $\frac{3}{8}$ | 16 | 6 | 12 | 110 | 90 | 85 | | | |
| | | 24/16 | $\frac{7}{16}$ | 16 | 6 | 12 | 110 | 100 | 90 | | | |
| | | | | | | 6 | 150 | 125 | 110 | | | |
| | 1.75 | 24/16 | $\frac{7}{16}$ | | | 12 | 130 | 110 | 105 | | | |
| | | | | | | 6 | 150 | 125 | 110 | | | |
| | | | | | | 12 | 110 | 90 | 85 | | | |
| | | | | | | 6 | 110 | 90 | 85 | | | |

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- a. Panel strength axis shall be parallel or perpendicular to supports. Three-ply plywood sheathing with studs spaced more than 16 inches on center shall be applied with panel strength axis perpendicular to supports.
- b. The table is based on wind pressures acting toward and away from building surfaces in accordance with Section 30.7 of ASCE 7. Lateral requirements shall be in accordance with Section 2305 or 2308.
- c. Wood structural panels with span ratings of wall 16 or wall 24 shall be permitted as an alternative to panels with a 24/0 span rating. Plywood siding rated 16 o.c. or 24 o.c. shall be permitted as an alternative to panels with a 24/16 span rating. Wall 16 and plywood siding 16 o.c. shall be used with studs spaced a maximum of 16 inches o.c.
- d. V_{asd} shall be determined in accordance with Section 1609.3.1.

**TABLE 2304.7(1)
ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHINGS^{a, b}**

| SPAN (inches) | MINIMUM NET THICKNESS (inches) OF LUMBER PLACED | | | |
|---------------|---|---------------------|---------------------------|---------------------|
| | Perpendicular to supports | | Diagonally to supports | |
| | Surfaced dry ^c | Surfaced unseasoned | Surfaced dry ^c | Surfaced unseasoned |
| Floors | | | | |
| 24 | $\frac{3}{4}$ | $\frac{25}{32}$ | $\frac{3}{4}$ | $\frac{25}{32}$ |
| 16 | $\frac{5}{8}$ | $\frac{11}{16}$ | $\frac{5}{8}$ | $\frac{11}{16}$ |
| Roofs | | | | |
| 24 | $\frac{5}{8}$ | $\frac{11}{16}$ | $\frac{3}{4}$ | $\frac{25}{32}$ |

For SI: 1 inch = 25.4 mm.

- a. Installation details shall conform to Sections 2304.7.1 and 2304.7.2 for floor and roof sheathing, respectively.
- b. Floor or roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.
- c. Maximum 19 percent moisture content.

**TABLE 2304.7(2)
SHEATHING LUMBER, MINIMUM GRADE REQUIREMENTS: BOARD GRADE**

| SOLID FLOOR OR ROOF SHEATHING | SPACED ROOF SHEATHING | GRADING RULES |
|-------------------------------|-----------------------|----------------------------------|
| Utility | Standard | NLGA, WCLIB, WWPA |
| 4 common or utility | 3 common or standard | NLGA, WCLIB, WWPA, NSLB or NELMA |
| No. 3 | No. 2 | SPIB |
| Merchantable | Construction common | RIS |

TABLE 2304.7(3)
ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND
SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS^{a, b}

| SHEATHING GRADES | | ROOF ^c | | | | FLOOR ^d |
|---------------------------------------|-----------------------------|--------------------------------|----------------------|-------------------------|-----------|--------------------------|
| Panel span rating roof/ floor span | Panel thickness (inches) | Maximum span (inches) | | Load ^e (psf) | | Maximum span (inches) |
| | | With edge support ^f | Without edge support | Total load | Live load | |
| 16/0 | 3/8 | 16 | 16 | 40 | 30 | 0 |
| 20/0 | 3/8 | 20 | 20 | 40 | 30 | 0 |
| 24/0 | 3/8, 7/16, 1/2 | 24 | 20 ^g | 40 | 30 | 0 |
| 24/16 | 7/16, 1/2 | 24 | 24 | 50 | 40 | 16 |
| 32/16 | 15/32, 1/2, 5/8 | 32 | 28 | 40 | 30 | 16 ^h |
| 40/20 | 19/32, 5/8, 3/4, 7/8 | 40 | 32 | 40 | 30 | 20 ^{h,i} |
| 48/24 | 23/32, 3/4, 7/8 | 48 | 36 | 45 | 35 | 24 |
| 54/32 | 7/8, 1 | 54 | 40 | 45 | 35 | 32 |
| 60/32 | 7/8, 1 1/8 | 60 | 48 | 45 | 35 | 32 |
| SINGLE FLOOR GRADES | | ROOF ^c | | | | FLOOR ^d |
| Panel span rating | Panel thickness (inches) | Maximum span (inches) | | Load ^e (psf) | | Maximum span (inches) |
| | | With edge support ^f | Without edge support | Total load | Live load | |
| 16 o.c. | 1/2, 19/32, 5/8 | 24 | 24 | 50 | 40 | 16 ^h |
| 20 o.c. | 19/32, 5/8, 3/4 | 32 | 32 | 40 | 30 | 20 ^{h,i} |
| 24 o.c. | 23/32, 3/4 | 48 | 36 | 35 | 25 | 24 |
| 32 o.c. | 7/8, 1 | 48 | 40 | 50 | 40 | 32 |
| 48 o.c. | 1 1/2, 1 1/8 | 60 | 48 | 50 | 40 | 48 |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m².

- a. Applies to panels 24 inches or wider.
- b. Floor and roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.
- c. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only.
- d. Panel edges shall have approved tongue and groove joints or shall be supported with blocking unless 1/4 inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4 inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 100 pounds per square foot except the span rating of 48 inches on center is based on a total load of 65 pounds per square foot.
- e. Allowable load at maximum span.
- f. Tongue and groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.
- g. For 1/2 inch panel, maximum span shall be 24 inches.
- h. Span is permitted to be 24 inches on center where 3/4 inch wood strip flooring is installed at right angles to joist.
- i. Span is permitted to be 24 inches on center for floors where 1 1/2 inches of cellular or lightweight concrete is applied over the panels.

TABLE 2304.7(4)
ALLOWABLE SPAN FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR-UNDERLayment (SINGLE FLOOR)^{a, b}
(Panels Continuous Over Two or More Spans and Strength Axis Perpendicular to Supports)

| IDENTIFICATION | MAXIMUM SPACING OF JOISTS (inches) | | | | |
|---------------------------------------|------------------------------------|--------------------|---------|---------|---------|
| | 16 | 20 | 24 | 32 | 48 |
| Species group ^c | | Thickness (inches) | | | |
| 1 | 1/2 | 5/8 | 3/4 | — | — |
| 2, 3 | 5/8 | 3/4 | 7/8 | — | — |
| 4 | 3/4 | 7/8 | 1 | — | — |
| Single floor span rating ^d | 16 o.c. | 20 o.c. | 24 o.c. | 32 o.c. | 48 o.c. |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m².

- a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of 1/360 of span is 100 pounds per square foot except allowable total uniform load for 1 1/8 inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved tongue and groove joints or shall be supported with blocking, unless 1/4 inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4 inch wood strip.
- b. Floor panels conforming with this table shall be deemed to meet the design criteria of Section 2304.7.
- c. Applicable to all grades of sanded exterior type plywood. See DOC PS 1 for plywood species groups.
- d. Applicable to Underlayment grade, C C (Plugged) plywood, and Single Floor grade wood structural panels.

TABLE 2304.7(5)
ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS
OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS
(Plywood Structural Panels Are Five-Ply, Five-Layer Unless Otherwise Noted)^{a, b}

| PANEL GRADE | THICKNESS (inch) | MAXIMUM SPAN (inches) | LOAD AT MAXIMUM SPAN (psf) | |
|--|------------------------------|-----------------------|----------------------------|-----------------|
| | | | Live | Total |
| Structural I sheathing | $\frac{7}{16}$ | 24 | 20 | 30 |
| | $\frac{15}{32}$ | 24 | 35 ^c | 45 ^c |
| | $\frac{1}{2}$ | 24 | 40 ^c | 50 ^c |
| | $\frac{19}{32}, \frac{5}{8}$ | 24 | 70 | 80 |
| | $\frac{23}{32}, \frac{3}{4}$ | 24 | 90 | 100 |
| Sheathing, other grades covered in DOC PS 1 or DOC PS 2 | $\frac{7}{16}$ | 16 | 40 | 50 |
| | $\frac{15}{32}$ | 24 | 20 | 25 |
| | $\frac{1}{2}$ | 24 | 25 | 30 |
| | $\frac{19}{32}$ | 24 | 40 ^c | 50 ^c |
| | $\frac{5}{8}$ | 24 | 45 ^c | 55 ^c |
| | $\frac{23}{32}, \frac{3}{4}$ | 24 | 60 ^c | 65 ^c |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m².

- a. Roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.
- b. Uniform load deflection limitations $\frac{1}{180}$ of span under live load plus dead load, $\frac{1}{240}$ under live load only. Edges shall be blocked with lumber or other approved type of edge supports.
- c. For composite and four ply plywood structural panel, load shall be reduced by 15 pounds per square foot.

2304.7.2 Structural roof sheathing. Structural roof sheathing shall be designed in accordance with the general provisions of this code and the special provisions in this section.

Roof sheathing conforming to the provisions of Table 2304.7(1), 2304.7(2), 2304.7(3) or 2304.7(5) shall be deemed to meet the requirements of this section. Wood structural panel roof sheathing shall be bonded by exterior glue.

2304.8 Lumber decking. Lumber decking shall be designed and installed in accordance with the general provisions of this code and Sections 2304.8.1 through 2304.8.5.3.

2304.8.1 General. Each piece of lumber decking shall be square-end trimmed. When random lengths are furnished, each piece shall be square end trimmed across the face so that at least 90 percent of the pieces are within 0.5 degrees (0.00873 rad) of square. The ends of the pieces shall be permitted to be beveled up to 2 degrees (0.0349 rad) from the vertical with the exposed face of the piece slightly longer than the opposite face of the piece. Tongue-and-groove decking shall be installed with the tongues up on sloped or pitched roofs with pattern faces down.

2304.8.2 Layup patterns. Lumber decking is permitted to be laid up following one of five standard patterns as defined in Sections 2304.8.2.1 through 2304.8.2.5. Other patterns are permitted to be used provided they are substantiated through engineering analysis.

2304.8.2.1 Simple span pattern. All pieces shall be supported on their ends (i.e., by two supports).

2304.8.2.2 Two-span continuous pattern. All pieces shall be supported by three supports, and all end joints shall occur in line on alternating supports. Supporting members shall be designed to accommodate the load redistribution caused by this pattern.

2304.8.2.3 Combination simple and two-span continuous pattern. Courses in end spans shall be alternating simple-span pattern and two-span continuous pattern. End joints shall be staggered in adjacent courses and shall bear on supports.

2304.8.2.4 Cantilevered pieces intermixed pattern. The decking shall extend across a minimum of three spans. Pieces in each starter course and every third course shall be simple span pattern. Pieces in other courses shall be cantilevered over the supports with end joints at alternating quarter or third points of the spans. Each piece shall bear on at least one support.

2304.8.2.5 Controlled random pattern. The decking shall extend across a minimum of three spans. End joints of pieces within 6 inches (152 mm) of the end joints of the adjacent pieces in either direction shall be separated by at least two intervening courses. In the end bays, each piece shall bear on at least one support. Where an end joint occurs in an end bay, the next piece in the same course shall continue over the first inner support for at least 24 inches (610 mm). The details of the controlled random pattern shall be as specified for each decking material in Section 2304.8.3.3, 2304.8.4.3 or 2304.8.5.3.

Decking that cantilevers beyond a support for a horizontal distance greater than 18 inches (457 mm), 24 inches (610 mm) or 36 inches (914 mm) for 2-inch (51

mm), 3-inch (76 mm) and 4-inch (102 mm) nominal thickness decking, respectively, shall comply with the following:

1. The maximum cantilevered length shall be 30 percent of the length of the first adjacent interior span.
2. A structural fascia shall be fastened to each decking piece to maintain a continuous, straight line.
3. There shall be no end joints in the decking between the cantilevered end of the decking and the centerline of the first adjacent interior span.

2304.8.3 Mechanically laminated decking. Mechanically laminated decking shall comply with Sections 2304.8.3.1 through 2304.8.3.3.

2304.8.3.1 General. Mechanically laminated decking consists of square-edged dimension lumber laminations set on edge and nailed to the adjacent pieces and to the supports.

2304.8.3.2 Nailing. The length of nails connecting laminations shall not be less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center (o.c.) or less, side nails shall be installed not more than 30 inches (762 mm) o.c. alternating between top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) o.c., side nails shall be installed not more than 18 inches (457 mm) o.c. alternating between top and bottom edges and staggered one-third of the spacing in adjacent laminations. Two side nails shall be installed at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) o.c. or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) o.c., alternate laminations shall be toenailed to every support.

2304.8.3.3 Controlled random pattern. There shall be a minimum distance of 24 inches (610 mm) between end joints in adjacent courses. The pieces in the first and second courses shall bear on at least two supports with end joints in these two courses occurring on alternate supports. A maximum of seven intervening courses shall be permitted before this pattern is repeated.

2304.8.4 Two-inch sawn tongue-and-groove decking. Two-inch (51 mm) sawn tongue-and-groove decking shall comply with Sections 2304.8.4.1 through 2304.8.4.3.

2304.8.4.1 General. Two-inch (51 mm) decking shall have a maximum moisture content of 15 percent. Decking shall be machined with a single tongue-and-groove pattern. Each decking piece shall be nailed to each support.

2304.8.4.2 Nailing. Each piece of decking shall be toenailed at each support with one 16d common nail through the tongue and face-nailed with one 16d common nail.

2304.8.4.3 Controlled random pattern. There shall be a minimum distance of 24 inches (610 mm) between end joints in adjacent courses. The pieces in the first and second courses shall bear on at least two supports with end joints in these two courses occurring on alternate supports. A maximum of seven intervening courses shall be permitted before this pattern is repeated.

2304.8.5 Three- and four-inch sawn tongue-and-groove decking. Three- and four-inch (76 mm and 102 mm) sawn tongue-and-groove decking shall comply with Sections 2304.8.5.1 through 2304.8.5.3.

2304.8.5.1 General. Three-inch (76 mm) and four-inch (102 mm) decking shall have a maximum moisture content of 19 percent. Decking shall be machined with a double tongue-and-groove pattern. Decking pieces shall be interconnected and nailed to the supports.

2304.8.5.2 Nailing. Each piece shall be toenailed at each support with one 40d common nail and face-nailed with one 60d common nail. Courses shall be spiked to each other with 8-inch (203 mm) spikes at maximum intervals of 30 inches (762 mm) through pre-drilled edge holes penetrating to a depth of approximately 4 inches (102 mm). One spike shall be installed at a distance not exceeding 10 inches (254 mm) from the end of each piece.

2304.8.5.3 Controlled random pattern. There shall be a minimum distance of 48 inches (1219 mm) between end joints in adjacent courses. Pieces not bearing on a support are permitted to be located in interior bays provided the adjacent pieces in the same course continue over the support for at least 24 inches (610 mm). This condition shall not occur more than once in every six courses in each interior bay.

2304.9 Connectors and fasteners. Connectors and fasteners shall comply with the applicable provisions of Sections 2304.9.1 through 2304.9.7.

2304.9.1 Fastener requirements. Connections for wood members shall be designed in accordance with the appropriate methodology in Section 2301.2. The number and size of fasteners connecting wood members shall not be less than that set forth in Table 2304.9.1.

2304.9.1.1 Additional requirements. [DSA-SS and OSHPD 1, 2 & 4] Fasteners used for the attachment of exterior wall coverings shall be of hot-dipped zinc-coated galvanized steel, mechanically deposited zinc-coated steel, stainless steel, silicon bronze or copper. The coating weights for hot-dipped zinc-coated fasteners shall be in accordance with ASTM A 153. The coating weights for mechanically deposited zinc coated fasteners shall be in accordance with ASTM B 695, Class 55 minimum.

**TABLE 2304.9.1
FASTENING SCHEDULE**

| CONNECTION | FASTENING ^{a, m} | LOCATION |
|--|---|---|
| 1. Joist to sill or girder | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | toenail |
| 2. Bridging to joist | 2 - 8d common ($2\frac{1}{2}$ " × 0.131") 2 - 3" × 0.131" nails 2 - 3" 14 gage staples | toenail each end |
| 3. 1" × 6" subfloor or less to each joist | 2 - 8d common ($2\frac{1}{2}$ " × 0.131") | face nail |
| 4. Wider than 1" × 6" subfloor to each joist | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") | face nail |
| 5. 2" subfloor to joist or girder | 2 - 16d common ($3\frac{1}{2}$ " × 0.162") | blind and face nail |
| 6. Sole plate to joist or blocking Sole plate to joist or blocking at braced wall panel | 16d ($3\frac{1}{2}$ " × 0.135") at 16" o.c. 3" × 0.131" nails at 8" o.c. 3" 14 gage staples at 12" o.c. 3 - 16d ($3\frac{1}{2}$ " × 0.135") at 16" o.c. 4 - 3" × 0.131" nails at 16" o.c. 4 - 3" 14 gage staples at 16" o.c. | typical face nail braced wall panels |
| 7. Top plate to stud | 2 - 16d common ($3\frac{1}{2}$ " × 0.162") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | end nail |
| 8. Stud to sole plate | 4 - 8d common ($2\frac{1}{2}$ " × 0.131") 4 - 3" × 0.131" nails 3 - 3" 14 gage staples 2 - 16d common ($3\frac{1}{2}$ " × 0.162") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | toenail end nail |
| 9. Double studs | 16d ($3\frac{1}{2}$ " × 0.135") at 24" o.c. 3" × 0.131" nail at 8" o.c. 3" 14 gage staple at 8" o.c. | face nail |
| 10. Double top plates Double top plates | 16d ($3\frac{1}{2}$ " × 0.135") at 16" o.c. 3" × 0.131" nail at 12" o.c. 3" 14 gage staple at 12" o.c. 8 - 16d common ($3\frac{1}{2}$ " × 0.162") 12 - 3" × 0.131" nails 12 - 3" 14 gage staples | typical face nail lap splice |
| 11. Blocking between joists or rafters to top plate | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | toenail |
| 12. Rim joist to top plate | 8d ($2\frac{1}{2}$ " × 0.131") at 6" o.c. 3" × 0.131" nail at 6" o.c. 3" 14 gage staple at 6" o.c. | toenail |
| 13. Top plates, laps and intersections | 2 - 16d common ($3\frac{1}{2}$ " × 0.162") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | face nail |
| 14. Continuous header, two pieces | 16d common ($3\frac{1}{2}$ " × 0.162") | 16" o.c. along edge |
| 15. Ceiling joists to plate | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") 5 - 3" × 0.131" nails 5 - 3" 14 gage staples | toenail |
| 16. Continuous header to stud | 4 - 8d common ($2\frac{1}{2}$ " × 0.131") | toenail |

(continued)

**TABLE 2304.9.1—continued
FASTENING SCHEDULE**

| CONNECTION | FASTENING ^{a, m} | LOCATION |
|--|--|---|
| 17. Ceiling joists, laps over partitions (see Section 2308.10.4.1, Table 2308.10.4.1) | 3 - 16d common ($3\frac{1}{2}$ " × 0.162") minimum, Table 2308.10.4.1 4 - 3" × 0.131" nails 4 - 3" 14 gage staples | face nail |
| 18. Ceiling joists to parallel rafters (see Section 2308.10.4.1, Table 2308.10.4.1) | 3 - 16d common ($3\frac{1}{2}$ " × 0.162") minimum, Table 2308.10.4.1 4 - 3" × 0.131" nails 4 - 3" 14 gage staples | face nail |
| 19. Rafter to plate (see Section 2308.10.1, Table 2308.10.1) | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | toenail |
| 20. 1" × 8" sheathing to each stud and plate | 2 - 8d common ($2\frac{1}{2}$ " × 0.131") 2 - 3" × 0.131" nails 3 - 3" 14 gage staples | face nail |
| 21. 1" × 8" sheathing to each bearing | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") | face nail |
| 22. Wider than 1" × 8" sheathing to each bearing | 3 - 8d common ($2\frac{1}{2}$ " × 0.131") | face nail |
| 23. Built-up corner studs | 16d common ($3\frac{1}{2}$ " × 0.162") 3" × 0.131" nails 3" 14 gage staples | 24" o.c. 16" o.c. 16" o.c. |
| 24. Built-up girder and beams | 20d common (4" × 0.192") 32" o.c. 3" × 0.131" nail at 24" o.c. 3" 14 gage staple at 24" o.c. | face nail at top and bottom staggered on opposite sides |
| | 2 - 20d common (4" × 0.192") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | face nail at ends and at each splice |
| 25. 2" planks | 16d common ($3\frac{1}{2}$ " × 0.162") | at each bearing |
| 26. Collar tie to rafter | 3 - 10d common (3" × 0.148") 4 - 3" × 0.131" nails 4 - 3" 14 gage staples | face nail |
| 27. Jack rafter to hip | 3 - 10d common (3" × 0.148") 4 - 3" × 0.131" nails 4 - 3" 14 gage staples | toenail |
| | 2 - 16d common ($3\frac{1}{2}$ " × 0.162") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | face nail |
| 28. Roof rafter to 2-by ridge beam | 2 - 16d common ($3\frac{1}{2}$ " × 0.162") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | toenail |
| | 2 - 16d common ($3\frac{1}{2}$ " × 0.162") 3 - 3" × 0.131" nails 3 - 3" 14 gage staples | face nail |
| 29. Joist to band joist | 3 - 16d common ($3\frac{1}{2}$ " × 0.162") 4 - 3" × 0.131" nails 4 - 3" 14 gage staples | face nail |

(continued)

**TABLE 2304.9.1—continued
FASTENING SCHEDULE**

| CONNECTION | FASTENING ^{a, m} | | LOCATION |
|---|---|--|-------------------------|
| 30. Ledger strip | 3 - 16d common ($3\frac{1}{2}$ " × 0.162") 4 - 3" × 0.131" nails 4 - 3" 14 gage staples | | face nail at each joist |
| 31. Wood structural panels and particleboard ^b Subfloor, roof and wall sheathing (to framing) | $\frac{1}{2}$ " and less $\frac{19}{32}$ " to $\frac{3}{4}$ " $\frac{7}{8}$ " to 1" $\frac{11}{8}$ " to $1\frac{1}{4}$ " | 6d ^{c, 1} $2\frac{3}{8}$ " × 0.113" nail ⁿ $1\frac{3}{4}$ " 16 gage ^o 8d ^d or 6d ^e $2\frac{3}{8}$ " × 0.113" nail ^p 2" 16 gage ^p 8d ^c 10d ^d or 8d ^e | |
| Single floor (combination subfloor-underlayment to framing) | $\frac{3}{4}$ " and less $\frac{7}{8}$ " to 1" $\frac{11}{8}$ " to $1\frac{1}{4}$ " | 6d ^e 8d ^e 10d ^d or 8d ^e | |
| 32. Panel siding (to framing) | $\frac{1}{2}$ " or less $\frac{5}{8}$ " | 6d ^f 8d ^f | |
| 33. Fiberboard sheathing ^g | $\frac{1}{2}$ " $\frac{25}{32}$ " | No. 11 gage roofing nail ^h 6d common nail (2" × 0.113") No. 16 gage staple ⁱ No. 11 gage roofing nail ^h 8d common nail ($2\frac{1}{2}$ " × 0.131") No. 16 gage staple ⁱ | |
| 34. Interior paneling | $\frac{1}{4}$ " $\frac{3}{8}$ " | 4d ^j 6d ^k | |

For SI: 1 inch = 25.4 mm.

- a. Common or box nails are permitted to be used except where otherwise stated.
- b. Nails spaced at 6 inches on center at edges, 12 inches at intermediate supports except 6 inches at supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.
- c. Common or deformed shank (6d 2" × 0.113"; 8d $2\frac{1}{2}$ " × 0.131"; 10d 3" × 0.148").
- d. Common (6d 2" × 0.113"; 8d $2\frac{1}{2}$ " × 0.131"; 10d 3" × 0.148").
- e. Deformed shank (6d 2" × 0.113"; 8d $2\frac{1}{2}$ " × 0.131"; 10d 3" × 0.148").
- f. Corrosion resistant siding (6d $1\frac{7}{8}$ " × 0.106"; 8d $2\frac{3}{8}$ " × 0.128") or casing (6d 2" × 0.099"; 8d $2\frac{1}{2}$ " × 0.113") nail.
- g. Fasteners spaced 3 inches on center at exterior edges and 6 inches on center at intermediate supports, when used as structural sheathing. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications.
- h. Corrosion resistant roofing nails with $\frac{7}{16}$ inch diameter head and $1\frac{1}{2}$ inch length for $\frac{1}{2}$ inch sheathing and $1\frac{3}{4}$ inch length for $\frac{25}{32}$ inch sheathing.
- i. Corrosion resistant staples with nominal $\frac{7}{16}$ inch crown or 1 inch crown and $1\frac{1}{4}$ inch length for $\frac{1}{2}$ inch sheathing and $1\frac{1}{2}$ inch length for $\frac{25}{32}$ inch sheathing. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).
- j. Casing ($1\frac{1}{2}$ " × 0.080") or finish ($1\frac{1}{2}$ " × 0.072") nails spaced 6 inches on panel edges, 12 inches at intermediate supports.
- k. Panel supports at 24 inches. Casing or finish nails spaced 6 inches on panel edges, 12 inches at intermediate supports.
- l. For roof sheathing applications, 8d nails ($2\frac{1}{2}$ " × 0.113") are the minimum required for wood structural panels.
- m. Staples shall have a minimum crown width of $\frac{7}{16}$ inch.
- n. For roof sheathing applications, fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.
- o. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports for subfloor and wall sheathing and 3 inches on center at edges, 6 inches at intermediate supports for roof sheathing.
- p. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.

2304.9.2 Sheathing fasteners. Sheathing nails or other approved sheathing connectors shall be driven so that their head or crown is flush with the surface of the sheathing.

2304.9.3 Joist hangers and framing anchors. Connections depending on joist hangers or framing anchors, ties and other mechanical fastenings not otherwise covered are permitted where approved. The vertical load-bearing capacity, torsional moment capacity and deflection characteristics of joist hangers shall be determined in accordance with Section 1716.1.

2304.9.4 Other fasteners. Clips, staples, glues and other approved methods of fastening are permitted where approved.

2304.9.5 Fasteners and connectors in contact with preservative-treated and fire-retardant-treated wood. Fasteners, including nuts and washers, and connectors in contact with preservative-treated and fire-retardant-treated wood shall be in accordance with Sections 2304.9.5.1 through 2304.9.5.4. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A 153.

2304.9.5.1 Fasteners and connectors for preservative-treated wood. Fasteners, including nuts and washers, in contact with preservative-treated wood shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, timber rivets, wood screws and lag screws shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum. Connectors that are used in exterior applications and in contact with preservative-treated wood shall have coating types and weights in accordance with the treated wood or connector manufacturer's recommendations. In the absence of manufacturer's recommendations, a minimum of ASTM A 653, type G185 zinc-coated galvanized steel, or equivalent, shall be used.

Exception: Plain carbon steel fasteners, including nuts and washers, in SBX/DOT and zinc borate preservative-treated wood in an interior, dry environment shall be permitted.

2304.9.5.2 Fastenings for wood foundations. Fastenings, including nuts and washers, for wood foundations shall be as required in AF&PA PWF.

2304.9.5.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations. Fasteners, including nuts and washers, for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, timber rivets, wood screws and lag screws shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.

2304.9.5.4 Fasteners for fire-retardant-treated wood used in interior applications. Fasteners, including nuts and washers, for fire-retardant-treated wood used

in interior locations shall be in accordance with the manufacturer's recommendations. In the absence of manufacturer's recommendations, Section 2304.9.5.3 shall apply.

2304.9.6 Load path. Where wall framing members are not continuous from foundation sill to roof, the members shall be secured to ensure a continuous load path. Where required, sheet metal clamps, ties or clips shall be formed of galvanized steel or other approved corrosion-resistant material not less than 0.040 inch (1.01 mm) nominal thickness.

2304.9.7 Framing requirements. Wood columns and posts shall be framed to provide full end bearing. Alternatively, column-and-post end connections shall be designed to resist the full compressive loads, neglecting end-bearing capacity. Column-and-post end connections shall be fastened to resist lateral and net induced uplift forces.

2304.10 Heavy timber construction. Where a structure or portion thereof is required to be of Type IV construction by other provisions of this code, the building elements therein shall comply with the applicable provisions of Sections 2304.10.1 through 2304.10.5.

2304.10.1 Columns. Columns shall be continuous or superimposed throughout all stories by means of reinforced concrete or metal caps with brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other approved methods.

2304.10.1.1 Column connections. Girders and beams shall be closely fitted around columns and adjoining ends shall be cross tied to each other, or intertied by caps or ties, to transfer horizontal loads across joints. Wood bolsters shall not be placed on tops of columns unless the columns support roof loads only.

2304.10.2 Floor framing. Approved wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. Where intermediate beams are used to support a floor, they shall rest on top of girders, or shall be supported by ledgers or blocks securely fastened to the sides of the girders, or they shall be supported by an approved metal hanger into which the ends of the beams shall be closely fitted.

2304.10.3 Roof framing. Every roof girder and at least every alternate roof beam shall be anchored to its supporting member; and every monitor and every sawtooth construction shall be anchored to the main roof construction. Such anchors shall consist of steel or iron bolts of sufficient strength to resist vertical uplift of the roof.

2304.10.4 Floor decks. Floor decks and covering shall not extend closer than $\frac{1}{2}$ inch (12.7 mm) to walls. Such $\frac{1}{2}$ -inch (12.7 mm) spaces shall be covered by a molding fastened to the wall either above or below the floor and arranged such that the molding will not obstruct the expansion or contraction movements of the floor. Corbeling of masonry walls under floors is permitted in place of such molding.

2304.10.5 Roof decks. Where supported by a wall, roof decks shall be anchored to walls to resist uplift forces determined in accordance with Chapter 16. Such anchors shall consist of steel or iron bolts of sufficient strength to resist vertical uplift of the roof.

2304.11 Protection against decay and termites. Wood shall be protected from decay and termites in accordance with the applicable provisions of Sections 2304.11.1 through 2304.11.9.

2304.11.1 General. Where required by this section, protection from decay and termites shall be provided by the use of naturally durable or preservative-treated wood.

2304.11.2 Wood used above ground. Wood used above ground in the locations specified in Sections 2304.11.2.1 through 2304.11.2.7, 2304.11.3 and 2304.11.5 shall be naturally durable wood or preservative-treated wood using water-borne preservatives, in accordance with AWPA U1 (Commodity Specifications A or F) for above-ground use.

2304.11.2.1 Joists, girders and subfloor. Where wood joists or the bottom of a wood structural floor without joists are closer than 18 inches (457 mm), or wood girders are closer than 12 inches (305 mm) to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation, the floor construction (including posts, girders, joists and subfloor) shall be of naturally durable or preservative-treated wood.

2304.11.2.1.1 [SPCB] *There shall be a clearance of at least 18 inches (457 mm) between the underside of wood floor joists and the finished surface of the ground, and at least 12 inches (305 mm) between the underside of any other wood horizontal framing member and the finished surface of the ground. The ground underneath floor joists shall be leveled or smoothed off so as to maintain a reasonably even surface.*

Exception: *For purposes of structural pest control inspection, a minimum of 12 inches (305 mm) of clearance under-floor joists shall be considered adequate except that such clearance shall not be necessary where the subarea soil is of such a nature as to prevent excavation or where excavation would create a hazard from shifting soil or other causes.*

2304.11.2.2 Wood supported by exterior foundation walls. Wood framing members, including wood sheathing, that rest on exterior foundation walls and are less than 8 inches (203 mm) from exposed earth shall be of naturally durable or preservative-treated wood.

Exception: *[DSA-SS and OSHPD 1, 2 & 4]* *At exterior walls where the earth is paved with an asphalt or concrete slab at least 18 inches (457 mm) wide and draining away from the building, the bottom of sills are permitted to be 6 inches (152 mm) above the top of such slab. Other equivalent means of termite and decay protection may be accepted by the enforcement agency.*

2304.11.2.3 Exterior walls below grade. Wood framing members and furring strips attached directly to the interior of exterior masonry or concrete walls below grade shall be of naturally durable or preservative-treated wood.

2304.11.2.4 Sleepers and sills. Sleepers and sills on a concrete or masonry slab that is in direct contact with earth shall be of naturally durable or preservative-treated wood.

2304.11.2.4.1 Additional requirements. [DSA-SS and OSHPD 1, 2 & 4] Stud walls or partitions at shower or toilet rooms with more than two fixtures, and stud walls adjacent to unroofed paved areas shall rest on a concrete curb extending at least 6 inches (152 mm) above finished floor or pavement level.

2304.11.2.5 Girder ends. The ends of wood girders entering exterior masonry or concrete walls shall be provided with a $\frac{1}{2}$ -inch (12.7 mm) air space on top, sides and end, unless naturally durable or preservative-treated wood is used.

2304.11.2.6 Wood siding. Clearance between wood siding and earth on the exterior of a building shall not be less than 6 inches (152 mm) or less than 2 inches (51 mm) vertical from concrete steps, porch slabs, patio slabs and similar horizontal surfaces exposed to the weather except where siding, sheathing and wall framing are of naturally durable or preservative-treated wood.

2304.11.2.7 Posts or columns. Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing that is in direct contact with the earth shall be of naturally durable or preservative-treated wood.

Exceptions:

1. Posts or columns that are either exposed to the weather or located in basements or cellars, supported by concrete piers or metal pedestals projected at least 1 inch (25 mm) above the slab or deck and 6 inches (152 mm) above exposed earth, and are separated therefrom by an impervious moisture barrier.
2. Posts or columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building, supported by a concrete pier or metal pedestal at a height greater than 8 inches (203 mm) from exposed ground, and are separated therefrom by an impervious moisture barrier.

2304.11.2.8 Separate wood framing. [SPCB] *Correct the conditions in frame and stucco walls and similar appurtenant construction so that the wood framing is separate from the main structure by a complete concrete or masonry plug with no voids that will allow infestations to enter the structure from the wall. If there is no plug, the foundation shall be 2 inches (51 mm) or more above the grade levels and at least as high as the*

adjoining slabs or 4-inch (102 mm) concrete barrier seat off installed.

2304.11.3 Laminated timbers. The portions of glued-laminated timbers that form the structural supports of a building or other structure and are exposed to weather and not fully protected from moisture by a roof, eave or similar covering shall be pressure treated with preservative or be manufactured from naturally durable or preservative-treated wood.

2304.11.4 Wood in contact with the ground or fresh water. Wood used in contact with the ground (exposed earth) in the locations specified in Sections 2304.11.4.1 and 2304.11.4.2 shall be naturally durable (species for both decay and termite resistance) or preservative treated using water-borne preservatives in accordance with AWPA U1 (Commodity Specifications A or F) for soil or fresh water use.

Exception: Untreated wood is permitted where such wood is continuously and entirely below the ground-water level or submerged in fresh water.

2304.11.4.1 Posts or columns. Posts and columns supporting permanent structures that are embedded in concrete that is in direct contact with the earth, embedded in concrete that is exposed to the weather or in direct contact with the earth shall be of preservative-treated wood.

2304.11.4.2 Wood structural members. Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or preservative-treated wood unless separated from such floors or roofs by an impervious moisture barrier.

2304.11.5 Supporting member for permanent appurtenances. Naturally durable or preservative-treated wood shall be utilized for those portions of wood members that form the structural supports of buildings, balconies, porches or similar permanent building appurtenances where such members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering to prevent moisture or water accumulation on the surface or at joints between members.

Exception: When a building is located in a geographical region where experience has demonstrated that climatic conditions preclude the need to use durable materials where the structure is exposed to the weather.

2304.11.6 Termite protection. In geographical areas where hazard of termite damage is known to be very heavy, wood floor framing in the locations specified in Section 2304.11.2.1 and exposed framing of exterior decks or balconies shall be of naturally durable species (termite resistant) or preservative treated in accordance with AWPA U1 for the species, product preservative and end use or provided with approved methods of termite protection.

2304.11.7 Wood used in retaining walls and cribs. Wood installed in retaining or crib walls shall be preservative treated in accordance with AWPA U1 (Commodity Specifications A or F) for soil and fresh water use.

2304.11.8 Attic ventilation. For attic ventilation, see Section 1203.2.

2304.11.9 Under-floor ventilation (crawl space). For under-floor ventilation (crawl space), see Section 1203.3.

2304.11.10 Earth fills. [SPCB] Separate the earth fills such as under porches or paving from all woodwork by concrete, masonry, good quality cement plaster or other material approved by local building codes. Chemical treatment of earth fills is considered adequate if the foundation adjoining the fill meets standards of the current building codes.

2304.12 Long-term loading. Wood members supporting concrete, masonry or similar materials shall be checked for the effects of long-term loading using the provisions of the AF&PA NDS. The total deflection, including the effects of long-term loading, shall be limited in accordance with Section 1604.3.1 for these supported materials.

Exception: Horizontal wood members supporting masonry or concrete nonstructural floor or roof surfacing not more than 4 inches (102 mm) thick need not be checked for long-term loading.

SECTION 2305 GENERAL DESIGN REQUIREMENTS FOR LATERAL FORCE-RESISTING SYSTEMS

2305.1 General. Structures using wood-frame shear walls or wood-frame diaphragms to resist wind, seismic or other lateral loads shall be designed and constructed in accordance with AF&PA SDPWS and the applicable provisions of Sections 2305, 2306 and 2307.

2305.1.1 Openings in shear panels. Openings in shear panels that materially affect their strength shall be detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

2305.1.2 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] The following limitations shall apply:

1. Straight-sheathed horizontal lumber diaphragms are not permitted.
2. Gypsum-based sheathing shear walls and portland cement plaster shear walls are not permitted.
3. Shear wall foundation anchor bolt washers shall be provided in accordance with AF&PA SDPWS Section 4.3.6.4.3.. The exception to AF&PA SDPWS Section 4.3.6.4.3 shall not apply.
4. Wood structural panel shear walls and diaphragms using staples as fasteners are not permitted.

5. Unblocked shear walls are not permitted.
6. Any wood structural panel sheathing used for shear walls that are part of the seismic force-resisting system shall be applied directly to framing members.
7. Single and double diagonally sheathed lumber walls shall not be used to resist seismic forces.

2305.2 Diaphragm deflection. The deflection of wood-frame diaphragms shall be determined in accordance with AF&PA SDPWS. The deflection (Δ) of a blocked wood structural panel diaphragm uniformly fastened throughout with staples is permitted to be calculated in accordance with Equation 23-1. If not uniformly fastened, the constant 0.188 (For SI: 1/1627) in the third term shall be modified by an approved method.

Exception: [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] Section 2305.2 is not permitted by DSA and OSHPD.

$$\Delta = \frac{5vL^3}{8EA} + \frac{vL}{4Gt} + 0.188Le_n + \frac{\Sigma(\Delta_cX)}{2b} \quad (\text{Equation 23-1})$$

$$\text{For SI: } \Delta = \frac{0.052vL^3}{EAb} + \frac{vL}{4Gt} + \frac{Le_n}{1627} + \frac{\Sigma(\Delta_cX)}{2b}$$

where:

A = Area of chord cross section, in square inches (mm^2).

b = Diaphragm width, in feet (mm).

E = Elastic modulus of chords, in pounds per square inch (N/mm^2).

e_n = Staple deformation, in inches (mm) [see Table 2305.2(1)].

Gt = Panel rigidity through the thickness, in pounds per inch (N/mm) of panel width or depth [see Table 2305.2(2)].

L = Diaphragm length, in feet (mm).

v = Maximum shear due to design loads in the direction under consideration, in pounds per linear foot (plf) (N/mm).

Δ = The calculated deflection, in inches (mm).

$\Sigma(\Delta_cX)$ = Sum of individual chord-splice slip values on both sides of the diaphragm, each multiplied by its distance to the nearest support.

TABLE 2305.2(1)
 e_n VALUES (inches) FOR USE IN CALCULATING DIAPHRAGM AND SHEAR WALL DEFLECTION DUE TO FASTENER SLIP
 (Structural I)^{a,c}

| LOAD PER FASTENER ^b (pounds) | FASTENER DESIGNATIONS |
|--|------------------------------|
| | 14-Ga staple x 2 inches long |
| 60 | 0.011 |
| 80 | 0.018 |
| 100 | 0.028 |
| 120 | 0.04 |
| 140 | 0.053 |
| 160 | 0.068 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N.

a. Increase e_n values 20 percent for plywood grades other than Structural I.

b. Load per fastener = maximum shear per foot divided by the number of fasteners per foot at interior panel edges.

c. Decrease e_n values 50 percent for seasoned lumber (moisture content < 19 percent).

2305.3 Shear wall deflection. The deflection of wood-frame shear walls shall be determined in accordance with AF&PA SDPWS. The deflection (Δ) of a blocked wood structural panel shear wall uniformly fastened throughout with staples is permitted to be calculated in accordance with Equation 23-2.

Exception: [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] Section 2305.3 is not permitted by DSA and OSHPD.

$$\Delta = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n + d_a \frac{h}{b} \quad (\text{Equation 23-2})$$

$$\text{For SI: } \Delta = \frac{vh^3}{3EAb} + \frac{vh}{Gt} + \frac{he_n}{407.6} + d_a \frac{h}{b}$$

where:

A = Area of boundary element cross section in square inches (mm^2) (vertical member at shear wall boundary).

b = Wall width, in feet (mm).

d_a = Vertical elongation of overturning anchorage (including fastener slip, device elongation, anchor rod elongation, etc.) at the design shear load (v).

E = Elastic modulus of boundary element (vertical member at shear wall boundary), in pounds per square inch (N/mm^2).

e_n = Staple deformation, in inches (mm) [see Table 2305.2(1)].

Gt = Panel rigidity through the thickness, in pounds per inch (N/mm) of panel width or depth [see Table 2305.2(2)].

h = Wall height, in feet (mm).

v = Maximum shear due to design loads at the top of the wall, in pounds per linear foot (N/mm).

Δ = The calculated deflection, in inches (mm).

TABLE 2305.2(2)
VALUES OF G_t FOR USE IN CALCULATING DEFLECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS AND DIAPHRAGMS

| PANEL TYPE | SPAN RATING | VALUES OF G_t (lb/in. panel depth or width) | | | | | | |
|---------------|----------------|---|------------------|-------------------------------|---------------------|------------------|------------------|-------------------------------|
| | | OTHER | | | | STRUCTURAL I | | |
| | | 3-ply Plywood | 4-ply Plywood | 5-ply Plywood ^a | OSB | 3-ply Plywood | 4-ply Plywood | 5-ply Plywood ^a |
| Sheathing | 24/0 | 25,000 | 32,500 | 37,500 | 77,500 | 32,500 | 42,500 | 41,500 |
| | 24/16 | 27,000 | 35,000 | 40,500 | 83,500 | 35,000 | 45,500 | 44,500 |
| | 32/16 | 27,000 | 35,000 | 40,500 | 83,500 | 35,000 | 45,500 | 44,500 |
| | 40/20 | 28,500 | 37,000 | 43,000 | 88,500 | 37,000 | 48,000 | 47,500 |
| | 48/24 | 31,000 | 40,500 | 46,500 | 96,000 | 40,500 | 52,500 | 51,000 |
| Single Floor | 16 o.c. | 27,000 | 35,000 | 40,500 | 83,500 | 35,000 | 45,500 | 44,500 |
| | 20 o.c. | 28,000 | 36,500 | 42,000 | 87,000 | 36,500 | 47,500 | 46,000 |
| | 24 o.c. | 30,000 | 39,000 | 45,000 | 93,000 | 39,000 | 50,500 | 49,500 |
| | 32 o.c. | 36,000 | 47,000 | 54,000 | 110,000 | 47,000 | 61,000 | 59,500 |
| | 48 o.c. | 50,500 | 65,500 | 76,000 | 155,000 | 65,500 | 85,000 | 83,500 |
| | | OTHER | | | | STRUCTURAL I | | |
| | | Thickness (in.) | A-A, A-C | Marine | All Other Grades | A-A, A-C | Marine | All Other Grades |
| | | $\frac{1}{4}$ | 24,000 | 31,000 | 24,000 | 31,000 | 31,000 | 31,000 |
| | | $\frac{11}{32}$ | 25,500 | 33,000 | 25,500 | 33,000 | 33,000 | 33,000 |
| | | $\frac{3}{8}$ | 26,000 | 34,000 | 26,000 | 34,000 | 34,000 | 34,000 |
| | | $\frac{15}{32}$ | 38,000 | 49,500 | 38,000 | 49,500 | 49,500 | 49,500 |
| | | $\frac{1}{2}$ | 38,500 | 50,000 | 38,500 | 50,000 | 50,000 | 50,000 |
| | | $\frac{19}{32}$ | 49,000 | 63,500 | 49,000 | 63,500 | 63,500 | 63,500 |
| | | $\frac{5}{8}$ | 49,500 | 64,500 | 49,500 | 64,500 | 64,500 | 64,500 |
| | | $\frac{23}{32}$ | 50,500 | 65,500 | 50,500 | 65,500 | 65,500 | 65,500 |
| | | $\frac{3}{4}$ | 51,000 | 66,500 | 51,000 | 66,500 | 66,500 | 66,500 |
| | | $\frac{7}{8}$ | 52,500 | 68,500 | 52,500 | 68,500 | 68,500 | 68,500 |
| | | 1 | 73,500 | 95,500 | 73,500 | 95,500 | 95,500 | 95,500 |
| | | $1\frac{1}{8}$ | 75,000 | 97,500 | 75,000 | 97,500 | 97,500 | 97,500 |

For SI: 1 inch = 25.4 mm, 1 pound/inch = 0.1751 N/mm.

a. Applies to plywood with five or more layers; for five ply/three layer plywood, use values for four ply.

SECTION 2306 ALLOWABLE STRESS DESIGN

2306.1 Allowable stress design. The design and construction of wood elements in structures using allowable stress design shall be in accordance with the following applicable standards:

American Forest & Paper Association.

NDS National Design Specification for Wood Construction

SDPWS Special Design Provisions for Wind and Seismic

American Institute of Timber Construction.

AITC 104 Typical Construction Details

AITC 110 Standard Appearance Grades for Structural Glued Laminated Timber

AITC 113 Standard for Dimensions of Structural Glued Laminated Timber

AITC 117 Standard Specifications for Structural Glued Laminated Timber of Softwood Species

AITC 119

Standard Specifications for Structural Glued Laminated Timber of Hardwood Species

ANSI/AITC A190.1 Structural Glued Laminated Timber

AITC 200 Inspection Manual

American Society of Agricultural and Biological Engineers.

ASABE EP 484.2 Diaphragm Design of Metal-clad, Post-Frame Rectangular Buildings

ASABE EP 486.1 Shallow Post Foundation Design

ASABE 559 Design Requirements and Bending Properties for Mechanically Laminated Columns

APA—The Engineered Wood Association.

Panel Design Specification

Plywood Design Specification Supplement 1—Design & Fabrication of Plywood Curved Panel

Plywood Design Specification Supplement 2—Design & Fabrication of Glued Plywood-lumber Beams

| | |
|--|---|
| Plywood Design Specification Supplement 3— Design & Fabrication of Plywood Stressed-skin Panels | |
| Plywood Design Specification Supplement 4— Design & Fabrication of Plywood Sandwich Panels | |
| Plywood Design Specification Supplement 5— Design & Fabrication of All-plywood Beams | |
| EWS T300 | Glulam Connection Details |
| EWS S560 | Field Notching and Drilling of Glued Laminated Timber Beams |
| EWS S475 | Glued Laminated Beam Design Tables |
| EWS X450 | Glulam in Residential Construction |
| EWS X440 | Product and Application Guide: Glulam |
| EWS R540 | Builders Tips: Proper Storage and Handling of Glulam Beams |

**TABLE 2306.1.4
ALLOWABLE LOADS FOR LUMBER DECKING**

| PATTERN | ALLOWABLE AREA LOAD ^{a,b} | |
|---|--|--|
| | Flexure | Deflection |
| Simple span | $\sigma_b = \frac{8F'_b d^2}{l^2 6}$ | $\sigma_\Delta = \frac{384\Delta E' d^3}{5l^4 12}$ |
| Two-span continuous | $\sigma_b = \frac{8F'_b d^2}{l^2 6}$ | $\sigma_\Delta = \frac{185\Delta E' d^3}{l^4 12}$ |
| Combination simple- and two-span continuous | $\sigma_b = \frac{8F'_b d^2}{l^2 6}$ | $\sigma_\Delta = \frac{131\Delta E' d^3}{l^4 12}$ |
| Cantilevered pieces intermixed | $\sigma_b = \frac{20F'_b d^2}{3l^2 6}$ | $\sigma_\Delta = \frac{105\Delta E' d^3}{l^4 12}$ |
| Controlled random layup | | |
| Mechanically laminated decking | $\sigma_b = \frac{20F'_b d^2}{3l^2 6}$ | $\sigma_\Delta = \frac{100\Delta E' d^3}{l^4 12}$ |
| 2-inch decking | $\sigma_b = \frac{20F'_b d^2}{3l^2 6}$ | $\sigma_\Delta = \frac{100\Delta E' d^3}{l^4 12}$ |
| 3-inch and 4-inch decking | $\sigma_b = \frac{20F'_b d^2}{3l^2 6}$ | $\sigma_\Delta = \frac{116\Delta E' d^3}{l^4 12}$ |

For SI: 1 inch = 25.4 mm.

a. σ_b = Allowable total uniform load limited by bending.

σ_Δ = Allowable total uniform load limited by deflection.

b. d = Actual decking thickness.

l = Span of decking.

F'_b = Allowable bending stress adjusted by applicable factors.

E' = Modulus of elasticity adjusted by applicable factors.

Truss Plate Institute, Inc.

TPI 1

National Design Standard for Metal Plate Connected Wood Truss Construction

2306.1.1 Joists and rafters. The design of rafter spans is permitted to be in accordance with the *AF&PA Span Tables for Joists and Rafters*.

2306.1.2 Plank and beam flooring. The design of plank and beam flooring is permitted to be in accordance with the *AF&PA Wood Construction Data No. 4*.

2306.1.3 Treated wood stress adjustments. The allowable unit stresses for preservative-treated wood need no adjustment for treatment, but are subject to other adjustments.

The allowable unit stresses for fire-retardant-treated wood, including fastener values, shall be developed from an approved method of investigation that considers the effects of anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and the redrying process. Other adjustments are applicable except that the impact load duration shall not apply.

2306.1.4 Lumber decking. The capacity of lumber decking arranged according to the patterns described in Section 2304.8.2 shall be the lesser of the capacities determined for flexure and deflection according to the formulas in Table 2306.1.4.

2306.2 Wood-frame diaphragms. Wood-frame diaphragms shall be designed and constructed in accordance with AF&PA SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AF&PA SDPWS shall be met and the allowable shear values set forth in Table 2306.2(1) or 2306.2(2) shall be permitted. The allowable shear values in Tables 2306.2(1) and 2306.2(2) are permitted to be increased 40 percent for wind design.

Exception: [DSA-SS, DSA-SS/CC and OSHPD 1, 2 & 4] Wood structural panel diaphragms using staples as fasteners are not permitted by DSA and OSHPD.

2306.2.1 Gypsum board diaphragm ceilings. Gypsum board diaphragm ceilings shall be in accordance with Section 2508.5.

2306.3 Wood-frame shear walls. Wood-frame shear walls shall be designed and constructed in accordance with AF&PA SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AF&PA SDPWS shall be met and the allowable shear values set forth in Table 2306.3(1), 2306.3(2) or 2306.3(3) shall be permitted. The allowable shear values in Tables 2306.3(1) and 2306.3(2) are permitted to be increased 40 percent for wind design. Panels complying with ANSI/APA PRP-210 shall be permitted to use design values for Plywood Siding in the AF&PA SDPWS.

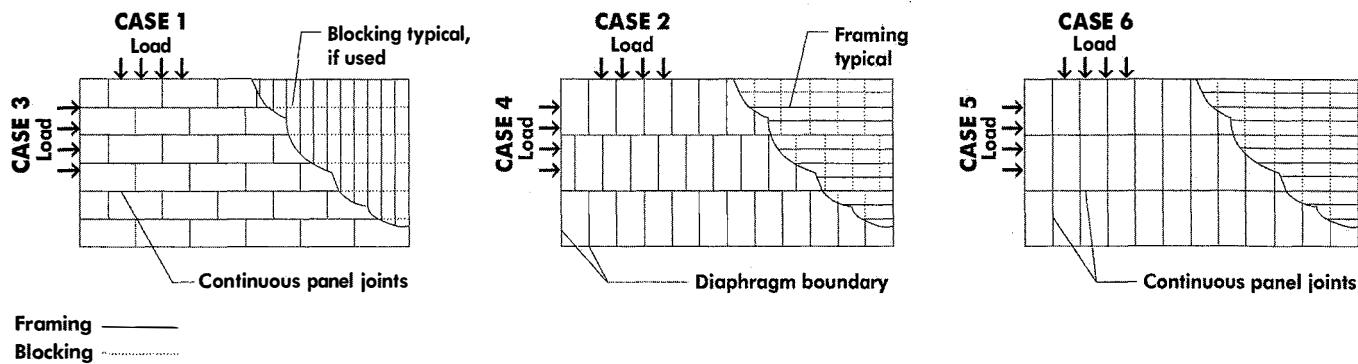
Exception: [DSA-SS & DSA-SS/CC and OSHPD 1, 2 & 4] Wood structural panel shear walls using staples as fasteners are not permitted by DSA and OSHPD.

TABLE 2306.2(1)
**ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS UTILIZING STAPLES
 WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE^a FOR WIND OR SEISMIC LOADING^f**

| PANEL GRADE | STAPLE LENGTH AND GAGE ^d | MINIMUM FASTENER PENETRATION IN FRAMING (inches) | MINIMUM NOMINAL PANEL THICKNESS (inch) | MINIMUM NOMINAL WIDTH OF FRAMING MEMBERS AT ADJOINING PANEL EDGES AND BOUNDARIES ^e (inches) | BLOCKED DIAPHRAGMS | | | | UNBLOCKED DIAPHRAGMS | |
|---------------------|-------------------------------------|--|--|--|---|-----|-------------------------------|----------------|---|---|
| | | | | | Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5, 6) ^b | | | | Fasteners spaced 6 max. at supported edges ^b | |
| | | | | | 6 | 4 | 2 ^{1/2} ^c | 2 ^c | Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4) ^b | |
| | | | | | 6 | 6 | 4 | 3 | Case 1 (No unblocked edges or continuous joints parallel to load) | All other configurations (Cases 2, 3, 4, 5 and 6) |
| Structural I grades | 1 ^{1/2} 16 gage | 1 | $\frac{3}{8}$ | 2 | 175 | 235 | 350 | 400 | 155 | 115 |
| | | | | 3 | 200 | 265 | 395 | 450 | 175 | 130 |
| | | | $\frac{15}{32}$ | 2 | 175 | 235 | 350 | 400 | 155 | 120 |
| | | | | 3 | 200 | 265 | 395 | 450 | 175 | 130 |
| | 1 ^{1/2} 16 gage | 1 | $\frac{3}{8}$ | 2 | 160 | 210 | 315 | 360 | 140 | 105 |
| | | | | 3 | 180 | 235 | 355 | 400 | 160 | 120 |
| | | | $\frac{7}{16}$ | 2 | 165 | 225 | 335 | 380 | 150 | 110 |
| | | | | 3 | 190 | 250 | 375 | 425 | 165 | 125 |
| | | | $\frac{15}{32}$ | 2 | 160 | 210 | 315 | 360 | 140 | 105 |
| | | | | 3 | 180 | 235 | 355 | 405 | 160 | 120 |
| | | | $\frac{19}{32}$ | 2 | 175 | 235 | 350 | 400 | 155 | 115 |
| | | | | 3 | 200 | 265 | 395 | 450 | 175 | 130 |

(continued)

TABLE 2306.2(1)—continued

ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS UTILIZING STAPLES WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE^a FOR WIND OR SEISMIC LOADING^b

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. For framing of other species: (1) Find specific gravity for species of lumber in AF&PA NDS. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- b. Space fasteners maximum 12 inches o.c. along intermediate framing members (6 inches o.c. where supports are spaced 48 inches o.c.).
- c. Framing at adjoining panel edges shall be 3 inches nominal or wider.
- d. Staples shall have a minimum crown width of $\frac{7}{16}$ inch and shall be installed with their crowns parallel to the long dimension of the framing members.
- e. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
- f. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

TABLE 2306.2(2)
ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS
UTILIZING MULTIPLE ROWS OF STAPLES (HIGH-LOAD DIAPHRAGMS) WITH FRAMING OF
DOUGLAS FIR-LARCH OR SOUTHERN PINE^a FOR WIND OR SEISMIC LOADING^{b, g, h}

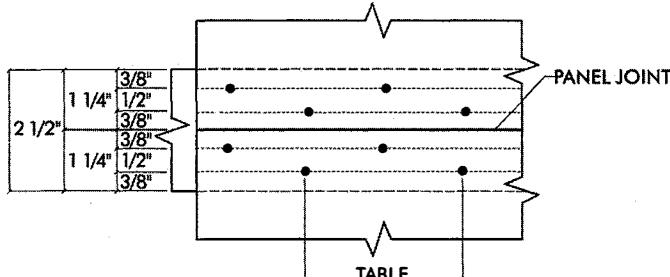
| PANEL GRADE ^c | STAPLE GAGE ^d | MINIMUM FASTENER PENETRATION IN FRAMING (inches) | MINIMUM NOMINAL PANEL THICKNESS (inch) | MINIMUM NOMINAL WIDTH OF FRAMING MEMBER AT ADJOINING PANEL EDGES AND BOUNDARIES ^e | LINES OF FASTENERS | BLOCKED DIAPHRAGMS | | | | | | | | | | | | | |
|--|--------------------------|--|--|--|--------------------|---|-----|-------|-------|-------|-------|---|---|--|--|--|--|--|--|
| | | | | | | Cases 1 and 2 ^f | | | | | | | | | | | | | |
| | | | | | | Fastener Spacing Per Line at Boundaries (inches) | | | | | | | | | | | | | |
| | | | | | | 4 | 2½ | 2 | 4 | 4 | 3 | 3 | 2 | | | | | | |
| | | | | | | Fastener Spacing Per Line at Other Panel Edges (inches) | | | | | | | | | | | | | |
| | | | | | | 6 | 4 | 4 | 3 | 3 | 3 | 2 | | | | | | | |
| Structural I grades | 14 gage staples | 2 | $\frac{15}{32}$ | 3 | 2 | 600 | 600 | 860 | 960 | 1,060 | 1,200 | | | | | | | | |
| | | | | 4 | 3 | 860 | 900 | 1,160 | 1,295 | 1,295 | 1,400 | | | | | | | | |
| | | | $\frac{19}{32}$ | 3 | 2 | 600 | 600 | 875 | 960 | 1,075 | 1,200 | | | | | | | | |
| | | | | 4 | 3 | 875 | 900 | 1,175 | 1,440 | 1,475 | 1,795 | | | | | | | | |
| Sheathing single floor and other grades covered in DOC PS 1 and PS 2 | 14 gage staples | 2 | $\frac{15}{32}$ | 3 | 2 | 540 | 540 | 735 | 865 | 915 | 1,080 | | | | | | | | |
| | | | | 4 | 3 | 735 | 810 | 1,005 | 1,105 | 1,105 | 1,195 | | | | | | | | |
| | | | $\frac{19}{32}$ | 3 | 2 | 600 | 600 | 865 | 960 | 1,065 | 1,200 | | | | | | | | |
| | | | | 4 | 3 | 865 | 900 | 1,130 | 1,430 | 1,370 | 1,485 | | | | | | | | |
| | | | $\frac{23}{32}$ | 4 | 3 | 865 | 900 | 1,130 | 1,490 | 1,430 | 1,545 | | | | | | | | |

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

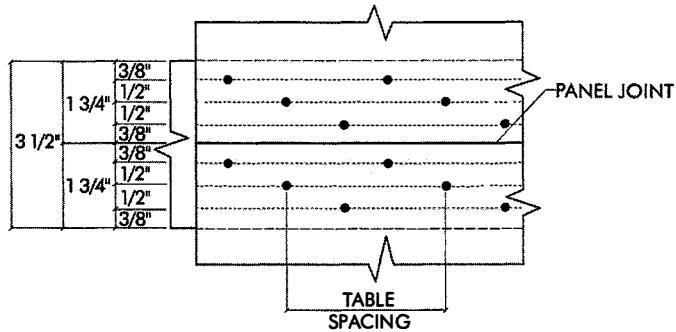
- a. For framing of other species: (1) Find specific gravity for species of framing lumber in AF&PA NDS. (2) For staples, find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- b. Fastening along intermediate framing members: Space fasteners a maximum of 12 inches on center, except 6 inches on center for spans greater than 32 inches.
- c. Panels conforming to PS 1 or PS 2.
- d. This table gives shear values for Cases 1 and 2 as shown in Table 2306.2(1). The values shown are applicable to Cases 3, 4, 5 and 6 as shown in Table 2306.2(1), providing fasteners at all continuous panel edges are spaced in accordance with the boundary fastener spacing.
- e. The minimum nominal depth of framing members shall be 3 inches nominal. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
- f. Staples shall have a minimum crown width of $\frac{7}{16}$ inch, and shall be installed with their crowns parallel to the long dimension of the framing members.
- g. High load diaphragms shall be subject to special inspection in accordance with Section 1705.5.1.
- h. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

(continued)

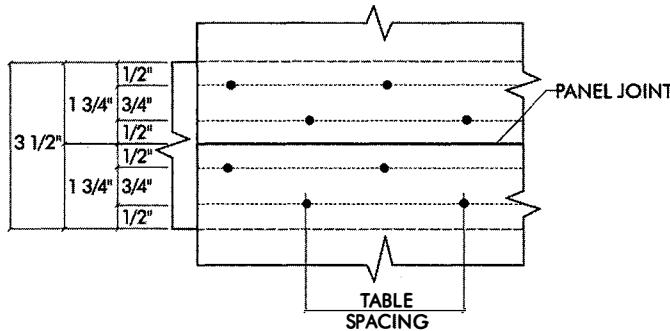
TABLE 2306.2(2)—continued
ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS
UTILIZING MULTIPLE ROWS OF STAPLES (HIGH-LOAD DIAPHRAGMS) WITH FRAMING OF
DOUGLAS FIR-LARCH OR SOUTHERN PINE FOR WIND OR SEISMIC LOADING



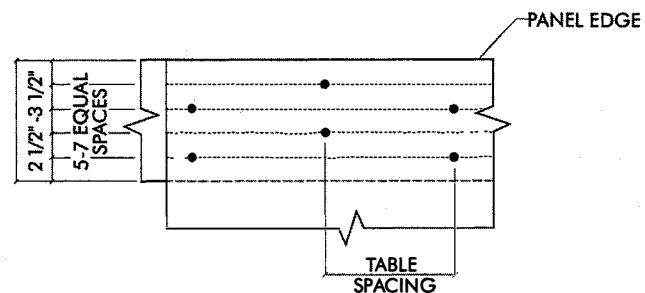
3" NOMINAL—TWO LINES



4" NOMINAL—THREE LINES



4" NOMINAL—TWO LINES



TYPICAL BOUNDARY FASTENING
 (Shown is two lines staggered.)

NOTE: SPACE PANEL END AND EDGE JOINT 1/8-INCH. REDUCE SPACING BETWEEN LINES OF NAILS AS NECESSARY TO MAINTAIN MINIMUM 3/8-INCH FASTENER EDGE MARGINS, MINIMUM SPACING BETWEEN LINES IS 3/8-INCH

TABLE 2306.3(1)

ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS UTILIZING STAPLES WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE^e FOR WIND OR SEISMIC LOADING^{b, f, g, i}

| PANEL GRADE | MINIMUM NOMINAL PANEL THICKNESS (inch) | MINIMUM FASTENER PENETRATION IN FRAMING (inches) | PANELS APPLIED DIRECT TO FRAMING | | | | PANELS APPLIED OVER $\frac{1}{2}$ " OR $\frac{5}{8}$ " GYPSUM SHEATHING | | | | | |
|--|---|--|----------------------------------|--|-----|-----|---|--|-----|-----|-----|-----|
| | | | Staple size ^h | Fastener spacing at panel edges (inches) | | | Staple size ^h | Fastener spacing at panel edges (inches) | | | | |
| | | | | 6 | 4 | 3 | | 6 | 4 | 3 | | |
| Structural I sheathing | $\frac{3}{8}$ | 1 | $1\frac{1}{2}$ 16 Gage | 155 | 235 | 315 | 400 | 2 16 Gage | 155 | 235 | 310 | 400 |
| | $\frac{7}{16}$ | | | 170 | 260 | 345 | 440 | | 155 | 235 | 310 | 400 |
| | $\frac{15}{32}$ | | | 185 | 280 | 375 | 475 | | 155 | 235 | 300 | 400 |
| Sheathing, plywood siding ^e except Group 5 Species, ANSI/APA PRP 210 siding | $\frac{5}{16}$ ^c or $\frac{1}{4}$ ^c | 1 | $1\frac{1}{2}$ 16 Gage | 145 | 220 | 295 | 375 | 2 16 Gage | 110 | 165 | 220 | 285 |
| | $\frac{3}{8}$ | | | 140 | 210 | 280 | 360 | | 140 | 210 | 280 | 360 |
| | $\frac{7}{16}$ | | | 155 | 230 | 310 | 395 | | 140 | 210 | 280 | 360 |
| | $\frac{15}{32}$ | | | 170 | 255 | 335 | 430 | | 140 | 210 | 280 | 360 |
| | $\frac{19}{32}$ | | $1\frac{3}{4}$ 16 Gage | 185 | 280 | 375 | 475 | — | — | — | — | — |

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. For framing of other species: (1) Find specific gravity for species of lumber in AF&PA NDS. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- b. Panel edges backed with 2 inch nominal or wider framing. Install panels either horizontally or vertically. Space fasteners maximum 6 inches on center along intermediate framing members for $\frac{3}{8}$ inch and $\frac{7}{16}$ inch panels installed on studs spaced 24 inches on center. For other conditions and panel thickness, space fasteners maximum 12 inches on center on intermediate supports.
- c. $\frac{3}{8}$ inch panel thickness or siding with a span rating of 16 inches on center is the minimum recommended where applied directly to framing as exterior siding. For grooved panel siding, the nominal panel thickness is the thickness of the panel measured at the point of fastening.
- d. Framing at adjoining panel edges shall be 3 inches nominal or wider.
- e. Values apply to all veneer plywood. Thickness at point of fastening on panel edges governs shear values.
- f. Where panels are applied on both faces of a wall and fastener spacing is less than 6 inches o.c. on either side, panel joints shall be offset to fall on different framing members, or framing shall be 3 inches nominal or thicker at adjoining panel edges.
- g. In Seismic Design Category D, E or F, where shear design values exceed 350 pounds per linear foot, all framing members receiving edge fastening from abutting panels shall not be less than a single 3 inch nominal member, or two 2 inch nominal members fastened together in accordance with Section 2306.1 to transfer the design shear value between framing members. Wood structural panel joint and sill plate nailing shall be staggered at all panel edges. See AF&PA SDPWS for sill plate size and anchorage requirements.
- h. Staples shall have a minimum crown width of $\frac{7}{16}$ inch and shall be installed with their crowns parallel to the long dimension of the framing members.
- i. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

TABLE 2306.3(2)

ALLOWABLE SHEAR VALUES (plf) FOR WIND OR SEISMIC LOADING ON SHEAR WALLS OF FIBERBOARD SHEATHING BOARD CONSTRUCTION UTILIZING STAPLES FOR TYPE V CONSTRUCTION ONLY^{a, b, c, d, e}

| THICKNESS AND GRADE | FASTENER SIZE | ALLOWABLE SHEAR VALUE (pounds per linear foot) STAPLE SPACING AT PANEL EDGES (inches) ^g | | |
|---|--|---|-----|-----|
| | | 4 | 3 | 2 |
| $\frac{1}{2}$ " or $\frac{25}{32}$ " Structural | No. 11 gage galvanized staple, $\frac{7}{16}$ " crown ^f | 150 | 200 | 225 |
| | No. 11 gage galvanized staple, 1" crown ^f | 220 | 290 | 325 |

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. Fiberboard sheathing shall not be used to brace concrete or masonry walls.
- b. Panel edges shall be backed with 2 inch or wider framing of Douglas fir larch or Southern pine. For framing of other species: (1) Find specific gravity for species of framing lumber in AF&PA NDS. (2) For staples, multiply the shear value from the table above by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- c. Values shown are for fiberboard sheathing on one side only with long panel dimension either parallel or perpendicular to studs.
- d. Fastener shall be spaced 6 inches on center along intermediate framing members.
- e. Values are not permitted in Seismic Design Category D, E or F.
- f. Staple length shall not be less than $1\frac{1}{2}$ inches for $\frac{25}{32}$ inch sheathing or $1\frac{1}{4}$ inches for $\frac{1}{2}$ inch sheathing.

TABLE 2306.3(3)
**ALLOWABLE SHEAR VALUES FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH AND PLASTER OR GYPSUM BOARD
WOOD FRAMED WALL ASSEMBLIES UTILIZING STAPLES**

| TYPE OF MATERIAL | THICKNESS OF MATERIAL | WALL CONSTRUCTION | STAPLE SPACING ^b MAXIMUM (inches) | SHEAR VALUE ^{a, c} (plf) | MINIMUM STAPLE SIZE ^{f, g} |
|---|--|-----------------------------------|--|-----------------------------------|---|
| 1. Expanded metal or woven wire lath and Portland cement plaster | $\frac{7}{8}$ " | Unblocked | 6 | 180 | No. 16 gage galv. staple, $\frac{7}{8}$ " legs |
| 2. Gypsum lath, plain or perforated | $\frac{3}{8}$ " lath and $\frac{1}{2}$ " plaster | Unblocked | 5 | 100 | No. 16 gage galv. staple, $1\frac{1}{8}$ " long |
| 3. Gypsum sheathing | $\frac{1}{2}$ " \times 2' \times 8' | Unblocked | 4 | 75 | No. 16 gage galv. staple, $1\frac{3}{4}$ " long |
| | $\frac{1}{2}$ " \times 4' | Blocked ^d Unblocked | 4 7 | 175 100 | |
| 4. Gypsum board, gypsum veneer base or water-resistant gypsum backing board | $\frac{1}{2}$ " | Unblocked ^d | 7 | 75 | No. 16 gage galv. staple, $1\frac{1}{2}$ " long |
| | | Unblocked ^d | 4 | 110 | |
| | | Unblocked | 7 | 100 | |
| | | Unblocked | 4 | 125 | |
| | | Blocked ^e | 7 | 125 | |
| | | Blocked ^e | 4 | 150 | |
| | $\frac{5}{8}$ " | Unblocked ^d | 7 | 115 | No. 16 gage galv. staple, $1\frac{1}{2}$ " legs, $1\frac{5}{8}$ " long |
| | | Unblocked ^d | 4 | 145 | |
| | | Blocked ^e | 7 | 145 | |
| | | Blocked ^e | 4 | 175 | |
| | | Blocked ^e Two-ply | Base ply: 9 Face ply: 7 | 250 | No. 16 gage galv. staple $1\frac{5}{8}$ " long No. 15 gage galv. staple, $2\frac{1}{4}$ " long |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

- a. These shear walls shall not be used to resist loads imposed by masonry or concrete walls (see AF & PA SDPWS). Values shown are for short term loading due to wind or seismic loading. Walls resisting seismic loads shall be subject to the limitations in Section 12.2.1 of ASCE 7. Values shown shall be reduced 25 percent for normal loading.
- b. Applies to fastening at studs, top and bottom plates and blocking.
- c. Except as noted, shear values are based on a maximum framing spacing of 16 inches on center.
- d. Maximum framing spacing of 24 inches on center.
- e. All edges are blocked, and edge fastening is provided at all supports and all panel edges.
- f. Staples shall have a minimum crown width of $\frac{7}{16}$ inch, measured outside the legs, and shall be installed with their crowns parallel to the long dimension of the framing members.
- g. Staples for the attachment of gypsum lath and woven wire lath shall have a minimum crown width of $\frac{3}{4}$ inch, measured outside the legs.

SECTION 2307

LOAD AND RESISTANCE FACTOR DESIGN

2307.1 Load and resistance factor design. The design and construction of wood elements and structures using load and resistance factor design shall be in accordance with AF&PA NDS and AF&PA SDPWS.

stories above grade plane in height with a separate means of egress and their accessory structures shall comply with the *California Residential Code*.

2308.1.1 Portions exceeding limitations of conventional construction.

When portions of a building of otherwise conventional construction exceed the limits of Section 2308.2, these portions and the supporting load path shall be designed in accordance with accepted engineering practice and the provisions of this code. For the purposes of this section, the term "portions" shall mean parts of buildings containing volume and area such as a room or a series of rooms.

2308.2 Limitations. Buildings are permitted to be constructed in accordance with the provisions of conventional light-frame construction, subject to the following limitations, and to further limitations of Sections 2308.11 and 2308.12.

1. Buildings shall be limited to a maximum of three stories above grade plane. For the purposes of this section,

for buildings assigned to Seismic Design Category D or E, cripple stud walls shall be considered to be a story.

Exception: Solid blocked cripple walls not exceeding 14 inches (356 mm) in height need not be considered a story.

2. Maximum floor-to-floor height shall not exceed 11 feet, 7 inches (3531 mm). Bearing wall height shall not exceed a stud height of 10 feet (3048 mm).
3. Loads as determined in Chapter 16 shall not exceed the following:

- 3.1. Average dead loads shall not exceed 15 psf (718 N/m²) for combined roof and ceiling, exterior walls, floors and partitions.

Exceptions:

1. Subject to the limitations of Sections 2308.11.2 and 2308.12.2, stone or masonry veneer up to the lesser of 5 inches (127 mm) thick or 50 psf (2395 N/m²) and installed in accordance with Chapter 14 is permitted to a height of 30 feet (9144 mm) above a noncombustible foundation, with an additional 8 feet (2438 mm) permitted for gable ends.
2. Concrete or masonry fireplaces, heaters and chimneys shall be permitted in accordance with the provisions of this code.
- 3.2. Live loads shall not exceed 40 psf (1916 N/m²) for floors.
- 3.3. Ground snow loads shall not exceed 50 psf (2395 N/m²).
4. V_{asd} as determined in accordance with Section 1609.3.1 shall not exceed 100 miles per hour (mph) (44 m/s) (3-second gust).

Exception: V_{asd} as determined in accordance with Section 1609.3.1 shall not exceed 110 mph (48.4 m/s) (3-second gust) for buildings in Exposure Category B that are not located in a hurricane-prone region.

5. Roof trusses and rafters shall not span more than 40 feet (12 192 mm) between points of vertical support.
6. The use of the provisions for conventional light-frame construction in this section shall not be permitted for Risk Category IV buildings assigned to Seismic Design Category B, C, D, E or F.
7. Conventional light-frame construction is limited in irregular structures assigned to Seismic Design Category D or E, as specified in Section 2308.12.6.
8. **[DSA-SS & DSA-SS/CC and OSHPD 2]** The use of conventional light-frame construction provisions in this section is permitted, subject to the following conditions:
 - 8.1. The design and construction shall also comply with Section 2304 and Section 2305.

8.2. In conjunction with the use of provisions in Section 2308.3 (Braced Wall Lines), engineering analysis shall be furnished that demonstrates compliance of lateral-force-resisting systems with Section 2305.

- 8.3. In addition to the use of provisions in Section 2308.8 (Floor Joists), engineering analysis shall be furnished that demonstrates compliance of floor framing elements and connections with Section 2301.2, Item 1 or 2.
- 8.4. In addition to the use of provisions in Section 2308.9 (Wall Framing), engineering analysis shall be furnished that demonstrates compliance of wall framing elements and connections with Section 2301.2, Item 1 or 2.

- 8.5. In addition to the use of provisions in Section 2308.10 (Roof and Ceiling Framing), engineering analysis shall be furnished demonstrating compliance of roof and ceiling framing elements and connections with Section 2301.2, Item 1 or 2.

2308.2.1 Nominal design wind speed greater than 100 mph (3-second gust). Where V_{asd} as determined in accordance with Section 1609.3.1 exceeds 100 mph (3-second gust), the provisions of either AF&PA WFCM or ICC 600 are permitted to be used. Wind speeds in Figures 1609A, 1609B, and 1609C shall be converted in accordance with Section 1609.3.1 for use with AF&PA WFCM or ICC 600.

2308.2.2 Buildings in Seismic Design Category B, C, D or E. Buildings of conventional light-frame construction and assigned to Seismic Design Category B or C shall comply with the additional requirements in Section 2308.11.

Buildings of conventional light-frame construction and assigned to Seismic Design Category D or E shall comply with the additional requirements in Section 2308.12.

2308.3 Braced wall lines. Buildings shall be provided with exterior and interior braced wall lines as described in Section 2308.9.3 and installed in accordance with Sections 2308.3.1 through 2308.3.4.

2308.3.1 Spacing. Spacing of braced wall lines shall not exceed 35 feet (10 668 mm) o.c. in both the longitudinal and transverse directions in each story.

2308.3.2 Braced wall line connections. Wind and seismic lateral forces shall be transferred from the roof and floor diaphragms to braced wall lines and from the braced wall lines in upper stories to the braced wall lines in the story below in accordance with Sections 2308.3.2.1 and 2308.3.2.2.

2308.3.2.1 Bottom plate connection. Braced wall line bottom plates shall be connected to joists or full-depth blocking below in accordance with Table 2304.9.1, Item 6, or to foundations in accordance with Section 2308.3.3.

2308.3.2.2 Top plate connection. Where joists and/or rafters are used, braced wall line top plates shall be fas-

tened over the full length of the braced wall line to joists, rafters, rimboards or blocking above in accordance with Table 2304.9.1, Items 11, 12, 15 or 19, as applicable, based on the orientation of the joists or rafters to the braced wall line. Blocking at joists with walls above shall be equal to the depth of the joist at the braced wall line. Blocking at rafters need not be full depth but shall extend to within 2 inches (51 mm) from the roof sheathing above. Blocking shall be a minimum of 2 inches (51 mm) nominal thickness and shall be fastened to the braced wall line top plate as specified in Table 2304.9.1, Item 11. Notching or drilling of holes in blocking in accordance with the requirements of Section 2308.8.2 or Section 2308.10.4.2 shall be permitted.

At exterior gable end walls braced wall panel sheathing in the top story shall be extended and fastened to roof framing where the spacing between parallel exterior braced wall lines is greater than 50 feet (15 240 mm).

Where roof trusses are used and are installed perpendicular to an exterior braced wall line, lateral forces shall be transferred from the roof diaphragm to the braced wall over the full length of the braced wall line by blocking of the ends of the trusses or by other approved methods providing equivalent lateral force transfer. Blocking shall be minimum 2 inches (51 mm) nominal thickness and shall extend to within 2 inches (51 mm) from the roof sheathing above and shall be fastened to the braced wall line top plate as specified in Table 2304.9.1, Item 11. Notching or drilling of holes in blocking in accordance with the requirements of Section 2308.8.2 or Section 2308.10.4.2 shall be permitted.

2308.3 Sill anchorage. Where foundations are required by Section 2308.3.4, braced wall line sills shall be anchored to concrete or masonry foundations. Such anchorage shall conform to the requirements of Section 2308.6 except that such anchors shall be spaced at not more than 4 feet (1219 mm) o.c. for structures over two stories above grade plane. The anchors shall be distributed along the length of the braced wall line. Other anchorage devices having equivalent capacity are permitted.

2308.3.3.1 Anchorage to all-wood foundations. Where all-wood foundations are used, the force transfer from the braced wall lines shall be determined based on calculation and shall have a capacity greater than or equal to the connections required by Section 2308.3.3.

2308.3.4 Braced wall line support. Braced wall lines shall be supported by continuous foundations.

Exception: For structures with a maximum plan dimension not over 50 feet (15 240 mm), continuous foundations are required at exterior walls only.

2308.4 Design of elements. Combining of engineered elements or systems and conventionally specified elements or systems is permitted subject to the following limits:

2308.4.1 Elements exceeding limitations of conventional construction. When a building of otherwise conventional construction contains structural elements exceeding the limits of Section 2308.2, these elements and the supporting load path shall be designed in accordance with accepted engineering practice and the provisions of this code.

2308.4.2 Structural elements or systems not described herein. When a building of otherwise conventional construction contains structural elements or systems not described in Section 2308, these elements or systems shall be designed in accordance with accepted engineering practice and the provisions of this code. The extent of such design need only demonstrate compliance of the nonconventional elements with other applicable provisions of this code and shall be compatible with the performance of the conventionally framed system.

2308.5 Connectors and fasteners. Connectors and fasteners used in conventional construction shall comply with the requirements of Section 2304.9.

2308.6 Foundation plates or sills. Foundations and footings shall be as specified in Chapter 18. Foundation plates or sills resting on concrete or masonry foundations shall comply with Section 2304.3.1. Foundation plates or sills shall be bolted or anchored to the foundation with not less than $\frac{1}{2}$ -inch-diameter (12.7 mm) steel bolts or approved anchors spaced to provide equivalent anchorage as the steel bolts. Bolts shall be embedded at least 7 inches (178 mm) into concrete or masonry, and spaced not more than 6 feet (1829 mm) apart. There shall be a minimum of two bolts or anchor straps per piece with one bolt or anchor strap located not more than 12 inches (305 mm) or less than 4 inches (102 mm) from each end of each piece. A properly sized nut and washer shall be tightened on each bolt to the plate.

2308.7 Girders. Girders for single-story construction or girders supporting loads from a single floor shall not be less than 4 inches by 6 inches (102 mm by 152 mm) for spans 6 feet (1829 mm) or less, provided that girders are spaced not more than 8 feet (2438 mm) o.c. Spans for built-up 2-inch (51 mm) girders shall be in accordance with Table 2308.9.5 or 2308.9.6. Other girders shall be designed to support the loads specified in this code. Girder end joints shall occur over supports.

Where a girder is spliced over a support, an adequate tie shall be provided. The ends of beams or girders supported on masonry or concrete shall not have less than 3 inches (76 mm) of bearing.

TABLE 2308.8(1)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Sleeping Areas, Live Load = 30 psf, L/Δ = 360)

| JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 psf | | | | DEAD LOAD = 20 psf | | | |
|------------------------------|----------------------|---------------------------|-------|-------|-------|--------------------|-------|-------|-------|
| | | 2x6 | 2x8 | 2x10 | 2x12 | 2x6 | 2x8 | 2x10 | 2x12 |
| | | Maximum floor joist spans | | | | | | | |
| 12 | Douglas Fir-Larch SS | 12-6 | 16-6 | 21-0 | 25-7 | 12-6 | 16-6 | 21-0 | 25-7 |
| | Douglas Fir-Larch #1 | 12-0 | 15-10 | 20-3 | 24-8 | 12-0 | 15-7 | 19-0 | 22-0 |
| | Douglas Fir-Larch #2 | 11-10 | 15-7 | 19-10 | 23-0 | 11-6 | 14-7 | 17-9 | 20-7 |
| | Douglas Fir-Larch #3 | 9-8 | 12-4 | 15-0 | 17-5 | 8-8 | 11-0 | 13-5 | 15-7 |
| | Hem-Fir SS | 11-10 | 15-7 | 19-10 | 24-2 | 11-10 | 15-7 | 19-10 | 24-2 |
| | Hem-Fir #1 | 11-7 | 15-3 | 19-5 | 23-7 | 11-7 | 15-2 | 18-6 | 21-6 |
| | Hem-Fir #2 | 11-0 | 14-6 | 18-6 | 22-6 | 11-0 | 14-4 | 17-6 | 20-4 |
| | Hem-Fir #3 | 9-8 | 12-4 | 15-0 | 17-5 | 8-8 | 11-0 | 13-5 | 15-7 |
| | Southern Pine SS | 12-3 | 16-2 | 20-8 | 25-1 | 12-3 | 16-2 | 20-8 | 25-1 |
| | Southern Pine #1 | 12-0 | 15-10 | 20-3 | 24-8 | 12-0 | 15-10 | 20-3 | 24-8 |
| | Southern Pine #2 | 11-10 | 15-7 | 19-10 | 24-2 | 11-10 | 15-7 | 18-7 | 21-9 |
| | Southern Pine #3 | 10-5 | 13-3 | 15-8 | 18-8 | 9-4 | 11-11 | 14-0 | 16-8 |
| | Spruce-Pine-Fir SS | 11-7 | 15-3 | 19-5 | 23-7 | 11-7 | 15-3 | 19-5 | 23-7 |
| | Spruce-Pine-Fir #1 | 11-3 | 14-11 | 19-0 | 23-0 | 11-3 | 14-7 | 17-9 | 20-7 |
| | Spruce-Pine-Fir #2 | 11-3 | 14-11 | 19-0 | 23-0 | 11-3 | 14-7 | 17-9 | 20-7 |
| | Spruce-Pine-Fir #3 | 9-8 | 12-4 | 15-0 | 17-5 | 8-8 | 11-0 | 13-5 | 15-7 |
| 16 | Douglas Fir-Larch SS | 11-4 | 15-0 | 19-1 | 23-3 | 11-4 | 15-0 | 19-1 | 23-0 |
| | Douglas Fir-Larch #1 | 10-11 | 14-5 | 18-5 | 21-4 | 10-8 | 13-6 | 16-5 | 19-1 |
| | Douglas Fir-Larch #2 | 10-9 | 14-1 | 17-2 | 19-11 | 9-11 | 12-7 | 15-5 | 17-10 |
| | Douglas Fir-Larch #3 | 8-5 | 10-8 | 13-0 | 15-1 | 7-6 | 9-6 | 11-8 | 13-6 |
| | Hem-Fir SS | 10-9 | 14-2 | 18-0 | 21-11 | 10-9 | 14-2 | 18-0 | 21-11 |
| | Hem-Fir #1 | 10-6 | 13-10 | 17-8 | 20-9 | 10-4 | 13-1 | 16-0 | 18-7 |
| | Hem-Fir #2 | 10-0 | 13-2 | 16-10 | 19-8 | 9-10 | 12-5 | 15-2 | 17-7 |
| | Hem-Fir #3 | 8-5 | 10-8 | 13-0 | 15-1 | 7-6 | 9-6 | 11-8 | 13-6 |
| | Southern Pine SS | 11-2 | 14-8 | 18-9 | 22-10 | 11-2 | 14-8 | 18-9 | 22-10 |
| | Southern Pine #1 | 10-11 | 14-5 | 18-5 | 22-5 | 10-11 | 14-5 | 17-11 | 21-4 |
| | Southern Pine #2 | 10-9 | 14-2 | 18-0 | 21-1 | 10-5 | 13-6 | 16-1 | 18-10 |
| | Southern Pine #3 | 9-0 | 11-6 | 13-7 | 16-2 | 8-1 | 10-3 | 12-2 | 14-6 |
| | Spruce-Pine-Fir SS | 10-6 | 13-10 | 17-8 | 21-6 | 10-6 | 13-10 | 17-8 | 21-4 |
| | Spruce-Pine-Fir #1 | 10-3 | 13-6 | 17-2 | 19-11 | 9-11 | 12-7 | 15-5 | 17-10 |
| | Spruce-Pine-Fir #2 | 10-3 | 13-6 | 17-2 | 19-11 | 9-11 | 12-7 | 15-5 | 17-10 |
| | Spruce-Pine-Fir #3 | 8-5 | 10-8 | 13-0 | 15-1 | 7-6 | 9-6 | 11-8 | 13-6 |
| 19.2 | Douglas Fir-Larch SS | 10-8 | 14-1 | 18-0 | 21-10 | 10-8 | 14-1 | 18-0 | 21-0 |
| | Douglas Fir-Larch #1 | 10-4 | 13-7 | 16-9 | 19-6 | 9-8 | 12-4 | 15-0 | 17-5 |
| | Douglas Fir-Larch #2 | 10-1 | 12-10 | 15-8 | 18-3 | 9-1 | 11-6 | 14-1 | 16-3 |
| | Douglas Fir-Larch #3 | 7-8 | 9-9 | 11-10 | 13-9 | 6-10 | 8-8 | 10-7 | 12-4 |
| | Hem-Fir SS | 10-1 | 13-4 | 17-0 | 20-8 | 10-1 | 13-4 | 17-0 | 20-7 |
| | Hem-Fir #1 | 9-10 | 13-0 | 16-4 | 19-0 | 9-6 | 12-0 | 14-8 | 17-0 |
| | Hem-Fir #2 | 9-5 | 12-5 | 15-6 | 17-1 | 8-11 | 11-4 | 13-10 | 16-1 |
| | Hem-Fir #3 | 7-8 | 9-9 | 11-10 | 13-9 | 6-10 | 8-8 | 10-7 | 12-4 |

(continued)

TABLE 2308.8(1)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Sleeping Areas, Live Load = 30 psf, L/Δ = 360)

| JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 psf | | | | DEAD LOAD = 20 psf | | | |
|------------------------------|----------------------|---------------------------|-------|-------|-------|--------------------|-------|------|-------|
| | | 2x6 | 2x8 | 2x10 | 2x12 | 2x6 | 2x8 | 2x10 | 2x12 |
| | | Maximum floor joist spans | | | | | | | |
| 19.2 | Southern Pine SS | 10-6 | 13-10 | 17-8 | 21-6 | 10-6 | 13-10 | 17-8 | 21-6 |
| | Southern Pine #1 | 10-4 | 13-7 | 17-4 | 21-1 | 10-4 | 13-7 | 16-4 | 19-6 |
| | Southern Pine #2 | 10-1 | 13-4 | 16-5 | 19-3 | 9-6 | 12-4 | 14-8 | 17-2 |
| | Southern Pine #3 | 8-3 | 10-6 | 12-5 | 14-9 | 7-4 | 9-5 | 11-1 | 13-2 |
| | Spruce-Pine-Fir SS | 9-10 | 13-0 | 16-7 | 20-2 | 9-10 | 13-0 | 16-7 | 19-6 |
| | Spruce-Pine-Fir #1 | 9-8 | 12-9 | 15-8 | 18-3 | 9-1 | 11-6 | 14-1 | 16-3 |
| | Spruce-Pine-Fir #2 | 9-8 | 12-9 | 15-8 | 18-3 | 9-1 | 11-6 | 14-1 | 16-3 |
| | Spruce-Pine-Fir #3 | 7-8 | 9-9 | 11-10 | 13-9 | 6-10 | 8-8 | 10-7 | 12-4 |
| 24 | Douglas Fir-Larch SS | 9-11 | 13-1 | 16-8 | 20-3 | 9-11 | 13-1 | 16-2 | 18-9 |
| | Douglas Fir-Larch #1 | 9-7 | 12-4 | 15-0 | 17-5 | 8-8 | 11-0 | 13-5 | 15-7 |
| | Douglas Fir-Larch #2 | 9-1 | 11-6 | 14-1 | 16-3 | 8-1 | 10-3 | 12-7 | 14-7 |
| | Douglas Fir-Larch #3 | 6-10 | 8-8 | 10-7 | 12-4 | 6-2 | 7-9 | 9-6 | 11-0 |
| | Hem-Fir SS | 9-4 | 12-4 | 15-9 | 19-2 | 9-4 | 12-4 | 15-9 | 18-5 |
| | Hem-Fir #1 | 9-2 | 12-0 | 14-8 | 17-0 | 8-6 | 10-9 | 13-1 | 15-2 |
| | Hem-Fir #2 | 8-9 | 11-4 | 13-10 | 16-1 | 8-0 | 10-2 | 12-5 | 14-4 |
| | Hem-Fir #3 | 6-10 | 8-8 | 10-7 | 12-4 | 6-2 | 7-9 | 9-6 | 11-0 |
| | Southern Pine SS | 9-9 | 12-10 | 16-5 | 19-11 | 9-9 | 12-10 | 16-5 | 19-11 |
| | Southern Pine #1 | 9-7 | 12-7 | 16-1 | 19-6 | 9-7 | 12-4 | 14-7 | 17-5 |
| | Southern Pine #2 | 9-4 | 12-4 | 14-8 | 17-2 | 8-6 | 11-0 | 13-1 | 15-5 |
| | Southern Pine #3 | 7-4 | 9-5 | 11-1 | 13-2 | 6-7 | 8-5 | 9-11 | 11-10 |
| | Spruce-Pine-Fir SS | 9-2 | 12-1 | 15-5 | 18-9 | 9-2 | 12-1 | 15-0 | 17-5 |
| | Spruce-Pine-Fir #1 | 8-11 | 11-6 | 14-1 | 16-3 | 8-1 | 10-3 | 12-7 | 14-7 |
| | Spruce-Pine-Fir #2 | 8-11 | 11-6 | 14-1 | 16-3 | 8-1 | 10-3 | 12-7 | 14-7 |
| | Spruce-Pine-Fir #3 | 6-10 | 8-8 | 10-7 | 12-4 | 6-2 | 7-9 | 9-6 | 11-0 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m².

TABLE 2308.8(2)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Living Areas, Live Load = 40 psf, L/Δ = 360)

| JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 psf | | | | DEAD LOAD = 20 psf | | | |
|---------------------------|----------------------|---------------------------|-------|-------|-------|--------------------|-------|-------|-------|
| | | 2x6 | 2x8 | 2x10 | 2x12 | 2x6 | 2x8 | 2x10 | 2x12 |
| | | Maximum floor joist spans | | | | | | | |
| 12 | Douglas Fir Larch SS | 11 4 | 15 0 | 19 1 | 23 3 | 11 4 | 15 0 | 19 1 | 23 3 |
| | Douglas Fir Larch #1 | 10 11 | 14 5 | 18 5 | 22 0 | 10 11 | 14 2 | 17 4 | 20 1 |
| | Douglas Fir Larch #2 | 10 9 | 14 2 | 17 9 | 20 7 | 10 6 | 13 3 | 16 3 | 18 10 |
| | Douglas Fir Larch #3 | 8 8 | 11 0 | 13 5 | 15 7 | 7 11 | 10 0 | 12 3 | 14 3 |
| | Hem Fir SS | 10 9 | 14 2 | 18 0 | 21 11 | 10 9 | 14 2 | 18 0 | 21 11 |
| | Hem Fir #1 | 10 6 | 13 10 | 17 8 | 21 6 | 10 6 | 13 10 | 16 11 | 19 7 |
| | Hem Fir #2 | 10 0 | 13 2 | 16 10 | 20 4 | 10 0 | 13 1 | 16 0 | 18 6 |
| | Hem Fir #3 | 8 8 | 11 0 | 13 5 | 15 7 | 7 11 | 10 0 | 12 3 | 14 3 |
| | Southern Pine SS | 11 2 | 14 8 | 18 9 | 22 10 | 11 2 | 14 8 | 18 9 | 22 10 |
| | Southern Pine #1 | 10 11 | 14 5 | 18 5 | 22 5 | 10 11 | 14 5 | 18 5 | 22 5 |
| | Southern Pine #2 | 10 9 | 14 2 | 18 0 | 21 9 | 10 9 | 14 2 | 16 11 | 19 10 |
| | Southern Pine #3 | 9 4 | 11 11 | 14 0 | 16 8 | 8 6 | 10 10 | 12 10 | 15 3 |
| | Spruce Pine Fir SS | 10 6 | 13 10 | 17 8 | 21 6 | 10 6 | 13 10 | 17 8 | 21 6 |
| | Spruce Pine Fir #1 | 10 3 | 13 6 | 17 3 | 20 7 | 10 3 | 13 3 | 16 3 | 18 10 |
| | Spruce Pine Fir #2 | 10 3 | 13 6 | 17 3 | 20 7 | 10 3 | 13 3 | 16 3 | 18 10 |
| | Spruce Pine Fir #3 | 8 8 | 11 0 | 13 5 | 15 7 | 7 11 | 10 0 | 12 3 | 14 3 |
| 16 | Douglas Fir Larch SS | 10 4 | 13 7 | 17 4 | 21 1 | 10 4 | 13 7 | 17 4 | 21 0 |
| | Douglas Fir Larch #1 | 9 11 | 13 1 | 16 5 | 19 1 | 9 8 | 12 4 | 15 0 | 17 5 |
| | Douglas Fir Larch #2 | 9 9 | 12 7 | 15 5 | 17 10 | 9 1 | 11 6 | 14 1 | 16 3 |
| | Douglas Fir Larch #3 | 7 6 | 9 6 | 11 8 | 13 6 | 6 10 | 8 8 | 10 7 | 12 4 |
| | Hem Fir SS | 9 9 | 12 10 | 16 5 | 19 11 | 9 9 | 12 10 | 16 5 | 19 11 |
| | Hem Fir #1 | 9 6 | 12 7 | 16 0 | 18 7 | 9 6 | 12 0 | 14 8 | 17 0 |
| | Hem Fir #2 | 9 1 | 12 0 | 15 2 | 17 7 | 8 11 | 11 4 | 13 10 | 16 1 |
| | Hem Fir #3 | 7 6 | 9 6 | 11 8 | 13 6 | 6 10 | 8 8 | 10 7 | 12 4 |
| | Southern Pine SS | 10 2 | 13 4 | 17 0 | 20 9 | 10 2 | 13 4 | 17 0 | 20 9 |
| | Southern Pine #1 | 9 11 | 13 1 | 16 9 | 20 4 | 9 11 | 13 1 | 16 4 | 19 6 |
| | Southern Pine #2 | 9 9 | 12 10 | 16 1 | 18 10 | 9 6 | 12 4 | 14 8 | 17 2 |
| | Southern Pine #3 | 8 1 | 10 3 | 12 2 | 14 6 | 7 4 | 9 5 | 11 1 | 13 2 |
| | Spruce Pine Fir SS | 9 6 | 12 7 | 16 0 | 19 6 | 9 6 | 12 7 | 16 0 | 19 6 |
| | Spruce Pine Fir #1 | 9 4 | 12 3 | 15 5 | 17 10 | 9 1 | 11 6 | 14 1 | 16 3 |
| | Spruce Pine Fir #2 | 9 4 | 12 3 | 15 5 | 17 10 | 9 1 | 11 6 | 14 1 | 16 3 |
| | Spruce Pine Fir #3 | 7 6 | 9 6 | 11 8 | 13 6 | 6 10 | 8 8 | 10 7 | 12 4 |
| 19.2 | Douglas Fir Larch SS | 9 8 | 12 10 | 16 4 | 19 10 | 9 8 | 12 10 | 16 4 | 19 2 |
| | Douglas Fir Larch #1 | 9 4 | 12 4 | 15 0 | 17 5 | 8 10 | 11 3 | 13 8 | 15 11 |
| | Douglas Fir Larch #2 | 9 1 | 11 6 | 14 1 | 16 3 | 8 3 | 10 6 | 12 10 | 14 10 |
| | Douglas Fir Larch #3 | 6 10 | 8 8 | 10 7 | 12 4 | 6 3 | 7 11 | 9 8 | 11 3 |
| | Hem Fir SS | 9 2 | 12 1 | 15 5 | 18 9 | 9 2 | 12 1 | 15 5 | 18 9 |
| | Hem Fir #1 | 9 0 | 11 10 | 14 8 | 17 0 | 8 8 | 10 11 | 13 4 | 15 6 |
| | Hem Fir #2 | 8 7 | 11 3 | 13 10 | 16 1 | 8 2 | 10 4 | 12 8 | 14 8 |
| | Hem Fir #3 | 6 10 | 8 8 | 10 7 | 12 4 | 6 3 | 7 11 | 9 8 | 11 3 |
| | Southern Pine SS | 9 6 | 12 7 | 16 0 | 19 6 | 9 6 | 12 7 | 16 0 | 19 6 |
| | Southern Pine #1 | 9 4 | 12 4 | 15 9 | 19 2 | 9 4 | 12 4 | 14 11 | 17 9 |
| | Southern Pine #2 | 9 2 | 12 1 | 14 8 | 17 2 | 8 8 | 11 3 | 13 5 | 15 8 |
| | Southern Pine #3 | 7 4 | 9 5 | 11 1 | 13 2 | 6 9 | 8 7 | 10 1 | 12 1 |
| | Spruce Pine Fir SS | 9 0 | 11 10 | 15 1 | 18 4 | 9 0 | 11 10 | 15 1 | 17 9 |
| | Spruce Pine Fir #1 | 8-9 | 11 6 | 14 1 | 16 3 | 8 3 | 10 6 | 12 10 | 14 10 |
| | Spruce Pine Fir #2 | 8 9 | 11 6 | 14 1 | 16 3 | 8 3 | 10 6 | 12 10 | 14 10 |
| | Spruce Pine Fir #3 | 6 10 | 8 8 | 10 7 | 12 4 | 6 3 | 7 11 | 9 8 | 11 3 |

(continued)

TABLE 2308.8(2)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Living Areas, Live Load = 40 psf, $L/\Delta = 360$)

| JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 psf | | | | DEAD LOAD = 20 psf | | | |
|---------------------------|----------------------|---------------------------|-------|-------|-------|--------------------|-------|-------|--------------------|
| | | 2x6 | 2x8 | 2x10 | 2x12 | 2x6 | 2x8 | 2x10 | 2x12 |
| | | Maximum floor joist spans | | | | | | | |
| 24 | Douglas Fir Larch SS | 9 0 | 11 11 | 15 2 | 18 5 | 9 0 | 11 11 | 14 9 | 17 1 |
| | Douglas Fir Larch #1 | 8 8 | 11 0 | 13 5 | 15 7 | 7 11 | 10 0 | 12 3 | 14 3 |
| | Douglas Fir Larch #2 | 8 1 | 10 3 | 12 7 | 14 7 | 7 5 | 9 5 | 11 6 | 13 4 |
| | Douglas Fir Larch #3 | 6 2 | 7 9 | 9 6 | 11 0 | 5 7 | 7 1 | 8 8 | 10 1 |
| | Hem Fir SS | 8 6 | 11 3 | 14 4 | 17 5 | 8 6 | 11 3 | 14 4 | 16 10 ^a |
| | Hem Fir #1 | 8 4 | 10 9 | 13 1 | 15 2 | 7 9 | 9 9 | 11 11 | 13 10 |
| | Hem Fir #2 | 7 11 | 10 2 | 12 5 | 14 4 | 7 4 | 9 3 | 11 4 | 13 1 |
| | Hem Fir #3 | 6 2 | 7 9 | 9 6 | 11 0 | 5 7 | 7 1 | 8 8 | 10 1 |
| | Southern Pine SS | 8 10 | 11 8 | 14 11 | 18 1 | 8 10 | 11 8 | 14 11 | 18 1 |
| | Southern Pine #1 | 8 8 | 11 5 | 14 7 | 17 5 | 8 8 | 11 3 | 13 4 | 15 11 |
| | Southern Pine #2 | 8 6 | 11 0 | 13 1 | 15 5 | 7 9 | 10 0 | 12 0 | 14 0 |
| | Southern Pine #3 | 6 7 | 8 5 | 9 11 | 11 10 | 6 0 | 7 8 | 9 1 | 10 9 |
| | Spruce Pine Fir SS | 8 4 | 11 0 | 14 0 | 17 0 | 8 4 | 11 0 | 13 8 | 15 11 |
| | Spruce Pine Fir #1 | 8 1 | 10 3 | 12 7 | 14 7 | 7 5 | 9 5 | 11 6 | 13 4 |
| | Spruce Pine Fir #2 | 8 1 | 10 3 | 12 7 | 14 7 | 7 5 | 9 5 | 11 6 | 13 4 |
| | Spruce Pine Fir #3 | 6 2 | 7 9 | 9 6 | 11 0 | 5 7 | 7 1 | 8 8 | 10 1 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m².

a. End bearing length shall be increased to 2 inches.

2308.8 Floor joists. Spans for floor joists shall be in accordance with Table 2308.8(1) or 2308.8(2). For other grades and or species, refer to the *AF&PA Span Tables for Joists and Rafters*.

2308.8.1 Bearing. Except where supported on a 1-inch by 4-inch (25.4 mm by 102 mm) ribbon strip and nailed to the adjoining stud, the ends of each joist shall not have less than 1½ inches (38 mm) of bearing on wood or metal, or less than 3 inches (76 mm) on masonry.

2308.8.2 Framing details. Joists shall be supported laterally at the ends and at each support by solid blocking except where the ends of the joists are nailed to a header, band or rim joist or to an adjoining stud or by other means. Solid blocking shall not be less than 2 inches (51mm) in thickness and the full depth of the joist. Notches on the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches (51 mm) of the top or bottom of the joist, and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.

Joist framing from opposite sides of a beam, girder or partition shall be lapped at least 3 inches (76 mm) or the opposing joists shall be tied together in an approved manner.

Joists framing into the side of a wood girder shall be supported by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

2308.8.2.1 Engineered wood products. Cuts, notches and holes bored in trusses, structural composite lumber, structural glue-laminated members or I-joists are not permitted except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a registered design professional.

2308.8.3 Framing around openings. Trimmer and header joists shall be doubled, or of lumber of equivalent cross section, where the span of the header exceeds 4 feet (1219 mm). The ends of header joists more than 6 feet (1829 mm) long shall be supported by framing anchors or joist hangers unless bearing on a beam, partition or wall. Tail joists over 12 feet (3658 mm) long shall be supported at the header by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

2308.8.4 Supporting bearing partitions. Bearing partitions parallel to joists shall be supported on beams, girders, doubled joists, walls or other bearing partitions. Bearing partitions perpendicular to joists shall not be offset from supporting girders, walls or partitions more than the joist depth unless such joists are of sufficient size to carry the additional load.

2308.8.5 Lateral support. Floor, attic and roof framing with a nominal depth-to-thickness ratio greater than or equal to 5:1 shall have one edge held in line for the entire span. Where the nominal depth-to-thickness ratio of the framing member exceeds 6:1, there shall be one line of bridging for each 8 feet (2438 mm) of span, unless both edges of the member are held in line. The bridging shall consist of not less than 1-inch by 3-inch (25 mm by 76

mm) lumber, double nailed at each end, of equivalent metal bracing of equal rigidity, full-depth solid blocking or other approved means. A line of bridging shall also be required at supports where equivalent lateral support is not otherwise provided.

2308.8.6 Structural floor sheathing. Structural floor sheathing shall comply with the provisions of Section 2304.7.1.

2308.8.7 Under-floor ventilation. For under-floor ventilation, see Section 1203.3.

2308.9 Wall framing. Walls and partitions shall be constructed in accordance with the applicable provisions of Sections 2308.9.1 through 2308.9.4.2.

2308.9.1 Size, height and spacing. The size, height and spacing of studs shall be in accordance with Table 2308.9.1 except that utility-grade studs shall not be spaced more than 16 inches (406 mm) o.c., or support more than a roof and ceiling, or exceed 8 feet (2438 mm) in height for exterior walls and load-bearing walls or 10 feet (3048 mm) for interior nonload-bearing walls. Studs shall be continuous from a support at the sole plate to a support at the top plate to resist loads perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof diaphragm or shall be designed in accordance with accepted engineering practice.

Exception: Jack studs, trimmer studs and cripple studs at openings in walls that comply with Table 2308.9.5.

2308.9.2 Framing details. Studs shall be placed with their wide dimension perpendicular to the wall. Not less than three studs shall be installed at each corner of an exterior wall.

Exception: At corners, two studs are permitted, provided wood spacers or backup cleats of $\frac{3}{8}$ -inch-thick (9.5 mm) wood structural panel, $\frac{3}{8}$ -inch (9.5 mm) Type M "Exterior Glue" particleboard, 1-inch-thick (25 mm) lumber or other approved devices that will serve as an adequate backing for the attachment of facing materials are used. Where fire-resistance ratings or shear values are involved, wood spacers, backup cleats or other devices shall not be used unless specifically approved for such use.

**TABLE 2308.9.1
SIZE, HEIGHT AND SPACING OF WOOD STUDS**

| STUD SIZE (inches) | BEARING WALLS | | | | NONBEARING WALLS | |
|-----------------------|---|----------------------------------|--|---|---|------------------|
| | Laterally unsupported stud height ^a (feet) | Supporting roof and ceiling only | Supporting one floor, roof and ceiling | Supporting two floors, roof and ceiling | Laterally unsupported stud height ^a (feet) | Spacing (inches) |
| 2 × 3 ^b | — | — | — | — | 10 | 16 |
| 2 × 4 | 10 | 24 | 16 | — | 14 | 24 |
| 3 × 4 | 10 | 24 | 24 | 16 | 14 | 24 |
| 2 × 5 | 10 | 24 | 24 | — | 16 | 24 |
| 2 × 6 | 10 | 24 | 24 | 16 | 20 | 24 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Increases in unsupported height are permitted where justified by an analysis.

b. Shall not be used in exterior walls.

2308.9.2.1 Top plates. Bearing and exterior wall studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with other partitions. End joints in double top plates shall be offset at least 48 inches (1219 mm), and shall be nailed with not less than eight 16d face nails on each side of the joint. Plates shall be a nominal 2 inches (51 mm) in depth and have a width at least equal to the width of the studs.

Exception: A single top plate is permitted, provided the plate is adequately tied at joints, corners and intersecting walls by at least the equivalent of 3-inch by 6-inch (76 mm by 152 mm) by 0.036-inch-thick (0.914 mm) galvanized steel that is nailed to each wall or segment of wall by six 8d nails or equivalent, provided the rafters, joists or trusses are centered over the studs with a tolerance of no more than 1 inch (25 mm).

2308.9.2.2 Top plates for studs spaced at 24 inches (610 mm). Where bearing studs are spaced at 24-inch (610 mm) intervals and top plates are less than two 2-inch by 6-inch (51 mm by 152 mm) or two 3-inch by 4-inch (76 mm by 102 mm) members and where the floor joists, floor trusses or roof trusses that they support are spaced at more than 16-inch (406 mm) intervals, such joists or trusses shall bear within 5 inches (127 mm) of the studs beneath or a third plate shall be installed.

2308.9.2.3 Nonbearing walls and partitions. In non-bearing walls and partitions, studs shall be spaced not more than 28 inches (711 mm) o.c. and in interior non-bearing walls and partitions, are permitted to be set with the long dimension parallel to the wall. Interior nonbearing partitions shall be capped with no less than a single top plate installed to provide overlapping at corners and at intersections with other walls and partitions. The plate shall be continuously tied at joints by solid blocking at least 16 inches (406 mm) in length and equal in size to the plate or by $\frac{1}{2}$ -inch by $1\frac{1}{2}$ -inch (12.7 mm by 38 mm) metal ties with spliced sections fastened with two 16d nails on each side of the joint.

2308.9.2.4 Plates or sills. Studs shall have full bearing on a plate or sill not less than 2 inches (51 mm) in thickness having a width not less than that of the wall studs.

2308.9.3 Bracing. Braced wall lines shall consist of braced wall panels that meet the requirements for location, type and amount of bracing as shown in Figure 2308.9.3, specified in Table 2308.9.3(1) and are in line or offset from each other by not more than 4 feet (1219 mm). Braced wall panels shall start not more than $12\frac{1}{2}$ feet (3810 mm) from each end of a braced wall line. Braced wall panels shall be clearly indicated on the plans. Construction of braced wall panels shall be by one of the following methods:

1. Nominal 1-inch by 4-inch (25 mm by 102 mm) continuous diagonal braces let into top and bottom plates and intervening studs, placed at an angle not more than 60 degrees (1.0 rad) or less than 45 degrees (0.79 rad) from the horizontal and attached to the framing in conformance with Table 2304.9.1.
2. Wood boards of $\frac{5}{8}$ inch (15.9 mm) net minimum thickness applied diagonally on studs spaced not over 24 inches (610 mm) o.c.
3. Wood structural panel sheathing with a thickness not less than $\frac{3}{8}$ inch (9.5 mm) for 16-inch (406 mm) or 24-inch (610 mm) stud spacing in accordance with Tables 2308.9.3(2) and 2308.9.3(3).
4. Fiberboard sheathing panels not less than $\frac{1}{2}$ inch (12.7 mm) thick applied vertically or horizontally on studs spaced not over 16 inches (406 mm) o.c. where installed with fasteners in accordance with Section 2306.6 and Table 2306.6.
5. Gypsum board [sheathing $\frac{1}{2}$ -inch-thick (12.7 mm) by 4-feet-wide (1219 mm) wallboard or veneer base] on studs spaced not over 24 inches (610 mm) o.c. and nailed at 7 inches (178 mm) o.c. with nails as required by Table 2306.7.
6. Particleboard wall sheathing panels where installed in accordance with Table 2308.9.3(4).
7. Portland cement plaster on studs spaced 16 inches (406 mm) o.c. installed in accordance with Section 2510.
8. Hardboard panel siding where installed in accordance with Section 2303.1.6 and Table 2308.9.3(5).

For cripple wall bracing, see Section 2308.9.4.1. For Methods 2, 3, 4, 6, 7 and 8, each panel must be at least 48 inches (1219 mm) in length, covering three stud spaces where studs are spaced 16 inches (406 mm) apart and covering two stud spaces where studs are spaced 24 inches (610 mm) apart.

For Method 5, each panel must be at least 96 inches (2438 mm) in length where applied to one face of a panel and 48 inches (1219 mm) where applied to both faces. All vertical joints of panel sheathing shall occur over studs

and adjacent panel joints shall be nailed to common framing members. Horizontal joints shall occur over blocking or other framing equal in size to the studding except where waived by the installation requirements for the specific sheathing materials. Sole plates shall be nailed to the floor framing and top plates shall be connected to the framing above in accordance with Section 2308.3.2. Where joists are perpendicular to braced wall lines above, blocking shall be provided under and in line with the braced wall panels.

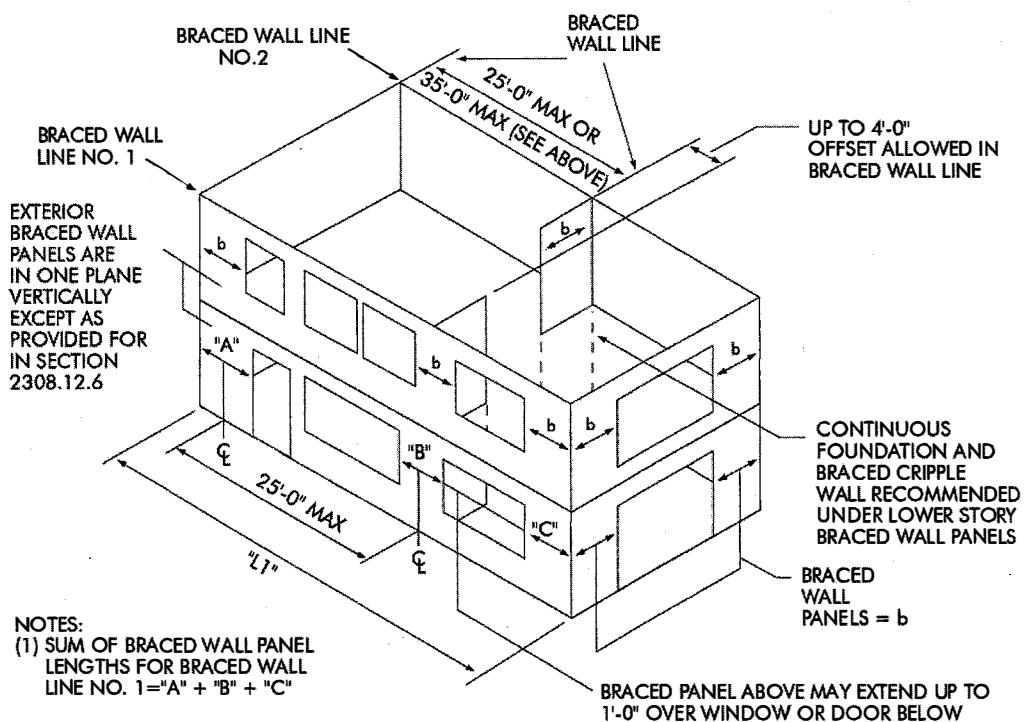
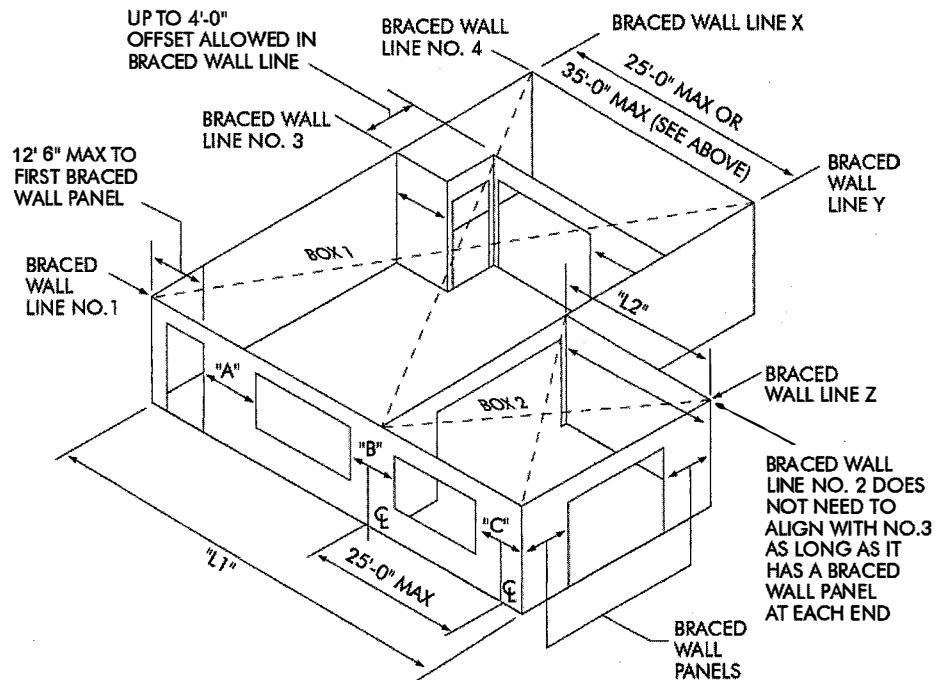
2308.9.3.1 Alternative bracing. Any bracing required by Section 2308.9.3 is permitted to be replaced by the following:

1. In one-story buildings, each panel shall have a length of not less than 2 feet 8 inches (813 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with $\frac{3}{8}$ -inch-minimum-thickness (9.5 mm) wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Table 2304.9.1 and blocked at wood structural panel edges. Two anchor bolts installed in accordance with Section 2308.6 shall be provided in each panel. Anchor bolts shall be placed at each panel outside quarter points. Each panel end stud shall have a tie-down device fastened to the foundation, capable of providing an approved uplift capacity of not less than 1,800 pounds (8006 N). The tie-down device shall be installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation or on floor framing supported directly on a foundation that is continuous across the entire length of the braced wall line. This foundation shall be reinforced with not less than one No. 4 bar top and bottom.

Where the continuous foundation is required to have a depth greater than 12 inches (305 mm), a minimum 12-inch by 12-inch (305 mm by 305 mm) continuous footing or turned down slab edge is permitted at door openings in the braced wall line. This continuous footing or turned down slab edge shall be reinforced with not less than one No. 4 bar top and bottom. This reinforcement shall be lapped 15 inches (381 mm) with the reinforcement required in the continuous foundation located directly under the braced wall line.

2. In the first story of two-story buildings, each wall panel shall be braced in accordance with Section 2308.9.3.1, Item 1, except that the wood structural panel sheathing shall be provided on both faces, three anchor bolts shall be placed at one-quarter points, and tie-down device uplift capacity shall not be less than 3,000 pounds (13,344 N).

| SEISMIC DESIGN CATEGORY | MAXIMUM WALL SPACING (feet) | REQUIRED BRACING LENGTH, b |
|-------------------------|--------------------------------|--|
| A, B and C | 35'-0" | Table 2308.9.3(1) and Section 2308.9.3 |
| D and E | 25'-0" | Table 2308.12.4 |



SI: 1 foot = 304.8 mm.

FIGURE 2308.9.3
BASIC COMPONENTS OF THE LATERAL BRACING SYSTEM

2308.9.3.2 Alternate bracing wall panel adjacent to a door or window opening. Any bracing required by Section 2308.9.3 is permitted to be replaced by the following when used adjacent to a door or window opening with a full-length header:

1. In one-story buildings, each panel shall have a length of not less than 16 inches (406 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with a single layer of $\frac{3}{8}$ inch (9.5 mm) minimum thickness wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Figure 2308.9.3.2. The wood structural panel sheathing shall extend up over the solid sawn or glued-laminated header and shall be nailed in accordance with Figure 2308.9.3.2. A built-up header consisting of at least two 2×12 s and fastened in accordance with Item 24 of Table 2304.9.1 shall be permitted to be used. A spacer, if used, shall be placed on the side of the built-up beam opposite the wood structural panel sheathing. The header shall extend between the inside faces of the first full-length outer studs of each panel. The clear span of the header between the inner studs of each panel shall be not less than 6 feet (1829 mm) and not more than 18 feet (5486 mm) in length. A strap with an uplift capacity of not less than 1,000 pounds (4,400 N) shall fasten the header to the inner studs opposite the sheathing. One anchor bolt not less than $\frac{5}{8}$ inch (15.9 mm) diameter and installed in accordance with Section 2308.6 shall be provided in the center of each sill plate. The studs at each end of the panel shall have a tie-down device fastened to the foundation with an uplift capacity of not less than 4,200 pounds (18,480 N).

Where a panel is located on one side of the opening, the header shall extend between the inside face of the first full-length stud of the panel and the bearing studs at the other end of the opening. A strap with an uplift capacity of not less than 1,000 pounds (4,400 N) shall fasten the header to the bearing studs. The bearing studs shall also have a tie-down device fastened to the foundation with an uplift capacity of not less than 1,000 pounds (4,400 N).

The tie-down devices shall be an embedded strap type, installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation that is continuous across the entire length of the braced wall line. This foundation shall be reinforced with not less than one No. 4 bar top and bottom.

Where the continuous foundation is required to have a depth greater than 12 inches (305 mm), a minimum 12-inch by 12-inch (305 mm by 305 mm) continuous footing or turned down slab

edge is permitted at door openings in the braced wall line. This continuous footing or turned down slab edge shall be reinforced with not less than one No. 4 bar top and bottom. This reinforcement shall be lapped not less than 15 inches (381 mm) with the reinforcement required in the continuous foundation located directly under the braced wall line.

2. In the first story of two-story buildings, each wall panel shall be braced in accordance with Item 1 above, except that each panel shall have a length of not less than 24 inches (610 mm).

2308.9.4 Cripple walls. Foundation cripple walls shall be framed of studs not less in size than the studding above with a minimum length of 14 inches (356 mm), or shall be framed of solid blocking. Where exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional story.

2308.9.4.1 Bracing. For the purposes of this section, cripple walls having a stud height exceeding 14 inches (356 mm) in structures assigned to Seismic Design Category A, B or C shall be considered a story and shall be braced in accordance with Table 2308.9.3(1). See Section 2308.12.4 for cripple walls in structures assigned to Seismic Design Category D or E.

2308.9.4.2 Nailing of bracing. Spacing of edge nailing for required wall bracing shall not exceed 6 inches (152 mm) o.c. along the foundation plate and the top plate of the cripple wall. Nail size, nail spacing for field nailing and more restrictive boundary nailing requirements shall be as required elsewhere in the code for the specific bracing material used.

2308.9.5 Openings in exterior walls. Openings in exterior walls shall be constructed in accordance with Sections 2308.9.5.1 and 2308.9.5.2.

2308.9.5.1 Headers. Headers shall be provided over each opening in exterior-bearing walls. The spans in Table 2308.9.5 are permitted to be used for one- and two-family dwellings. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers shall be of two pieces of nominal 2-inch (51 mm) framing lumber set on edge as permitted by Table 2308.9.5 and nailed together in accordance with Table 2304.9.1 or of solid lumber of equivalent size.

2308.9.5.2 Header support. Wall studs shall support the ends of the header in accordance with Table 2308.9.5. Each end of a lintel or header shall have a length of bearing of not less than $1\frac{1}{2}$ inches (38 mm) for the full width of the lintel.

2308.9.6 Openings in interior bearing partitions. Headers shall be provided over each opening in interior bearing partitions as required in Section 2308.9.5. The spans in Table 2308.9.6 are permitted to be used. Wall studs shall support the ends of the header in accordance with Table 2308.9.5 or 2308.9.6, as appropriate.

**TABLE 2308.9.3(1)
BRACED WALL PANELS^a**

| SEISMIC DESIGN CATEGORY | CONDITION | CONSTRUCTION METHODS ^{b,c} | | | | | | | | BRACED PANEL LOCATION AND LENGTH ^d |
|-------------------------|---|-------------------------------------|---|---|---|----------------|---|---|---|--|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| A and B | One story, top of two or three story | X | X | X | X | X | X | X | X | Located in accordance with Section 2308.9.3 and not more than 25 feet on center. |
| | First story of two story or second story of three story | X | X | X | X | X | X | X | X | |
| | First story of three story | — | X | X | X | X ^e | X | X | X | |
| C | One story or top of two story | — | X | X | X | X | X | X | X | Located in accordance with Section 2308.9.3 and not more than 25 feet on center. |
| | First story of two story | — | X | X | X | X ^e | X | X | X | Located in accordance with Section 2308.9.3 and not more than 25 feet on center, but total length shall not be less than 25% of building length ^f . |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. This table specifies minimum requirements for braced panels that form interior or exterior braced wall lines.
- b. See Section 2308.9.3 for full description.
- c. See Sections 2308.9.3.1 and 2308.9.3.2 for alternative braced panel requirements.
- d. Building length is the dimension parallel to the braced wall length.
- e. Gypsum wallboard applied to framing supports that are spaced at 16 inches on center.
- f. The required lengths shall be doubled for gypsum board applied to only one face of a braced wall panel.

**TABLE 2308.9.3(2)
EXPOSED PLYWOOD PANEL SIDING**

| MINIMUM THICKNESS ^a (inch) | MINIMUM NUMBER OF PLIES | STUD SPACING (inches) | |
|--|-------------------------|--|--|
| | | Plywood siding applied directly to studs or over sheathing | |
| 3/8 | 3 | 16 ^b | |
| 1/2 | 4 | 24 | |

For SI: 1 inch = 25.4 mm.

- a. Thickness of grooved panels is measured at bottom of grooves.
- b. Spans are permitted to be 24 inches if plywood siding applied with face grain perpendicular to studs or over one of the following: (1) 1-inch board sheathing, (2) 7/16 inch wood structural panel sheathing or (3) 3/8 inch wood structural panel sheathing with strength axis (which is the long direction of the panel unless otherwise marked) of sheathing perpendicular to studs.

**TABLE 2308.9.3(3)
WOOD STRUCTURAL PANEL WALL SHEATHING^b
(Not Exposed to the Weather, Strength Axis Parallel or Perpendicular to Studs Except as Indicated Below)**

| MINIMUM THICKNESS (inch) | PANEL SPAN RATING | STUD SPACING (inches) | | |
|-----------------------------|--|------------------------|-----------------------------|----------------------------------|
| | | Siding nailed to studs | Nailable sheathing | |
| | | | Sheathing parallel to studs | Sheathing perpendicular to studs |
| 3/8, 15/32, 1/2 | 16/0, 20/0, 24/0, 32/16 Wall—24" o.c. | 24 | 16 | 24 |
| 7/16, 15/32, 1/2 | 24/0, 24/16, 32/16 Wall—24" o.c. | 24 | 24 ^a | 24 |

For SI: 1 inch = 25.4 mm.

- a. Plywood shall consist of four or more plies.
- b. Blocking of horizontal joints shall not be required except as specified in Sections 2306.3 and 2308.12.4.

WOOD

TABLE 2308.9.3(4)
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING
(Not Exposed to the Weather, Long Dimension of the Panel Parallel or Perpendicular to Studs)

| GRADE | THICKNESS (inch) | STUD SPACING (inches) | |
|--|---------------------|---------------------------|---|
| | | Siding nailed to studs | Sheathing under coverings specified in Section 2308.9.3 parallel or perpendicular to studs |
| M-S "Exterior Glue" and M-2 "Exterior Glue" | $\frac{3}{8}$ | 16 | — |
| | $\frac{1}{2}$ | 16 | 16 |

For SI: 1 inch = 25.4 mm.

TABLE 2308.9.3(5)
HARDBOARD SIDING

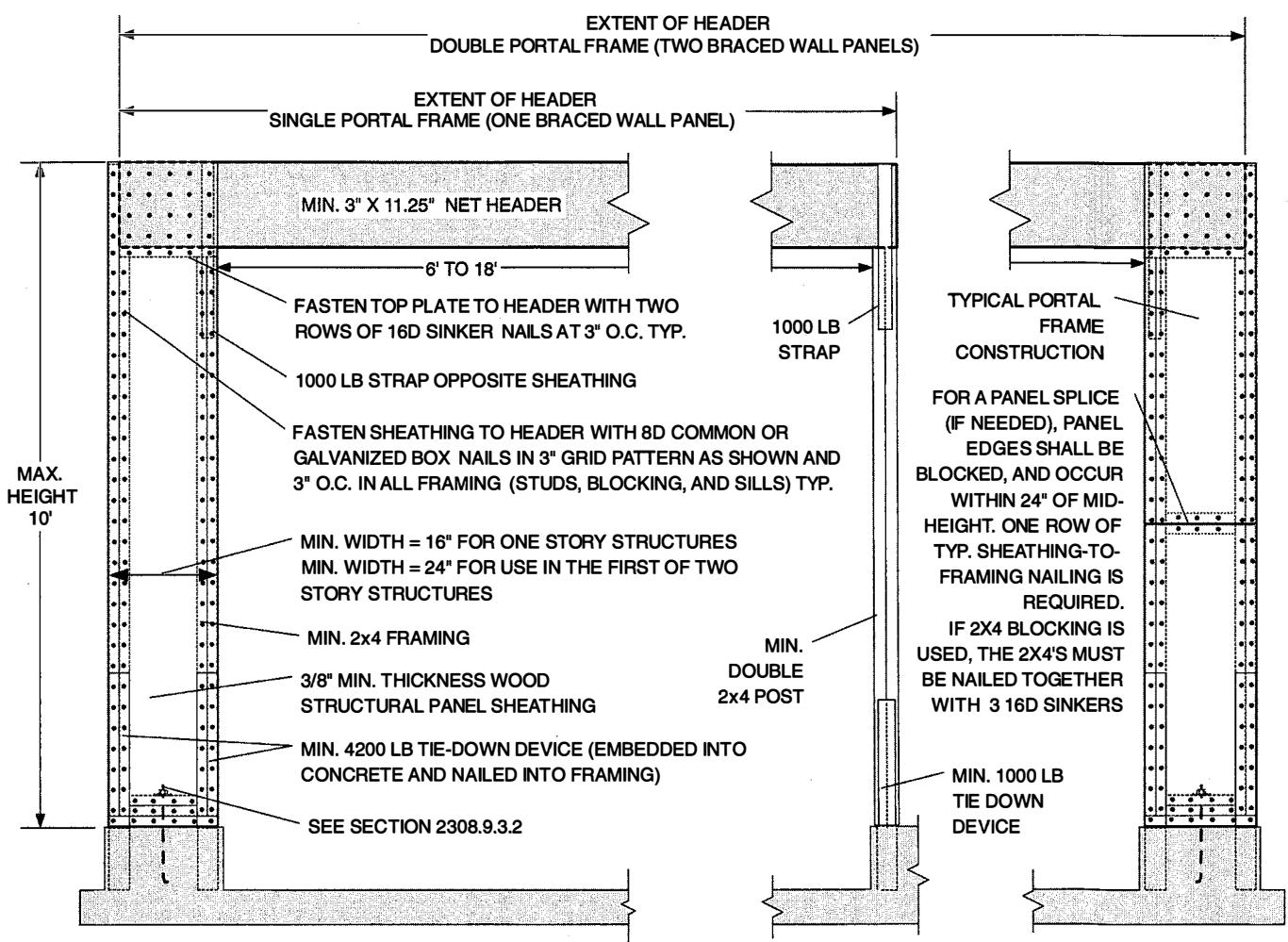
| SIDING | MINIMUM NOMINAL THICKNESS (inch) | 2 x 4 FRAMING MAXIMUM SPACING | NAIL SIZE ^{a, b, d} | NAIL SPACING | |
|-------------------------------------|--|----------------------------------|------------------------------|---|--|
| | | | | General | Bracing panels ^c |
| 1. Lap siding | | | | | |
| Direct to studs | $\frac{3}{8}$ | 16" o.c. | 8d | 16" o.c. | Not applicable |
| Over sheathing | $\frac{3}{8}$ | 16" o.c. | 10d | 16" o.c. | Not applicable |
| 2. Square edge panel siding | | | | | |
| Direct to studs | $\frac{3}{8}$ | 24" o.c. | 6d | 6" o.c. edges; 12" o.c. at intermediate supports | 4" o.c. edges; 8" o.c. at intermediate supports |
| Over sheathing | $\frac{3}{8}$ | 24" o.c. | 8d | 6" o.c. edges; 12" o.c. at intermediate supports | 4" o.c. edges; 8" o.c. at intermediate supports |
| 3. Shiplap edge panel siding | | | | | |
| Direct to studs | $\frac{3}{8}$ | 16" o.c. | 6d | 6" o.c. edges; 12" o.c. at intermediate supports | 4" o.c. edges; 8" o.c. at intermediate supports |
| Over sheathing | $\frac{3}{8}$ | 16" o.c. | 8d | 6" o.c. edges; 12" o.c. at intermediate supports | 4" o.c. edges; 8" o.c. at intermediate supports |

For SI: 1 inch = 25.4 mm.

- a. Nails shall be corrosion resistant.
- b. Minimum acceptable nail dimensions:
- c. Where used to comply with Section 2308.9.3.

| | Panel Siding (inch) | Lap Siding (inch) |
|----------------|---------------------|-------------------|
| Shank diameter | 0.092 | 0.099 |
| Head diameter | 0.225 | 0.240 |

- d. Nail length must accommodate the sheathing and penetrate framing $1\frac{1}{2}$ inches.



For SI: 1 foot = 304.8 mm; 1 inch = 25.4 mm; 1 pound = 4.448 N.

FIGURE 2308.9.3.2
ALTERNATE BRACED WALL PANEL ADJACENT TO A DOOR OR WINDOW OPENING

TABLE 2308.9.5
HEADER AND GIRDER SPANS^a FOR EXTERIOR BEARING WALLS
(Maximum Spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir^b and Required Number of Jack Studs)

| HEADERS SUPPORTING | SIZE | GROUND SNOW LOAD (psf) ^c | | | | | | | | | | | | |
|--|--------|-------------------------------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|
| | | 30 | | | | 50 | | | | | | | | |
| | | Building width ^d (feet) | | | | | | | | | | | | |
| | | 20 | | 28 | | 36 | | 20 | | 28 | | 36 | | |
| Roof & Ceiling | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d |
| | 2-2x4 | 3-6 | 1 | 3-2 | 1 | 2-10 | 1 | 3-2 | 1 | 2-9 | 1 | 2-6 | 1 | |
| | 2-2x6 | 5-5 | 1 | 4-8 | 1 | 4-2 | 1 | 4-8 | 1 | 4-1 | 1 | 3-8 | 2 | |
| | 2-2x8 | 6-10 | 1 | 5-11 | 2 | 5-4 | 2 | 5-11 | 2 | 5-2 | 2 | 4-7 | 2 | |
| | 2-2x10 | 8-5 | 2 | 7-3 | 2 | 6-6 | 2 | 7-3 | 2 | 6-3 | 2 | 5-7 | 2 | |
| | 2-2x12 | 9-9 | 2 | 8-5 | 2 | 7-6 | 2 | 8-5 | 2 | 7-3 | 2 | 6-6 | 2 | |
| | 3-2x8 | 8-4 | 1 | 7-5 | 1 | 6-8 | 1 | 7-5 | 1 | 6-5 | 2 | 5-9 | 2 | |
| | 3-2x10 | 10-6 | 1 | 9-1 | 2 | 8-2 | 2 | 9-1 | 2 | 7-10 | 2 | 7-0 | 2 | |
| | 3-2x12 | 12-2 | 2 | 10-7 | 2 | 9-5 | 2 | 10-7 | 2 | 9-2 | 2 | 8-2 | 2 | |
| | 4-2x8 | 9-2 | 1 | 8-4 | 1 | 7-8 | 1 | 8-4 | 1 | 7-5 | 1 | 6-8 | 1 | |
| | 4-2x10 | 11-8 | 1 | 10-6 | 1 | 9-5 | 2 | 10-6 | 1 | 9-1 | 2 | 8-2 | 2 | |
| | 4-2x12 | 14-1 | 1 | 12-2 | 2 | 10-11 | 2 | 12-2 | 2 | 10-7 | 2 | 9-5 | 2 | |
| Roof, Ceiling & 1 Center-Bearing Floor | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d |
| | 2-2x4 | 3-1 | 1 | 2-9 | 1 | 2-5 | 1 | 2-9 | 1 | 2-5 | 1 | 2-2 | 1 | |
| | 2-2x6 | 4-6 | 1 | 4-0 | 1 | 3-7 | 2 | 4-1 | 1 | 3-7 | 2 | 3-3 | 2 | |
| | 2-2x8 | 5-9 | 2 | 5-0 | 2 | 4-6 | 2 | 5-2 | 2 | 4-6 | 2 | 4-1 | 2 | |
| | 2-2x10 | 7-0 | 2 | 6-2 | 2 | 5-6 | 2 | 6-4 | 2 | 5-6 | 2 | 5-0 | 2 | |
| | 2-2x12 | 8-1 | 2 | 7-1 | 2 | 6-5 | 2 | 7-4 | 2 | 6-5 | 2 | 5-9 | 3 | |
| | 3-2x8 | 7-2 | 1 | 6-3 | 2 | 5-8 | 2 | 6-5 | 2 | 5-8 | 2 | 5-1 | 2 | |
| | 3-2x10 | 8-9 | 2 | 7-8 | 2 | 6-11 | 2 | 7-11 | 2 | 6-11 | 2 | 6-3 | 2 | |
| | 3-2x12 | 10-2 | 2 | 8-11 | 2 | 8-0 | 2 | 9-2 | 2 | 8-0 | 2 | 7-3 | 2 | |
| | 4-2x8 | 8-1 | 1 | 7-3 | 1 | 6-7 | 1 | 7-5 | 1 | 6-6 | 1 | 5-11 | 2 | |
| | 4-2x10 | 10-1 | 1 | 8-10 | 2 | 8-0 | 2 | 9-1 | 2 | 8-0 | 2 | 7-2 | 2 | |
| | 4-2x12 | 11-9 | 2 | 10-3 | 2 | 9-3 | 2 | 10-7 | 2 | 9-3 | 2 | 8-4 | 2 | |
| Roof, Ceiling & 1 Clear Span Floor | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d |
| | 2-2x4 | 2-8 | 1 | 2-4 | 1 | 2-1 | 1 | 2-7 | 1 | 2-3 | 1 | 2-0 | 1 | |
| | 2-2x6 | 3-11 | 1 | 3-5 | 2 | 3-0 | 2 | 3-10 | 2 | 3-4 | 2 | 3-0 | 2 | |
| | 2-2x8 | 5-0 | 2 | 4-4 | 2 | 3-10 | 2 | 4-10 | 2 | 4-2 | 2 | 3-9 | 2 | |
| | 2-2x10 | 6-1 | 2 | 5-3 | 2 | 4-8 | 2 | 5-11 | 2 | 5-1 | 2 | 4-7 | 3 | |
| | 2-2x12 | 7-1 | 2 | 6-1 | 3 | 5-5 | 3 | 6-10 | 2 | 5-11 | 3 | 5-4 | 3 | |
| | 3-2x8 | 6-3 | 2 | 5-5 | 2 | 4-10 | 2 | 6-1 | 2 | 5-3 | 2 | 4-8 | 2 | |
| | 3-2x10 | 7-7 | 2 | 6-7 | 2 | 5-11 | 2 | 7-5 | 2 | 6-5 | 2 | 5-9 | 2 | |
| | 3-2x12 | 8-10 | 2 | 7-8 | 2 | 6-10 | 2 | 8-7 | 2 | 7-5 | 2 | 6-8 | 2 | |
| | 4-2x8 | 7-2 | 1 | 6-3 | 2 | 5-7 | 2 | 7-0 | 1 | 6-1 | 2 | 5-5 | 2 | |
| | 4-2x10 | 8-9 | 2 | 7-7 | 2 | 6-10 | 2 | 8-7 | 2 | 7-5 | 2 | 6-7 | 2 | |
| | 4-2x12 | 10-2 | 2 | 8-10 | 2 | 7-11 | 2 | 9-11 | 2 | 8-7 | 2 | 7-8 | 2 | |

(continued)

**TABLE 2308.9.5—continued
HEADER AND GIRDER SPANS^a FOR EXTERIOR BEARING WALLS
(Maximum Spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir^b and Required Number of Jack Studs)**

| HEADERS SUPPORTING | SIZE | GROUND SNOW LOAD (psf) ^c | | | | | | | | | | | | |
|---|--------|-------------------------------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|
| | | 30 | | | | | | 50 | | | | | | |
| | | Building width ^c (feet) | | | | | | | | | | | | |
| | | 20 | | 28 | | 36 | | 20 | | 28 | | 36 | | |
| Roof, Ceiling & 2 Center-Bearing Floors | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d |
| | 2-2x4 | 2-7 | 1 | 2-3 | 1 | 2-0 | 1 | 2-6 | 1 | 2-2 | 1 | 1-11 | 1 | |
| | 2-2x6 | 3-9 | 2 | 3-3 | 2 | 2-11 | 2 | 3-8 | 2 | 3-2 | 2 | 2-10 | 2 | |
| | 2-2x8 | 4-9 | 2 | 4-2 | 2 | 3-9 | 2 | 4-7 | 2 | 4-0 | 2 | 3-8 | 2 | |
| | 2-2x10 | 5-9 | 2 | 5-1 | 2 | 4-7 | 3 | 5-8 | 2 | 4-11 | 2 | 4-5 | 3 | |
| | 2-2x12 | 6-8 | 2 | 5-10 | 3 | 5-3 | 3 | 6-6 | 2 | 5-9 | 3 | 5-2 | 3 | |
| | 3-2x8 | 5-11 | 2 | 5-2 | 2 | 4-8 | 2 | 5-9 | 2 | 5-1 | 2 | 4-7 | 2 | |
| | 3-2x10 | 7-3 | 2 | 6-4 | 2 | 5-8 | 2 | 7-1 | 2 | 6-2 | 2 | 5-7 | 2 | |
| | 3-2x12 | 8-5 | 2 | 7-4 | 2 | 6-7 | 2 | 8-2 | 2 | 7-2 | 2 | 6-5 | 3 | |
| | 4-2x8 | 6-10 | 1 | 6-0 | 2 | 5-5 | 2 | 6-8 | 1 | 5-10 | 2 | 5-3 | 2 | |
| Roof, Ceiling & 2 Clear Span Floors | 4-2x10 | 8-4 | 2 | 7-4 | 2 | 6-7 | 2 | 8-2 | 2 | 7-2 | 2 | 6-5 | 2 | |
| | 4-2x12 | 9-8 | 2 | 8-6 | 2 | 7-8 | 2 | 9-5 | 2 | 8-3 | 2 | 7-5 | 2 | |
| | 2-2x4 | 2-1 | 1 | 1-8 | 1 | 1-6 | 2 | 2-0 | 1 | 1-8 | 1 | 1-5 | 2 | |
| | 2-2x6 | 3-1 | 2 | 2-8 | 2 | 2-4 | 2 | 3-0 | 2 | 2-7 | 2 | 2-3 | 2 | |
| | 2-2x8 | 3-10 | 2 | 3-4 | 2 | 3-0 | 3 | 3-10 | 2 | 3-4 | 2 | 2-11 | 3 | |
| | 2-2x10 | 4-9 | 2 | 4-1 | 3 | 3-8 | 3 | 4-8 | 2 | 4-0 | 3 | 3-7 | 3 | |
| | 2-2x12 | 5-6 | 3 | 4-9 | 3 | 4-3 | 3 | 5-5 | 3 | 4-8 | 3 | 4-2 | 3 | |
| | 3-2x8 | 4-10 | 2 | 4-2 | 2 | 3-9 | 2 | 4-9 | 2 | 4-1 | 2 | 3-8 | 2 | |
| | 3-2x10 | 5-11 | 2 | 5-1 | 2 | 4-7 | 3 | 5-10 | 2 | 5-0 | 2 | 4-6 | 3 | |
| | 3-2x12 | 6-10 | 2 | 5-11 | 3 | 5-4 | 3 | 6-9 | 2 | 5-10 | 3 | 5-3 | 3 | |
| | 4-2x8 | 5-7 | 2 | 4-10 | 2 | 4-4 | 2 | 5-6 | 2 | 4-9 | 2 | 4-3 | 2 | |
| | 4-2x10 | 6-10 | 2 | 5-11 | 2 | 5-3 | 2 | 6-9 | 2 | 5-10 | 2 | 5-2 | 2 | |
| | 4-2x12 | 7-11 | 2 | 6-10 | 2 | 6-2 | 3 | 7-9 | 2 | 6-9 | 2 | 6-0 | 3 | |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m².

a. Spans are given in feet and inches (ft in).

b. Tabulated values are for No. 2 grade lumber.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full height wall stud and to the header.

e. Use 30 pounds per square foot ground snow load for cases in which ground snow load is less than 30 pounds per square foot and the roof live load is equal to or less than 20 pounds per square foot.

TABLE 2308.9.6
HEADER AND GIRDER SPANS^a FOR INTERIOR BEARING WALLS
(Maximum Spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir^b and Required Number of Jack Studs)

| HEADERS AND GIRDERS SUPPORTING | SIZE | BUILDING width ^c (feet) | | | | | |
|--------------------------------|--------|------------------------------------|-----------------|------|-----------------|------|-----------------|
| | | 20 | | 28 | | 36 | |
| | | Span | NJ ^d | Span | NJ ^d | Span | NJ ^d |
| One Floor Only | 2-2x4 | 3-1 | 1 | 2-8 | 1 | 2-5 | 1 |
| | 2-2x6 | 4-6 | 1 | 3-11 | 1 | 3-6 | 1 |
| | 2-2x8 | 5-9 | 1 | 5-0 | 2 | 4-5 | 2 |
| | 2-2x10 | 7-0 | 2 | 6-1 | 2 | 5-5 | 2 |
| | 2-2x12 | 8-1 | 2 | 7-0 | 2 | 6-3 | 2 |
| | 3-2x8 | 7-2 | 1 | 6-3 | 1 | 5-7 | 2 |
| | 3-2x10 | 8-9 | 1 | 7-7 | 2 | 6-9 | 2 |
| | 3-2x12 | 10-2 | 2 | 8-10 | 2 | 7-10 | 2 |
| | 4-2x8 | 9-0 | 1 | 7-8 | 1 | 6-9 | 1 |
| | 4-2x10 | 10-1 | 1 | 8-9 | 1 | 7-10 | 2 |
| | 4-2x12 | 11-9 | 1 | 10-2 | 2 | 9-1 | 2 |
| | 2-2x4 | 2-2 | 1 | 1-10 | 1 | 1-7 | 1 |
| Two Floors | 2-2x6 | 3-2 | 2 | 2-9 | 2 | 2-5 | 2 |
| | 2-2x8 | 4-1 | 2 | 3-6 | 2 | 3-2 | 2 |
| | 2-2x10 | 4-11 | 2 | 4-3 | 2 | 3-10 | 3 |
| | 2-2x12 | 5-9 | 2 | 5-0 | 3 | 4-5 | 3 |
| | 3-2x8 | 5-1 | 2 | 4-5 | 2 | 3-11 | 2 |
| | 3-2x10 | 6-2 | 2 | 5-4 | 2 | 4-10 | 2 |
| | 3-2x12 | 7-2 | 2 | 6-3 | 2 | 5-7 | 3 |
| | 4-2x8 | 6-1 | 1 | 5-3 | 2 | 4-8 | 2 |
| | 4-2x10 | 7-2 | 2 | 6-2 | 2 | 5-6 | 2 |
| | 4-2x12 | 8-4 | 2 | 7-2 | 2 | 6-5 | 2 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Spans are given in feet and inches (ft in).

b. Tabulated values are for No. 2 grade lumber.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ Number of jack studs required to support each end. Where the number of required jack studs equals one, the headers are permitted to be supported by an approved framing anchor attached to the full height wall stud and to the header.

2308.9.7 Openings in interior nonbearing partitions.

Openings in nonbearing partitions are permitted to be framed with single studs and headers. Each end of a lintel or header shall have a length of bearing of not less than $1\frac{1}{2}$ inches (38 mm) for the full width of the lintel.

2308.9.8 Pipes in walls. Stud partitions containing plumbing, heating or other pipes shall be so framed and the joists underneath so spaced as to give proper clearance for the piping. Where a partition containing such piping runs parallel to the floor joists, the joists underneath such partitions shall be doubled and spaced to permit the passage of such pipes and shall be bridged. Where plumbing, heating or other pipes are placed in or partly in a partition, necessitating the cutting of the soles or plates, a metal tie not less than 0.058 inch (1.47 mm) (16 galvanized gage) and $1\frac{1}{2}$ inches (38 mm) wide shall be fastened to each plate across and to each side of the opening with not less than six 16d nails.

2308.9.9 Bridging. Unless covered by interior or exterior wall coverings or sheathing meeting the minimum requirements of this code, stud partitions or walls with studs having a height-to-least-thickness ratio exceeding 50 shall have bridging not less than 2 inches (51 mm) in thickness and of the same width as the studs fitted snugly and nailed thereto to provide adequate lateral support. Bridging shall be placed in every stud cavity and at a frequency such that no stud so braced shall have a height-to-least-thickness ratio exceeding 50 with the height of the stud measured between horizontal framing and bridging or between bridging, whichever is greater.

2308.9.10 Cutting and notching. In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched to a depth not exceeding 25 percent of its width. Cutting or notching of studs to a depth not greater than 40 percent of the width of the stud is permitted in nonbearing partitions supporting no loads other than the weight of the partition.

TABLE 2308.10.1
REQUIRED RATING OF APPROVED UPLIFT CONNECTORS (pounds)^{a, b, c, e, f, g, h}

| NOMINAL DESIGN WIND SPEED, V_{asd} ⁱ | ROOF SPAN (feet) | | | | | | | OVERHANGS (pounds/feet) ^d |
|---|------------------|------|------|------|------|------|------|--------------------------------------|
| | 12 | 20 | 24 | 28 | 32 | 36 | 40 | |
| 85 | -72 | -120 | -145 | -169 | -193 | -217 | -241 | -38.55 |
| 90 | -91 | -151 | -181 | -212 | -242 | -272 | -302 | -43.22 |
| 100 | -131 | -281 | -262 | -305 | -349 | -393 | -436 | -53.36 |
| 110 | -175 | -292 | -351 | -409 | -467 | -526 | -584 | -64.56 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.61 km/hr, 1 pound = 0.454 Kg, 1 pound/foot = 14.5939 N/m.

a. The uplift connection requirements are based on a 30 foot mean roof height located in Exposure B. For Exposure C or D and for other mean roof heights, multiply the above loads by the adjustment coefficients below.

| EXPOSURE | Mean Roof Height (feet) | | | | | | | | | |
|----------|-------------------------|------|------|------|------|------|------|------|------|------|
| | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| B | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.09 | 1.12 | 1.16 | 1.19 | 1.22 |
| C | 1.21 | 1.29 | 1.35 | 1.40 | 1.45 | 1.49 | 1.53 | 1.56 | 1.59 | 1.62 |
| D | 1.47 | 1.55 | 1.61 | 1.66 | 1.70 | 1.74 | 1.78 | 1.81 | 1.84 | 1.87 |

- b. The uplift connection requirements are based on the framing being spaced 24 inches on center. Multiply by 0.67 for framing spaced 16 inches on center and multiply by 0.5 for framing spaced 12 inches on center.
- c. The uplift connection requirements include an allowance for 10 pounds of dead load.
- d. The uplift connection requirements do not account for the effects of overhangs. The magnitude of the above loads shall be increased by adding the overhang loads found in the table. The overhang loads are also based on framing spaced 24 inches on center. The overhang loads given shall be multiplied by the overhang projection and added to the roof uplift value in the table.
- e. The uplift connection requirements are based upon wind loading on end zones as defined in Figure 28.6.3 of ASCE 7. Connection loads for connections located a distance of 20 percent of the least horizontal dimension of the building from the corner of the building are permitted to be reduced by multiplying the table connection value by 0.7 and multiplying the overhang load by 0.8.
- f. For wall to wall and wall to foundation connections, the capacity of the uplift connector is permitted to be reduced by 100 pounds for each full wall above. (For example, if a 500 pound rated connector is used on the roof framing, a 400 pound rated connector is permitted at the next floor level down).
- g. Interpolation is permitted for intermediate values of V_{asd} and roof spans.
- h. The rated capacity of approved tie down devices is permitted to include up to a 60 percent increase for wind effects where allowed by material specifications.
- i. V_{asd} shall be determined in accordance with Section 1609.3.1.

2308.9.11 Bored holes. A hole not greater in diameter than 40 percent of the stud width is permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the width of the stud are permitted in nonbearing partitions or in any wall where each bored stud is doubled, provided not more than two such successive doubled studs are so bored.

In no case shall the edge of the bored hole be nearer than $\frac{5}{8}$ inch (15.9 mm) to the edge of the stud.

Bored holes shall not be located at the same section of stud as a cut or notch.

2308.10 Roof and ceiling framing. The framing details required in this section apply to roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) or greater. Where the roof slope is less than three units vertical in 12 units horizontal (25-percent slope), members supporting rafters and ceiling joists such as ridge board, hips and valleys shall be designed as beams.

2308.10.1 Wind uplift. The roof construction shall have rafter and truss ties to the wall below. Resultant uplift

loads shall be transferred to the foundation using a continuous load path. The rafter or truss to wall connection shall comply with Tables 2304.9.1 and 2308.10.1.

2308.10.2 Ceiling joist spans. Allowable spans for ceiling joists shall be in accordance with Table 2308.10.2(1) or 2308.10.2(2). For other grades and species, refer to the AF&PA Span Tables for Joists and Rafters.

2308.10.3 Rafter spans. Allowable spans for rafters shall be in accordance with Table 2308.10.3(1), 2308.10.3(2), 2308.10.3(3), 2308.10.3(4), 2308.10.3(5) or 2308.10.3(6). For other grades and species, refer to the AF&PA Span Tables for Joists and Rafters.

2308.10.4 Ceiling joist and rafter framing. Rafters shall be framed directly opposite each other at the ridge. There shall be a ridge board at least 1-inch (25 mm) nominal thickness at ridges and not less in depth than the cut end of the rafter. At valleys and hips, there shall be a single valley or hip rafter not less than 2-inch (51 mm) nominal thickness and not less in depth than the cut end of the rafter.

TABLE 2308.10.2(1)
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics Without Storage, Live Load = 10 pounds psf, L/Δ = 240)

| CEILING JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 5 pounds per square foot | | | |
|-----------------------------------|----------------------|--------------------------------------|-------|-------|--------|
| | | 2 × 4 | 2 × 6 | 2 × 8 | 2 × 10 |
| | | Maximum ceiling joist spans | | | |
| 12 | Douglas Fir-Larch SS | 13-2 | 20-8 | 26-0 | 26-0 |
| | Douglas Fir-Larch #1 | 12-8 | 19-11 | 26-0 | 26-0 |
| | Douglas Fir-Larch #2 | 12-5 | 19-6 | 25-8 | 26-0 |
| | Douglas Fir-Larch #3 | 10-10 | 15-10 | 20-1 | 24-6 |
| | Hem-Fir SS | 12-5 | 19-6 | 25-8 | 26-0 |
| | Hem-Fir #1 | 12-2 | 19-1 | 25-2 | 26-0 |
| | Hem-Fir #2 | 11-7 | 18-2 | 24-0 | 26-0 |
| | Hem-Fir #3 | 10-10 | 15-10 | 20-1 | 24-6 |
| | Southern Pine SS | 12-11 | 20-3 | 26-0 | 26-0 |
| | Southern Pine #1 | 12-8 | 19-11 | 26-0 | 26-0 |
| | Southern Pine #2 | 12-5 | 19-6 | 25-8 | 26-0 |
| | Southern Pine #3 | 11-6 | 17-0 | 21-8 | 25-7 |
| | Spruce-Pine-Fir SS | 12-2 | 19-1 | 25-2 | 26-0 |
| | Spruce-Pine-Fir #1 | 11-10 | 18-8 | 24-7 | 26-0 |
| | Spruce-Pine-Fir #2 | 11-10 | 18-8 | 24-7 | 26-0 |
| 16 | Spruce-Pine-Fir #3 | 10-10 | 15-10 | 20-1 | 24-6 |
| | Douglas Fir-Larch SS | 11-11 | 18-9 | 24-8 | 26-0 |
| | Douglas Fir-Larch #1 | 11-6 | 18-1 | 23-10 | 26-0 |
| | Douglas Fir-Larch #2 | 11-3 | 17-8 | 23-0 | 26-0 |
| | Douglas Fir-Larch #3 | 9-5 | 13-9 | 17-5 | 21-3 |
| | Hem-Fir SS | 11-3 | 17-8 | 23-4 | 26-0 |
| | Hem-Fir #1 | 11-0 | 17-4 | 22-10 | 26-0 |
| | Hem-Fir #2 | 10-6 | 16-6 | 21-9 | 26-0 |
| | Hem-Fir #3 | 9-5 | 13-9 | 17-5 | 21-3 |
| | Southern Pine SS | 11-9 | 18-5 | 24-3 | 26-0 |
| | Southern Pine #1 | 11-6 | 18-1 | 23-1 | 26-0 |
| | Southern Pine #2 | 11-3 | 17-8 | 23-4 | 26-0 |
| | Southern Pine #3 | 10-0 | 14-9 | 18-9 | 22-2 |
| | Spruce-Pine-Fir SS | 11-0 | 17-4 | 22-10 | 26-0 |
| | Spruce-Pine-Fir #1 | 10-9 | 16-11 | 22-4 | 26-0 |
| | Spruce-Pine-Fir #2 | 10-9 | 16-11 | 22-4 | 26-0 |
| | Spruce-Pine-Fir #3 | 9-5 | 13-9 | 17-5 | 21-3 |

(continued)

**TABLE 2308.10.2(1)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics Without Storage, Live Load = 10 pounds psf, $L/\Delta = 240$)**

| CEILING JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 5 pounds per square foot | | | |
|-----------------------------------|----------------------|--------------------------------------|-------|-------|--------|
| | | 2 × 4 | 2 × 6 | 2 × 8 | 2 × 10 |
| | | Maximum ceiling joist spans | | | |
| 19.2 | Douglas Fir-Larch SS | 11-3 | 17-8 | 23-3 | 26-0 |
| | Douglas Fir-Larch #1 | 10-10 | 17-0 | 22-5 | 26-0 |
| | Douglas Fir-Larch #2 | 10-7 | 16-7 | 21-0 | 25-8 |
| | Douglas Fir-Larch #3 | 8-7 | 12-6 | 15-10 | 19-5 |
| | Hem-Fir SS | 10-7 | 16-8 | 21-11 | 26-0 |
| | Hem-Fir #1 | 10-4 | 16-4 | 21-6 | 26-0 |
| | Hem-Fir #2 | 9-11 | 15-7 | 20-6 | 25-3 |
| | Hem-Fir #3 | 8-7 | 12-6 | 15-10 | 19-5 |
| | Southern Pine SS | 11-0 | 17-4 | 22-10 | 26-0 |
| | Southern Pine #1 | 10-10 | 17-0 | 22-5 | 26-0 |
| | Southern Pine #2 | 10-7 | 16-8 | 21-11 | 26-0 |
| | Southern Pine #3 | 9-1 | 13-6 | 17-2 | 20-3 |
| | Spruce-Pine-Fir SS | 10-4 | 16-4 | 21-6 | 26-0 |
| | Spruce-Pine-Fir #1 | 10-2 | 15-11 | 21-0 | 25-8 |
| | Spruce-Pine-Fir #2 | 10-2 | 15-11 | 21-0 | 25-8 |
| | Spruce-Pine-Fir #3 | 8-7 | 12-6 | 15-10 | 19-5 |
| 24 | Douglas Fir-Larch SS | 10-5 | 16-4 | 21-7 | 26-0 |
| | Douglas Fir-Larch #1 | 10-0 | 15-9 | 20-1 | 24-6 |
| | Douglas Fir-Larch #2 | 9-10 | 14-10 | 18-9 | 22-11 |
| | Douglas Fir-Larch #3 | 7-8 | 11-2 | 14-2 | 17-4 |
| | Hem-Fir SS | 9-10 | 15-6 | 20-5 | 26-0 |
| | Hem-Fir #1 | 9-8 | 15-2 | 19-7 | 23-11 |
| | Hem-Fir #2 | 9-2 | 14-5 | 18-6 | 22-7 |
| | Hem-Fir #3 | 7-8 | 11-2 | 14-2 | 17-4 |
| | Southern Pine SS | 10-3 | 16-1 | 21-2 | 26-0 |
| | Southern Pine #1 | 10-0 | 15-9 | 20-10 | 26-0 |
| | Southern Pine #2 | 9-10 | 15-6 | 20-1 | 23-11 |
| | Southern Pine #3 | 8-2 | 12-0 | 15-4 | 18-1 |
| | Spruce-Pine-Fir SS | 9-8 | 15-2 | 19-11 | 25-5 |
| | Spruce-Pine-Fir #1 | 9-5 | 14-9 | 18-9 | 22-11 |
| | Spruce-Pine-Fir #2 | 9-5 | 14-9 | 18-9 | 22-11 |
| | Spruce-Pine-Fir #3 | 7-8 | 11-2 | 14-2 | 17-4 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m².

TABLE 2308.10.2(2)
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics With Limited Storage, Live Load = 20 pounds per square foot, $L/\Delta = 240$)

| CEILING JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | |
|-----------------------------------|----------------------|---------------------------------------|-------|-------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 |
| | | Maximum ceiling joist spans | | | |
| 12 | Douglas Fir-Larch SS | 10-5 | 16-4 | 21-7 | 26-0 |
| | Douglas Fir-Larch #1 | 10-0 | 15-9 | 20-1 | 24-6 |
| | Douglas Fir-Larch #2 | 9-10 | 14-10 | 18-9 | 22-11 |
| | Douglas Fir-Larch #3 | 7-8 | 11-2 | 14-2 | 17-4 |
| | Hem-Fir SS | 9-10 | 15-6 | 20-5 | 26-0 |
| | Hem-Fir #1 | 9-8 | 15-2 | 19-7 | 23-11 |
| | Hem-Fir #2 | 9-2 | 14-5 | 18-6 | 22-7 |
| | Hem-Fir #3 | 7-8 | 11-2 | 14-2 | 17-4 |
| | Southern Pine SS | 10-3 | 16-1 | 21-2 | 26-0 |
| | Southern Pine #1 | 10-0 | 15-9 | 20-10 | 26-0 |
| | Southern Pine #2 | 9-10 | 15-6 | 20-1 | 23-11 |
| | Southern Pine #3 | 8-2 | 12-0 | 15-4 | 18-1 |
| | Spruce-Pine-Fir SS | 9-8 | 15-2 | 19-11 | 25-5 |
| | Spruce-Pine-Fir #1 | 9-5 | 14-9 | 18-9 | 22-11 |
| | Spruce-Pine-Fir #2 | 9-5 | 14-9 | 18-9 | 22-11 |
| | Spruce-Pine-Fir #3 | 7-8 | 11-2 | 14-2 | 17-4 |
| 16 | Douglas Fir-Larch SS | 9-6 | 14-11 | 19-7 | 25-0 |
| | Douglas Fir-Larch #1 | 9-1 | 13-9 | 17-5 | 21-3 |
| | Douglas Fir-Larch #2 | 8-9 | 12-10 | 16-3 | 19-10 |
| | Douglas Fir-Larch #3 | 6-8 | 9-8 | 12-4 | 15-0 |
| | Hem-Fir SS | 8-11 | 14-1 | 18-6 | 23-8 |
| | Hem-Fir #1 | 8-9 | 13-5 | 16-10 | 20-8 |
| | Hem-Fir #2 | 8-4 | 12-8 | 16-0 | 19-7 |
| | Hem-Fir #3 | 6-8 | 9-8 | 12-4 | 15-0 |
| | Southern Pine SS | 9-4 | 14-7 | 19-3 | 24-7 |
| | Southern Pine #1 | 9-1 | 14-4 | 18-11 | 23-1 |
| | Southern Pine #2 | 8-11 | 13-6 | 17-5 | 20-9 |
| | Southern Pine #3 | 7-1 | 10-5 | 13-3 | 15-8 |
| | Spruce-Pine-Fir SS | 8-9 | 13-9 | 18-1 | 23-1 |
| | Spruce-Pine-Fir #1 | 8-7 | 12-10 | 16-3 | 19-10 |
| | Spruce-Pine-Fir #2 | 8-7 | 12-10 | 16-3 | 19-10 |
| | Spruce-Pine-Fir #3 | 6-8 | 9-8 | 12-4 | 15-0 |

(continued)

TABLE 2308.10.2(2)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
 (Uninhabitable Attics With Limited Storage, Live Load = 20 pounds per square foot, $L/\Delta = 240$)

| CEILING JOIST SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | |
|-----------------------------------|----------------------|---------------------------------------|-------|-------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 |
| | | Maximum ceiling joist spans | | | |
| 19.2 | Douglas Fir-Larch SS | 8-11 | 14-0 | 18-5 | 23-4 |
| | Douglas Fir-Larch #1 | 8-7 | 12-6 | 15-10 | 19-5 |
| | Douglas Fir-Larch #2 | 8-0 | 11-9 | 14-10 | 18-2 |
| | Douglas Fir-Larch #3 | 6-1 | 8-10 | 11-3 | 13-8 |
| | Hem-Fir SS | 8-5 | 13-3 | 17-5 | 22-3 |
| | Hem-Fir #1 | 8-3 | 12-3 | 15-6 | 18-11 |
| | Hem-Fir #2 | 7-10 | 11-7 | 14-8 | 17-10 |
| | Hem-Fir #3 | 6-1 | 8-10 | 11-3 | 13-8 |
| | Southern Pine SS | 8-9 | 13-9 | 18-1 | 23-1 |
| | Southern Pine #1 | 8-7 | 13-6 | 17-9 | 21-1 |
| | Southern Pine #2 | 8-5 | 12-3 | 15-10 | 18-11 |
| | Southern Pine #3 | 6-5 | 9-6 | 12-1 | 14-4 |
| | Spruce-Pine-Fir SS | 8-3 | 12-11 | 17-1 | 21-8 |
| | Spruce-Pine-Fir #1 | 8-0 | 11-9 | 14-10 | 18-2 |
| | Spruce-Pine-Fir #2 | 8-0 | 11-9 | 14-10 | 18-2 |
| | Spruce-Pine-Fir #3 | 6-1 | 8-10 | 11-3 | 13-8 |
| 24 | Douglas Fir-Larch SS | 8-3 | 13-0 | 17-1 | 20-11 |
| | Douglas Fir-Larch #1 | 7-8 | 11-2 | 14-2 | 17-4 |
| | Douglas Fir-Larch #2 | 7-2 | 10-6 | 13-3 | 16-3 |
| | Douglas Fir-Larch #3 | 5-5 | 7-11 | 10-0 | 12-3 |
| | Hem-Fir SS | 7-10 | 12-3 | 16-2 | 20-6 |
| | Hem-Fir #1 | 7-6 | 10-11 | 13-10 | 16-11 |
| | Hem-Fir #2 | 7-1 | 10-4 | 13-1 | 16-0 |
| | Hem-Fir #3 | 5-5 | 7-11 | 10-0 | 12-3 |
| | Southern Pine SS | 8-1 | 12-9 | 16-10 | 21-6 |
| | Southern Pine #1 | 8-0 | 12-6 | 15-10 | 18-10 |
| | Southern Pine #2 | 7-8 | 11-0 | 14-2 | 16-11 |
| | Southern Pine #3 | 5-9 | 8-6 | 10-10 | 12-10 |
| | Spruce-Pine-Fir SS | 7-8 | 12-0 | 15-10 | 19-5 |
| | Spruce-Pine-Fir #1 | 7-2 | 10-6 | 13-3 | 16-3 |
| | Spruce-Pine-Fir #2 | 7-2 | 10-6 | 13-3 | 16-3 |
| | Spruce-Pine-Fir #3 | 5-5 | 7-11 | 10-0 | 12-3 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m².

TABLE 2308.10.3(1)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)

| RAFTER SPACING (Inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 12 | Douglas Fir-Larch SS | 11-6 | 18-0 | 23-9 | 26-0 | 26-0 | 11-6 | 18-0 | 23-5 | 26-0 | 26-0 |
| | Douglas Fir-Larch #1 | 11-1 | 17-4 | 22-5 | 26-0 | 26-0 | 10-6 | 15-4 | 19-5 | 23-9 | 26-0 |
| | Douglas Fir-Larch #2 | 10-10 | 16-7 | 21-0 | 25-8 | 26-0 | 9-10 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Douglas Fir-Larch #3 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| | Hem-Fir SS | 10-10 | 17-0 | 22-5 | 26-0 | 26-0 | 10-10 | 17-0 | 22-5 | 26-0 | 26-0 |
| | Hem-Fir #1 | 10-7 | 16-8 | 21-10 | 26-0 | 26-0 | 10-3 | 14-11 | 18-11 | 23-2 | 26-0 |
| | Hem-Fir #2 | 10-1 | 15-11 | 20-8 | 25-3 | 26-0 | 9-8 | 14-2 | 17-11 | 21-11 | 25-5 |
| | Hem-Fir #3 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| | Southern Pine SS | 11-3 | 17-8 | 23-4 | 26-0 | 26-0 | 11-3 | 17-8 | 23-4 | 26-0 | 26-0 |
| | Southern Pine #1 | 11-1 | 17-4 | 22-11 | 26-0 | 26-0 | 11-1 | 17-3 | 21-9 | 25-10 | 26-0 |
| | Southern Pine #2 | 10-10 | 17-0 | 22-5 | 26-0 | 26-0 | 10-6 | 15-1 | 19-5 | 23-2 | 26-0 |
| | Southern Pine #3 | 9-1 | 13-6 | 17-2 | 20-3 | 24-1 | 7-11 | 11-8 | 14-10 | 17-6 | 20-11 |
| | Spruce-Pine-Fir SS | 10-7 | 16-8 | 21-11 | 26-0 | 26-0 | 10-7 | 16-8 | 21-9 | 26-0 | 26-0 |
| | Spruce-Pine-Fir #1 | 10-4 | 16-3 | 21-0 | 25-8 | 26-0 | 9-10 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Spruce-Pine-Fir #2 | 10-4 | 16-3 | 21-0 | 25-8 | 26-0 | 9-10 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Spruce-Pine-Fir #3 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| 16 | Douglas Fir-Larch SS | 10-5 | 16-4 | 21-7 | 26-0 | 26-0 | 10-5 | 16-0 | 20-3 | 24-9 | 26-0 |
| | Douglas Fir-Larch #1 | 10-0 | 15-4 | 19-5 | 23-9 | 26-0 | 9-1 | 13-3 | 16-10 | 20-7 | 23-10 |
| | Douglas Fir-Larch #2 | 9-10 | 14-4 | 18-2 | 22-3 | 25-9 | 8-6 | 12-5 | 15-9 | 19-3 | 22-4 |
| | Douglas Fir-Larch #3 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |
| | Hem-Fir SS | 9-10 | 15-6 | 20-5 | 26-0 | 26-0 | 9-10 | 15-6 | 19-11 | 24-4 | 26-0 |
| | Hem-Fir #1 | 9-8 | 14-11 | 18-11 | 23-2 | 26-0 | 8-10 | 12-11 | 16-5 | 20-0 | 23-3 |
| | Hem-Fir #2 | 9-2 | 14-2 | 17-11 | 21-11 | 25-5 | 8-5 | 12-3 | 15-6 | 18-11 | 22-0 |
| | Hem-Fir #3 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |
| | Southern Pine SS | 10-3 | 16-1 | 21-2 | 26-0 | 26-0 | 10-3 | 16-1 | 21-2 | 26-0 | 26-0 |
| | Southern Pine #1 | 10-0 | 15-9 | 20-10 | 25-10 | 26-0 | 10-0 | 15-0 | 18-10 | 22-4 | 26-0 |
| | Southern Pine #2 | 9-10 | 15-1 | 19-5 | 23-2 | 26-0 | 9-1 | 13-0 | 16-10 | 20-1 | 23-7 |
| | Southern Pine #3 | 7-11 | 11-8 | 14-10 | 17-6 | 20-11 | 6-10 | 10-1 | 12-10 | 15-2 | 18-1 |
| | Spruce-Pine-Fir SS | 9-8 | 15-2 | 19-11 | 25-5 | 26-0 | 9-8 | 14-10 | 18-10 | 23-0 | 26-0 |
| | Spruce-Pine-Fir #1 | 9-5 | 14-4 | 18-2 | 22-3 | 25-9 | 8-6 | 12-5 | 15-9 | 19-3 | 22-4 |
| | Spruce-Pine-Fir #2 | 9-5 | 14-4 | 18-2 | 22-3 | 25-9 | 8-6 | 12-5 | 15-9 | 19-3 | 22-4 |
| | Spruce-Pine-Fir #3 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |

(continued)

**TABLE 2308.10.3(1)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)**

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 19.2 | Douglas Fir-Larch SS | 9-10 | 15-5 | 20-4 | 25-11 | 26-0 | 9-10 | 14-7 | 18-6 | 22-7 | 26-0 |
| | Douglas Fir-Larch #1 | 9-5 | 14-0 | 17-9 | 21-8 | 25-2 | 8-4 | 12-2 | 15-4 | 18-9 | 21-9 |
| | Douglas Fir-Larch #2 | 8-11 | 13-1 | 16-7 | 20-3 | 23-6 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 |
| | Douglas Fir-Larch #3 | 6-9 | 9-11 | 12-7 | 15-4 | 17-9 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Hem-Fir SS | 9-3 | 14-7 | 19-2 | 24-6 | 26-0 | 9-3 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Hem-Fir #1 | 9-1 | 13-8 | 17-4 | 21-1 | 24-6 | 8-1 | 11-10 | 15-0 | 18-4 | 21-3 |
| | Hem-Fir #2 | 8-8 | 12-11 | 16-4 | 20-0 | 23-2 | 7-8 | 11-2 | 14-2 | 17-4 | 20-1 |
| | Hem-Fir #3 | 6-9 | 9-11 | 12-7 | 15-4 | 17-9 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Southern Pine SS | 9-8 | 15-2 | 19-11 | 25-5 | 26-0 | 9-8 | 15-2 | 19-11 | 25-5 | 26-0 |
| | Southern Pine #1 | 9-5 | 14-10 | 19-7 | 23-7 | 26-0 | 9-3 | 13-8 | 17-2 | 20-5 | 24-4 |
| | Southern Pine #2 | 9-3 | 13-9 | 17-9 | 21-2 | 24-10 | 8-4 | 11-11 | 15-4 | 18-4 | 21-6 |
| | Southern Pine #3 | 7-3 | 10-8 | 13-7 | 16-0 | 19-1 | 6-3 | 9-3 | 11-9 | 13-10 | 16-6 |
| | Spruce-Pine-Fir SS | 9-1 | 14-3 | 18-9 | 23-11 | 26-0 | 9-1 | 13-7 | 17-2 | 21-0 | 24-4 |
| | Spruce-Pine-Fir #1 | 8-10 | 13-1 | 16-7 | 20-3 | 23-6 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 |
| | Spruce-Pine-Fir #2 | 8-10 | 13-1 | 16-7 | 20-3 | 23-6 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 |
| | Spruce-Pine-Fir #3 | 6-9 | 9-11 | 12-7 | 15-4 | 17-9 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| 24 | Douglas Fir-Larch SS | 9-1 | 14-4 | 18-10 | 23-4 | 26-0 | 8-11 | 13-1 | 16-7 | 20-3 | 23-5 |
| | Douglas Fir-Larch #1 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| | Douglas Fir-Larch #2 | 8-0 | 11-9 | 14-10 | 18-2 | 21-0 | 6-11 | 10-2 | 12-10 | 15-8 | 18-3 |
| | Douglas Fir-Larch #3 | 6-1 | 8-10 | 11-3 | 13-8 | 15-11 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |
| | Hem-Fir SS | 8-7 | 13-6 | 17-10 | 22-9 | 26-0 | 8-7 | 12-10 | 16-3 | 19-10 | 23-0 |
| | Hem-Fir #1 | 8-4 | 12-3 | 15-6 | 18-11 | 21-11 | 7-3 | 10-7 | 13-5 | 16-4 | 19-0 |
| | Hem-Fir #2 | 7-11 | 11-7 | 14-8 | 17-10 | 20-9 | 6-10 | 10-0 | 12-8 | 15-6 | 17-11 |
| | Hem-Fir #3 | 6-1 | 8-10 | 11-3 | 13-8 | 15-11 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |
| | Southern Pine SS | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 | 8-11 | 14-1 | 18-6 | 22-11 | 26-0 |
| | Southern Pine #1 | 8-9 | 13-9 | 17-9 | 21-1 | 25-2 | 8-3 | 12-3 | 15-4 | 18-3 | 21-9 |
| | Southern Pine #2 | 8-7 | 12-3 | 15-10 | 18-11 | 22-2 | 7-5 | 10-8 | 13-9 | 16-5 | 19-3 |
| | Southern Pine #3 | 6-5 | 9-6 | 12-1 | 14-4 | 17-1 | 5-7 | 8-3 | 10-6 | 12-5 | 14-9 |
| | Spruce-Pine-Fir SS | 8-5 | 13-3 | 17-5 | 21-8 | 25-2 | 8-4 | 12-2 | 15-4 | 18-9 | 21-9 |
| | Spruce-Pine-Fir #1 | 8-0 | 11-9 | 14-10 | 18-2 | 21-0 | 6-11 | 10-2 | 12-10 | 15-8 | 18-3 |
| | Spruce-Pine-Fir #2 | 8-0 | 11-9 | 14-10 | 18-2 | 21-0 | 6-11 | 10-2 | 12-10 | 15-8 | 18-3 |
| | Spruce-Pine-Fir #3 | 6-1 | 8-10 | 11-3 | 13-8 | 15-11 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m².

TABLE 2308.10.3(2)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Attached to Rafters, $L/\Delta = 240$)

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 12 | Douglas Fir-Larch SS | 10-5 | 16-4 | 21-7 | 26-0 | 26-0 | 10-5 | 16-4 | 21-7 | 26-0 | 26-0 |
| | Douglas Fir-Larch #1 | 10-0 | 15-9 | 20-10 | 26-0 | 26-0 | 10-0 | 15-4 | 19-5 | 23-9 | 26-0 |
| | Douglas Fir-Larch #2 | 9-10 | 15-6 | 20-5 | 25-8 | 26-0 | 9-10 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Douglas Fir-Larch #3 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| | Hem-Fir SS | 9-10 | 15-6 | 20-5 | 26-0 | 26-0 | 9-10 | 15-6 | 20-5 | 26-0 | 26-0 |
| | Hem-Fir #1 | 9-8 | 15-2 | 19-11 | 25-5 | 26-0 | 9-8 | 14-11 | 18-11 | 23-2 | 26-0 |
| | Hem-Fir #2 | 9-2 | 14-5 | 19-0 | 24-3 | 26-0 | 9-2 | 14-2 | 17-11 | 21-11 | 25-5 |
| | Hem-Fir #3 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| | Southern Pine SS | 10-3 | 16-1 | 21-2 | 26-0 | 26-0 | 10-3 | 16-1 | 21-2 | 26-0 | 26-0 |
| | Southern Pine #1 | 10-0 | 15-9 | 20-10 | 26-0 | 26-0 | 10-0 | 15-9 | 20-10 | 25-10 | 26-0 |
| | Southern Pine #2 | 9-10 | 15-6 | 20-5 | 26-0 | 26-0 | 9-10 | 15-1 | 19-5 | 23-2 | 26-0 |
| | Southern Pine #3 | 9-1 | 13-6 | 17-2 | 20-3 | 24-1 | 7-11 | 11-8 | 14-10 | 17-6 | 20-11 |
| | Spruce-Pine-Fir SS | 9-8 | 15-2 | 19-11 | 25-5 | 26-0 | 9-8 | 15-2 | 19-11 | 25-5 | 26-0 |
| | Spruce-Pine-Fir #1 | 9-5 | 14-9 | 19-6 | 24-10 | 26-0 | 9-5 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Spruce-Pine-Fir #2 | 9-5 | 14-9 | 19-6 | 24-10 | 26-0 | 9-5 | 14-4 | 18-2 | 22-3 | 25-9 |
| | Spruce-Pine-Fir #3 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| 16 | Douglas Fir-Larch SS | 9-6 | 14-11 | 19-7 | 25-0 | 26-0 | 9-6 | 14-11 | 19-7 | 24-9 | 26-0 |
| | Douglas Fir-Larch #1 | 9-1 | 14-4 | 18-11 | 23-9 | 26-0 | 9-1 | 13-3 | 16-10 | 20-7 | 23-10 |
| | Douglas Fir-Larch #2 | 8-11 | 14-1 | 18-2 | 22-3 | 25-9 | 8-6 | 12-5 | 15-9 | 19-3 | 22-4 |
| | Douglas Fir-Larch #3 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |
| | Hem-Fir SS | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 |
| | Hem-Fir #1 | 8-9 | 13-9 | 18-1 | 23-1 | 26-0 | 8-9 | 12-11 | 16-5 | 20-0 | 23-3 |
| | Hem-Fir #2 | 8-4 | 13-1 | 17-3 | 21-11 | 25-5 | 8-4 | 12-3 | 15-6 | 18-11 | 22-0 |
| | Hem-Fir #3 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |
| | Southern Pine SS | 9-4 | 14-7 | 19-3 | 24-7 | 26-0 | 9-4 | 14-7 | 19-3 | 24-7 | 26-0 |
| | Southern Pine #1 | 9-1 | 14-4 | 18-11 | 24-1 | 26-0 | 9-1 | 14-4 | 18-10 | 22-4 | 26-0 |
| | Southern Pine #2 | 8-11 | 14-1 | 18-6 | 23-2 | 26-0 | 8-11 | 13-0 | 16-10 | 20-1 | 23-7 |
| | Southern Pine #3 | 7-11 | 11-8 | 14-10 | 17-6 | 20-11 | 6-10 | 10-1 | 12-10 | 15-2 | 18-1 |
| | Spruce-Pine-Fir SS | 8-9 | 13-9 | 18-1 | 23-1 | 26-0 | 8-9 | 13-9 | 18-1 | 23-0 | 26-0 |
| | Spruce-Pine-Fir #1 | 8-7 | 13-5 | 17-9 | 22-3 | 25-9 | 8-6 | 12-5 | 15-9 | 19-3 | 22-4 |
| | Spruce-Pine-Fir #2 | 8-7 | 13-5 | 17-9 | 22-3 | 25-9 | 8-6 | 12-5 | 15-9 | 19-3 | 22-4 |
| | Spruce-Pine-Fir #3 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |

(continued)

**TABLE 2308.10.3(2)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Attached to Rafters, $L/\Delta = 240$)**

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | | |
|-------------------------------|-------------------|---------------------------------------|-------------|-------------|-------------|-------------|---------------------------------------|-------------|-------------|-------------|--------|-------|
| | | 2 × 4 | 2 × 6 | 2 × 8 | 2 × 10 | 2 × 12 | 2 × 4 | 2 × 6 | 2 × 8 | 2 × 10 | 2 × 12 | |
| | | Maximum rafter spans | | | | | | | | | | |
| (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | (ft. - in.) | | |
| 19.2 | Douglas Fir-Larch | SS | 8-11 | 14-0 | 18-5 | 23-7 | 26-0 | 8-11 | 14-0 | 18-5 | 22-7 | 26-0 |
| | Douglas Fir-Larch | #1 | 8-7 | 13-6 | 17-9 | 21-8 | 25-2 | 8-4 | 12-2 | 15-4 | 18-9 | 21-9 |
| | Douglas Fir-Larch | #2 | 8-5 | 13-1 | 16-7 | 20-3 | 23-6 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 |
| | Douglas Fir-Larch | #3 | 6-9 | 9-11 | 12-7 | 15-4 | 17-9 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Hem-Fir | SS | 8-5 | 13-3 | 17-5 | 22-3 | 26-0 | 8-5 | 13-3 | 17-5 | 22-3 | 25-9 |
| | Hem-Fir | #1 | 8-3 | 12-11 | 17-1 | 21-1 | 24-6 | 8-1 | 11-10 | 15-0 | 18-4 | 21-3 |
| | Hem-Fir | #2 | 7-10 | 12-4 | 16-3 | 20-0 | 23-2 | 7-8 | 11-2 | 14-2 | 17-4 | 20-1 |
| | Hem-Fir | #3 | 6-9 | 9-11 | 12-7 | 15-4 | 17-9 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Southern Pine | SS | 8-9 | 13-9 | 18-1 | 23-1 | 26-0 | 8-9 | 13-9 | 18-1 | 23-1 | 26-0 |
| | Southern Pine | #1 | 8-7 | 13-6 | 17-9 | 22-8 | 26-0 | 8-7 | 13-6 | 17-2 | 20-5 | 24-4 |
| | Southern Pine | #2 | 8-5 | 13-3 | 17-5 | 21-2 | 24-10 | 8-4 | 11-11 | 15-4 | 18-4 | 21-6 |
| | Southern Pine | #3 | 7-3 | 10-8 | 13-7 | 16-0 | 19-1 | 6-3 | 9-3 | 11-9 | 13-10 | 16-6 |
| | Spruce-Pine-Fir | SS | 8-3 | 12-11 | 17-1 | 21-9 | 26-0 | 8-3 | 12-11 | 17-1 | 21-0 | 24-4 |
| | Spruce-Pine-Fir | #1 | 8-1 | 12-8 | 16-7 | 20-3 | 23-6 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 |
| | Spruce-Pine-Fir | #2 | 8-1 | 12-8 | 16-7 | 20-3 | 23-6 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 |
| | Spruce-Pine-Fir | #3 | 6-9 | 9-11 | 12-7 | 15-4 | 17-9 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| 24 | Douglas Fir-Larch | SS | 8-3 | 13-0 | 17-2 | 21-10 | 26-0 | 8-3 | 13-0 | 16-7 | 20-3 | 23-5 |
| | Douglas Fir-Larch | #1 | 8-0 | 12-6 | 15-10 | 19-5 | 22-6 | 7-5 | 10-10 | 13-9 | 16-9 | 19-6 |
| | Douglas Fir-Larch | #2 | 7-10 | 11-9 | 14-10 | 18-2 | 21-0 | 6-11 | 10-2 | 12-10 | 15-8 | 18-3 |
| | Douglas Fir-Larch | #3 | 6-1 | 8-10 | 11-3 | 13-8 | 15-11 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |
| | Hem-Fir | SS | 7-10 | 12-3 | 16-2 | 20-8 | 25-1 | 7-10 | 12-3 | 16-2 | 19-10 | 23-0 |
| | Hem-Fir | #1 | 7-8 | 12-0 | 15-6 | 18-11 | 21-11 | 7-3 | 10-7 | 13-5 | 16-4 | 19-0 |
| | Hem-Fir | #2 | 7-3 | 11-5 | 14-8 | 17-10 | 20-9 | 6-10 | 10-0 | 12-8 | 15-6 | 17-11 |
| | Hem-Fir | #3 | 6-1 | 8-10 | 11-3 | 13-8 | 15-11 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |
| | Southern Pine | SS | 8-1 | 12-9 | 16-10 | 21-6 | 26-0 | 8-1 | 12-9 | 16-10 | 21-6 | 26-0 |
| | Southern Pine | #1 | 8-0 | 12-6 | 16-6 | 21-1 | 25-2 | 8-0 | 12-3 | 15-4 | 18-3 | 21-9 |
| | Southern Pine | #2 | 7-10 | 12-3 | 15-10 | 18-11 | 22-2 | 7-5 | 10-8 | 13-9 | 16-5 | 19-3 |
| | Southern Pine | #3 | 6-5 | 9-6 | 12-1 | 14-4 | 17-1 | 5-7 | 8-3 | 10-6 | 12-5 | 14-9 |
| | Spruce-Pine-Fir | SS | 7-8 | 12-0 | 15-10 | 20-2 | 24-7 | 7-8 | 12-0 | 15-4 | 18-9 | 21-9 |
| | Spruce-Pine-Fir | #1 | 7-6 | 11-9 | 14-10 | 18-2 | 21-0 | 6-11 | 10-2 | 12-10 | 15-8 | 18-3 |
| | Spruce-Pine-Fir | #2 | 7-6 | 11-9 | 14-10 | 18-2 | 21-0 | 6-11 | 10-2 | 12-10 | 15-8 | 18-3 |
| | Spruce-Pine-Fir | #3 | 6-1 | 8-10 | 11-3 | 13-8 | 15-11 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m².



TABLE 2308.10.3(3)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 12 | Douglas Fir-Larch SS | 10-0 | 15-9 | 20-9 | 26-0 | 26-0 | 10-0 | 15-9 | 20-1 | 24-6 | 26-0 |
| | Douglas Fir-Larch #1 | 9-8 | 14-9 | 18-8 | 22-9 | 26-0 | 9-0 | 13-2 | 16-8 | 20-4 | 23-7 |
| | Douglas Fir-Larch #2 | 9-5 | 13-9 | 17-5 | 21-4 | 24-8 | 8-5 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Douglas Fir-Larch #3 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Hem-Fir SS | 9-6 | 14-10 | 19-7 | 25-0 | 26-0 | 9-6 | 14-10 | 19-7 | 24-1 | 26-0 |
| | Hem-Fir #1 | 9-3 | 14-4 | 18-2 | 22-2 | 25-9 | 8-9 | 12-10 | 16-3 | 19-10 | 23-0 |
| | Hem-Fir #2 | 8-10 | 13-7 | 17-2 | 21-0 | 24-4 | 8-4 | 12-2 | 15-4 | 18-9 | 21-9 |
| | Hem-Fir #3 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Southern Pine SS | 9-10 | 15-6 | 20-5 | 26-0 | 26-0 | 9-10 | 15-6 | 20-5 | 26-0 | 26-0 |
| | Southern Pine #1 | 9-8 | 15-2 | 20-0 | 24-9 | 26-0 | 9-8 | 14-10 | 18-8 | 22-2 | 26-0 |
| | Southern Pine #2 | 9-6 | 14-5 | 18-8 | 22-3 | 26-0 | 9-0 | 12-11 | 16-8 | 19-11 | 23-4 |
| | Southern Pine #3 | 7-7 | 11-2 | 14-3 | 16-10 | 20-0 | 6-9 | 10-0 | 12-9 | 15-1 | 17-11 |
| | Spruce-Pine-Fir SS | 9-3 | 14-7 | 19-2 | 24-6 | 26-0 | 9-3 | 14-7 | 18-8 | 22-9 | 26-0 |
| | Spruce-Pine-Fir #1 | 9-1 | 13-9 | 17-5 | 21-4 | 24-8 | 8-5 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Spruce-Pine-Fir #2 | 9-1 | 13-9 | 17-5 | 21-4 | 24-8 | 8-5 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Spruce-Pine-Fir #3 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| 16 | Douglas Fir-Larch SS | 9-1 | 14-4 | 18-10 | 23-9 | 26-0 | 9-1 | 13-9 | 17-5 | 21-3 | 24-8 |
| | Douglas Fir-Larch #1 | 8-9 | 12-9 | 16-2 | 19-9 | 22-10 | 7-10 | 11-5 | 14-5 | 17-8 | 20-5 |
| | Douglas Fir-Larch #2 | 8-2 | 11-11 | 15-1 | 18-5 | 21-5 | 7-3 | 10-8 | 13-6 | 16-6 | 19-2 |
| | Douglas Fir-Larch #3 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 | 5-6 | 8-1 | 10-3 | 12-6 | 14-6 |
| | Hem-Fir SS | 8-7 | 13-6 | 17-10 | 22-9 | 26-0 | 8-7 | 13-6 | 17-1 | 20-10 | 24-2 |
| | Hem-Fir #1 | 8-5 | 12-5 | 15-9 | 19-3 | 22-3 | 7-7 | 11-1 | 14-1 | 17-2 | 19-11 |
| | Hem-Fir #2 | 8-0 | 11-9 | 14-11 | 18-2 | 21-1 | 7-2 | 10-6 | 13-4 | 16-3 | 18-10 |
| | Hem-Fir #3 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 | 5-6 | 8-1 | 10-3 | 12-6 | 14-6 |
| | Southern Pine SS | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 |
| | Southern Pine #1 | 8-9 | 13-9 | 18-1 | 21-5 | 25-7 | 8-8 | 12-10 | 16-2 | 19-2 | 22-10 |
| | Southern Pine #2 | 8-7 | 12-6 | 16-2 | 19-3 | 22-7 | 7-10 | 11-2 | 14-5 | 17-3 | 20-2 |
| | Southern Pine #3 | 6-7 | 9-8 | 12-4 | 14-7 | 17-4 | 5-10 | 8-8 | 11-0 | 13-0 | 15-6 |
| | Spruce-Pine-Fir SS | 8-5 | 13-3 | 17-5 | 22-1 | 25-7 | 8-5 | 12-9 | 16-2 | 19-9 | 22-10 |
| | Spruce-Pine-Fir #1 | 8-2 | 11-11 | 15-1 | 18-5 | 21-5 | 7-3 | 10-8 | 13-6 | 16-6 | 19-2 |
| | Spruce-Pine-Fir #2 | 8-2 | 11-11 | 15-1 | 18-5 | 21-5 | 7-3 | 10-8 | 13-6 | 16-6 | 19-2 |
| | Spruce-Pine-Fir #3 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 | 5-6 | 8-1 | 10-3 | 12-6 | 14-6 |

(continued)

TABLE 2308.10.3(3)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 19.2 | Douglas Fir-Larch SS | 8-7 | 13-6 | 17-9 | 21-8 | 25-2 | 8-7 | 12-6 | 15-10 | 19-5 | 22-6 |
| | Douglas Fir-Larch #1 | 7-11 | 11-8 | 14-9 | 18-0 | 20-11 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Douglas Fir-Larch #2 | 7-5 | 10-11 | 13-9 | 16-10 | 19-6 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 |
| | Douglas Fir-Larch #3 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Hem-Fir SS | 8-1 | 12-9 | 16-9 | 21-4 | 24-8 | 8-1 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Hem-Fir #1 | 7-9 | 11-4 | 14-4 | 17-7 | 20-4 | 6-11 | 10-2 | 12-10 | 15-8 | 18-2 |
| | Hem-Fir #2 | 7-4 | 10-9 | 13-7 | 16-7 | 19-3 | 6-7 | 9-7 | 12-2 | 14-10 | 17-3 |
| | Hem-Fir #3 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Southern Pine SS | 8-5 | 13-3 | 17-5 | 22-3 | 26-0 | 8-5 | 13-3 | 17-5 | 22-0 | 25-9 |
| | Southern Pine #1 | 8-3 | 13-0 | 16-6 | 19-7 | 23-4 | 7-11 | 11-9 | 14-9 | 17-6 | 20-11 |
| | Southern Pine #2 | 7-11 | 11-5 | 14-9 | 17-7 | 20-7 | 7-1 | 10-2 | 13-2 | 15-9 | 18-5 |
| | Southern Pine #3 | 6-0 | 8-10 | 11-3 | 13-4 | 15-10 | 5-4 | 7-11 | 10-1 | 11-11 | 14-2 |
| | Spruce-Pine-Fir SS | 7-11 | 12-5 | 16-5 | 20-2 | 23-4 | 7-11 | 11-8 | 14-9 | 18-0 | 20-11 |
| | Spruce-Pine-Fir #1 | 7-5 | 10-11 | 13-9 | 16-10 | 19-6 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 |
| | Spruce-Pine-Fir #2 | 7-5 | 10-11 | 13-9 | 16-10 | 19-6 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 |
| | Spruce-Pine-Fir #3 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| 24 | Douglas Fir-Larch SS | 7-11 | 12-6 | 15-10 | 19-5 | 22-6 | 7-8 | 11-3 | 14-2 | 17-4 | 20-1 |
| | Douglas Fir-Larch #1 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Douglas Fir-Larch #2 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 5-11 | 8-8 | 11-0 | 13-6 | 15-7 |
| | Douglas Fir-Larch #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-6 | 6-7 | 8-4 | 10-2 | 11-10 |
| | Hem-Fir SS | 7-6 | 11-10 | 15-7 | 19-1 | 22-1 | 7-6 | 11-0 | 13-11 | 17-0 | 19-9 |
| | Hem-Fir #1 | 6-11 | 10-2 | 12-10 | 15-8 | 18-2 | 6-2 | 9-1 | 11-6 | 14-0 | 16-3 |
| | Hem-Fir #2 | 6-7 | 9-7 | 12-2 | 14-10 | 17-3 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Hem-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-6 | 6-7 | 8-4 | 10-2 | 11-10 |
| | Southern Pine SS | 7-10 | 12-3 | 16-2 | 20-8 | 25-1 | 7-10 | 12-3 | 16-2 | 19-8 | 23-0 |
| | Southern Pine #1 | 7-8 | 11-9 | 14-9 | 17-6 | 20-11 | 7-1 | 10-6 | 13-2 | 15-8 | 18-8 |
| | Southern Pine #2 | 7-1 | 10-2 | 13-2 | 15-9 | 18-5 | 6-4 | 9-2 | 11-9 | 14-1 | 16-6 |
| | Southern Pine #3 | 5-4 | 7-11 | 10-1 | 11-11 | 14-2 | 4-9 | 7-1 | 9-0 | 10-8 | 12-8 |
| | Spruce-Pine-Fir SS | 7-4 | 11-7 | 14-9 | 18-0 | 20-11 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Spruce-Pine-Fir #1 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 5-11 | 8-8 | 11-0 | 13-6 | 15-7 |
| | Spruce-Pine-Fir #2 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 5-11 | 8-8 | 11-0 | 13-6 | 15-7 |
| | Spruce-Pine-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-6 | 6-7 | 8-4 | 10-2 | 11-10 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m².

TABLE 2308.10.3(4)
RFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)

| RAFTER SPACING (Inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 12 | Douglas Fir-Larch SS | 8-5 | 13-3 | 17-6 | 22-4 | 26-0 | 8-5 | 13-3 | 17-0 | 20-9 | 24-10 |
| | Douglas Fir-Larch #1 | 8-2 | 12-0 | 15-3 | 18-7 | 21-7 | 7-7 | 11-2 | 14-1 | 17-3 | 20-0 |
| | Douglas Fir-Larch #2 | 7-8 | 11-3 | 14-3 | 17-5 | 20-2 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Douglas Fir-Larch #3 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| | Hem-Fir SS | 8-0 | 12-6 | 16-6 | 21-1 | 25-6 | 8-0 | 12-6 | 16-6 | 20-4 | 23-7 |
| | Hem-Fir #1 | 7-10 | 11-9 | 14-10 | 18-1 | 21-0 | 7-5 | 10-10 | 13-9 | 16-9 | 19-5 |
| | Hem-Fir #2 | 7-5 | 11-1 | 14-0 | 17-2 | 19-11 | 7-0 | 10-3 | 13-0 | 15-10 | 18-5 |
| | Hem-Fir #3 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| | Southern Pine SS | 8-4 | 13-0 | 17-2 | 21-11 | 26-0 | 8-4 | 13-0 | 17-2 | 21-11 | 26-0 |
| | Southern Pine #1 | 8-2 | 12-10 | 16-10 | 20-3 | 24-1 | 8-2 | 12-6 | 15-9 | 18-9 | 22-4 |
| | Southern Pine #2 | 8-0 | 11-9 | 15-3 | 18-2 | 21-3 | 7-7 | 10-11 | 14-1 | 16-10 | 19-9 |
| | Southern Pine #3 | 6-2 | 9-2 | 11-8 | 13-9 | 16-4 | 5-9 | 8-5 | 10-9 | 12-9 | 15-2 |
| | Spruce-Pine-Fir SS | 7-10 | 12-3 | 16-2 | 20-8 | 24-1 | 7-10 | 12-3 | 15-9 | 19-3 | 22-4 |
| | Spruce-Pine-Fir #1 | 7-8 | 11-3 | 14-3 | 17-5 | 20-2 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Spruce-Pine-Fir #2 | 7-8 | 11-3 | 14-3 | 17-5 | 20-2 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Spruce-Pine-Fir #3 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| 16 | Douglas Fir-Larch SS | 7-8 | 12-1 | 15-10 | 19-5 | 22-6 | 7-8 | 11-7 | 14-8 | 17-11 | 20-10 |
| | Douglas Fir-Larch #1 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-7 | 9-8 | 12-2 | 14-11 | 17-3 |
| | Douglas Fir-Larch #2 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 |
| | Douglas Fir-Larch #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-8 | 6-10 | 8-8 | 10-6 | 12-3 |
| | Hem-Fir SS | 7-3 | 11-5 | 15-0 | 19-1 | 22-1 | 7-3 | 11-5 | 14-5 | 17-8 | 20-5 |
| | Hem-Fir #1 | 6-11 | 10-2 | 12-10 | 15-8 | 18-2 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |
| | Hem-Fir #2 | 6-7 | 9-7 | 12-2 | 14-10 | 17-3 | 6-1 | 8-11 | 11-3 | 13-9 | 15-11 |
| | Hem-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-8 | 6-10 | 8-8 | 10-6 | 12-3 |
| | Southern Pine SS | 7-6 | 11-10 | 15-7 | 19-11 | 24-3 | 7-6 | 11-10 | 15-7 | 19-11 | 23-10 |
| | Southern Pine #1 | 7-5 | 11-7 | 14-9 | 17-6 | 20-11 | 7-4 | 10-10 | 13-8 | 16-2 | 19-4 |
| | Southern Pine #2 | 7-1 | 10-2 | 13-2 | 15-9 | 18-5 | 6-7 | 9-5 | 12-2 | 14-7 | 17-1 |
| | Southern Pine #3 | 5-4 | 7-11 | 10-1 | 11-11 | 14-2 | 4-11 | 7-4 | 9-4 | 11-0 | 13-1 |
| | Spruce-Pine-Fir SS | 7-1 | 11-2 | 14-8 | 18-0 | 20-11 | 7-1 | 10-9 | 13-8 | 16-8 | 19-4 |
| | Spruce-Pine-Fir #1 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 |
| | Spruce-Pine-Fir #2 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 |
| | Spruce-Pine-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-8 | 6-10 | 8-8 | 10-6 | 12-3 |

(continued)

TABLE 2308.10.3(4)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)

| RAFTER SPACING (Inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 19.2 | Douglas Fir-Larch SS | 7-3 | 11-4 | 14-6 | 17-8 | 20-6 | 7-3 | 10-7 | 13-5 | 16-5 | 19-0 |
| | Douglas Fir-Larch #1 | 6-6 | 9-6 | 12-0 | 14-8 | 17-1 | 6-0 | 8-10 | 11-2 | 13-7 | 15-9 |
| | Douglas Fir-Larch #2 | 6-1 | 8-11 | 11-3 | 13-9 | 15-11 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 |
| | Douglas Fir-Larch #3 | 4-7 | 6-9 | 8-6 | 10-5 | 12-1 | 4-3 | 6-3 | 7-11 | 9-7 | 11-2 |
| | Hem-Fir SS | 6-10 | 10-9 | 14-2 | 17-5 | 20-2 | 6-10 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Hem-Fir #1 | 6-4 | 9-3 | 11-9 | 14-4 | 16-7 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Hem-Fir #2 | 6-0 | 8-9 | 11-1 | 13-7 | 15-9 | 5-7 | 8-1 | 10-3 | 12-7 | 14-7 |
| | Hem-Fir #3 | 4-7 | 6-9 | 8-6 | 10-5 | 12-1 | 4-3 | 6-3 | 7-11 | 9-7 | 11-2 |
| | Southern Pine SS | 7-1 | 11-2 | 14-8 | 18-9 | 22-10 | 7-1 | 11-2 | 14-8 | 18-7 | 21-9 |
| | Southern Pine #1 | 7-0 | 10-8 | 13-5 | 16-0 | 19-1 | 6-8 | 9-11 | 12-5 | 14-10 | 17-8 |
| | Southern Pine #2 | 6-6 | 9-4 | 12-0 | 14-4 | 16-10 | 6-0 | 8-8 | 11-2 | 13-4 | 15-7 |
| | Southern Pine #3 | 4-11 | 7-3 | 9-2 | 10-10 | 12-11 | 4-6 | 6-8 | 8-6 | 10-1 | 12-0 |
| | Spruce-Pine-Fir SS | 6-8 | 10-6 | 13-5 | 16-5 | 19-1 | 6-8 | 9-10 | 12-5 | 15-3 | 17-8 |
| | Spruce-Pine-Fir #1 | 6-1 | 8-11 | 11-3 | 13-9 | 15-11 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 |
| | Spruce-Pine-Fir #2 | 6-1 | 8-11 | 11-3 | 13-9 | 15-11 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 |
| | Spruce-Pine-Fir #3 | 4-7 | 6-9 | 8-6 | 10-5 | 12-1 | 4-3 | 6-3 | 7-11 | 9-7 | 11-2 |
| 24 | Douglas Fir-Larch SS | 6-8 | 10-3 | 13-0 | 15-10 | 18-4 | 6-6 | 9-6 | 12-0 | 14-8 | 17-0 |
| | Douglas Fir-Larch #1 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| | Douglas Fir-Larch #2 | 5-5 | 7-11 | 10-1 | 12-4 | 14-3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Douglas Fir-Larch #3 | 4-1 | 6-0 | 7-7 | 9-4 | 10-9 | 3-10 | 5-7 | 7-1 | 8-7 | 10-0 |
| | Hem-Fir SS | 6-4 | 9-11 | 12-9 | 15-7 | 18-0 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Hem-Fir #1 | 5-8 | 8-3 | 10-6 | 12-10 | 14-10 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |
| | Hem-Fir #2 | 5-4 | 7-10 | 9-11 | 12-1 | 14-1 | 4-11 | 7-3 | 9-2 | 11-3 | 13-0 |
| | Hem-Fir #3 | 4-1 | 6-0 | 7-7 | 9-4 | 10-9 | 3-10 | 5-7 | 7-1 | 8-7 | 10-0 |
| | Southern Pine SS | 6-7 | 10-4 | 13-8 | 17-5 | 21-0 | 6-7 | 10-4 | 13-8 | 16-7 | 19-5 |
| | Southern Pine #1 | 6-5 | 9-7 | 12-0 | 14-4 | 17-1 | 6-0 | 8-10 | 11-2 | 13-3 | 15-9 |
| | Southern Pine #2 | 5-10 | 8-4 | 10-9 | 12-10 | 15-1 | 5-5 | 7-9 | 10-0 | 11-11 | 13-11 |
| | Southern Pine #3 | 4-4 | 6-5 | 8-3 | 9-9 | 11-7 | 4-1 | 6-0 | 7-7 | 9-0 | 10-8 |
| | Spruce-Pine-Fir SS | 6-2 | 9-6 | 12-0 | 14-8 | 17-1 | 6-0 | 8-10 | 11-2 | 13-7 | 15-9 |
| | Spruce-Pine-Fir #1 | 5-5 | 7-11 | 10-1 | 12-4 | 14-3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Spruce-Pine-Fir #2 | 5-5 | 7-11 | 10-1 | 12-4 | 14-3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Spruce-Pine-Fir #3 | 4-1 | 6-0 | 7-7 | 9-4 | 10-9 | 3-10 | 5-7 | 7-1 | 8-7 | 10-0 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m².



TABLE 2308.10.3(5)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 pounds per square foot, Ceiling Attached to Rafters, $L/\Delta = 240$)

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 12 | Douglas Fir-Larch SS | 9-1 | 14-4 | 18-10 | 24-1 | 26-0 | 9-1 | 14-4 | 18-10 | 24-1 | 26-0 |
| | Douglas Fir-Larch #1 | 8-9 | 13-9 | 18-2 | 22-9 | 26-0 | 8-9 | 13-2 | 16-8 | 20-4 | 23-7 |
| | Douglas Fir-Larch #2 | 8-7 | 13-6 | 17-5 | 21-4 | 24-8 | 8-5 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Douglas Fir-Larch #3 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Hem-Fir SS | 8-7 | 13-6 | 17-10 | 22-9 | 26-0 | 8-7 | 13-6 | 17-10 | 22-9 | 26-0 |
| | Hem-Fir #1 | 8-5 | 13-3 | 17-5 | 22-2 | 25-9 | 8-5 | 12-10 | 16-3 | 19-10 | 23-0 |
| | Hem-Fir #2 | 8-0 | 12-7 | 16-7 | 21-0 | 24-4 | 8-0 | 12-2 | 15-4 | 18-9 | 21-9 |
| | Hem-Fir #3 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Southern Pine SS | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 | 8-11 | 14-1 | 18-6 | 23-8 | 26-0 |
| | Southern Pine #1 | 8-9 | 13-9 | 18-2 | 23-2 | 26-0 | 8-9 | 13-9 | 18-2 | 22-2 | 26-0 |
| | Southern Pine #2 | 8-7 | 13-6 | 17-10 | 22-3 | 26-0 | 8-7 | 12-11 | 16-8 | 19-11 | 23-4 |
| | Southern Pine #3 | 7-7 | 11-2 | 14-3 | 16-10 | 20-0 | 6-9 | 10-0 | 12-9 | 15-1 | 17-11 |
| | Spruce-Pine-Fir SS | 8-5 | 13-3 | 17-5 | 22-3 | 26-0 | 8-5 | 13-3 | 17-5 | 22-3 | 26-0 |
| | Spruce-Pine-Fir #1 | 8-3 | 12-11 | 17-0 | 21-4 | 24-8 | 8-3 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Spruce-Pine-Fir #2 | 8-3 | 12-11 | 17-0 | 21-4 | 24-8 | 8-3 | 12-4 | 15-7 | 19-1 | 22-1 |
| | Spruce-Pine-Fir #3 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| 16 | Douglas Fir-Larch SS | 8-3 | 13-0 | 17-2 | 21-10 | 26-0 | 8-3 | 13-0 | 17-2 | 21-3 | 24-8 |
| | Douglas Fir-Larch #1 | 8-0 | 12-6 | 16-2 | 19-9 | 22-10 | 7-10 | 11-5 | 14-5 | 17-8 | 20-5 |
| | Douglas Fir-Larch #2 | 7-10 | 11-11 | 15-1 | 18-5 | 21-5 | 7-3 | 10-8 | 13-6 | 16-6 | 19-2 |
| | Douglas Fir-Larch #3 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 | 5-6 | 8-1 | 10-3 | 12-6 | 14-6 |
| | Hem-Fir SS | 7-10 | 12-3 | 16-2 | 20-8 | 25-1 | 7-10 | 12-3 | 16-2 | 20-8 | 24-2 |
| | Hem-Fir #1 | 7-8 | 12-0 | 15-9 | 19-3 | 22-3 | 7-7 | 11-1 | 14-1 | 17-2 | 19-11 |
| | Hem-Fir #2 | 7-3 | 11-5 | 14-11 | 18-2 | 21-1 | 7-2 | 10-6 | 13-4 | 16-3 | 18-10 |
| | Hem-Fir #3 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 | 5-6 | 8-1 | 10-3 | 12-6 | 14-6 |
| | Southern Pine SS | 8-1 | 12-9 | 16-10 | 21-6 | 26-0 | 8-1 | 12-9 | 16-10 | 21-6 | 26-0 |
| | Southern Pine #1 | 8-0 | 12-6 | 16-6 | 21-1 | 25-7 | 8-0 | 12-6 | 16-2 | 19-2 | 22-10 |
| | Southern Pine #2 | 7-10 | 12-3 | 16-2 | 19-3 | 22-7 | 7-10 | 11-2 | 14-5 | 17-3 | 20-2 |
| | Southern Pine #3 | 6-7 | 9-8 | 12-4 | 14-7 | 17-4 | 5-10 | 8-8 | 11-0 | 13-0 | 15-6 |
| | Spruce-Pine-Fir SS | 7-8 | 12-0 | 15-10 | 20-2 | 24-7 | 7-8 | 12-0 | 15-10 | 19-9 | 22-10 |
| | Spruce-Pine-Fir #1 | 7-6 | 11-9 | 15-1 | 18-5 | 21-5 | 7-3 | 10-8 | 13-6 | 16-6 | 19-2 |
| | Spruce-Pine-Fir #2 | 7-6 | 11-9 | 15-1 | 18-5 | 21-5 | 7-3 | 10-8 | 13-6 | 16-6 | 19-2 |
| | Spruce-Pine-Fir #3 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 | 5-6 | 8-1 | 10-3 | 12-6 | 14-6 |

(continued)

**TABLE 2308.10.3(5)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 pounds per square foot, Ceiling Attached to Rafters, $L/\Delta = 240$)**

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 19.2 | Douglas Fir-Larch SS | 7-9 | 12-3 | 16-1 | 20-7 | 25-0 | 7-9 | 12-3 | 15-10 | 19-5 | 22-6 |
| | Douglas Fir-Larch #1 | 7-6 | 11-8 | 14-9 | 18-0 | 20-11 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Douglas Fir-Larch #2 | 7-4 | 10-11 | 13-9 | 16-10 | 19-6 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 |
| | Douglas Fir-Larch #3 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Hem-Fir SS | 7-4 | 11-7 | 15-3 | 19-5 | 23-7 | 7-4 | 11-7 | 15-3 | 19-1 | 22-1 |
| | Hem-Fir #1 | 7-2 | 11-4 | 14-4 | 17-7 | 20-4 | 6-11 | 10-2 | 12-10 | 15-8 | 18-2 |
| | Hem-Fir #2 | 6-10 | 10-9 | 13-7 | 16-7 | 19-3 | 6-7 | 9-7 | 12-2 | 14-10 | 17-3 |
| | Hem-Fir #3 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Southern Pine SS | 7-8 | 12-0 | 15-10 | 20-2 | 24-7 | 7-8 | 12-0 | 15-10 | 20-2 | 24-7 |
| | Southern Pine #1 | 7-6 | 11-9 | 15-6 | 19-7 | 23-4 | 7-6 | 11-9 | 14-9 | 17-6 | 20-11 |
| | Southern Pine #2 | 7-4 | 11-5 | 14-9 | 17-7 | 20-7 | 7-1 | 10-2 | 13-2 | 15-9 | 18-5 |
| | Southern Pine #3 | 6-0 | 8-10 | 11-3 | 13-4 | 15-10 | 5-4 | 7-11 | 10-1 | 11-11 | 14-2 |
| | Spruce-Pine-Fir SS | 7-2 | 11-4 | 14-11 | 19-0 | 23-1 | 7-2 | 11-4 | 14-9 | 18-0 | 20-11 |
| | Spruce-Pine-Fir #1 | 7-0 | 10-11 | 13-9 | 16-10 | 19-6 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 |
| | Spruce-Pine-Fir #2 | 7-0 | 10-11 | 13-9 | 16-10 | 19-6 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 |
| | Spruce-Pine-Fir #3 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| 24 | Douglas Fir-Larch SS | 7-3 | 11-4 | 15-0 | 19-1 | 22-6 | 7-3 | 11-3 | 14-2 | 17-4 | 20-1 |
| | Douglas Fir-Larch #1 | 7-0 | 10-5 | 13-2 | 16-1 | 18-8 | 6-4 | 9-4 | 11-9 | 14-5 | 16-8 |
| | Douglas Fir-Larch #2 | 6-8 | 9-9 | 12-4 | 15-1 | 17-6 | 5-11 | 8-8 | 11-0 | 13-6 | 15-7 |
| | Douglas Fir-Larch #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-6 | 6-7 | 8-4 | 10-2 | 11-10 |
| | Hem-Fir SS | 6-10 | 10-9 | 14-2 | 18-0 | 21-11 | 6-10 | 10-9 | 13-11 | 17-0 | 19-9 |
| | Hem-Fir #1 | 6-8 | 10-2 | 12-10 | 15-8 | 18-2 | 6-2 | 9-1 | 11-6 | 14-0 | 16-3 |
| | Hem-Fir #2 | 6-4 | 9-7 | 12-2 | 14-10 | 17-3 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Hem-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-6 | 6-7 | 8-4 | 10-2 | 11-10 |
| | Southern Pine SS | 7-1 | 11-2 | 14-8 | 18-9 | 22-10 | 7-1 | 11-2 | 14-8 | 18-9 | 22-10 |
| | Southern Pine #1 | 7-0 | 10-11 | 14-5 | 17-6 | 20-11 | 7-0 | 10-6 | 13-2 | 15-8 | 18-8 |
| | Southern Pine #2 | 6-10 | 10-2 | 13-2 | 15-9 | 18-5 | 6-4 | 9-2 | 11-9 | 14-1 | 16-6 |
| | Southern Pine #3 | 5-4 | 7-11 | 10-1 | 11-11 | 14-2 | 4-9 | 7-1 | 9-0 | 10-8 | 12-8 |
| | Spruce-Pine-Fir SS | 6-8 | 10-6 | 13-10 | 17-8 | 20-11 | 6-8 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Spruce-Pine-Fir #1 | 6-6 | 9-9 | 12-4 | 15-1 | 17-6 | 5-11 | 8-8 | 11-0 | 13-6 | 15-7 |
| | Spruce-Pine-Fir #2 | 6-6 | 9-9 | 12-4 | 15-1 | 17-6 | 5-11 | 8-8 | 11-0 | 13-6 | 15-7 |
| | Spruce-Pine-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-6 | 6-7 | 8-4 | 10-2 | 11-10 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m².

TABLE 2308.10.3(6)
RFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 pounds per square foot, Ceiling Attached to Rafters, $L/\Delta = 240$)

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 12 | Douglas Fir-Larch SS | 7-8 | 12-1 | 15-11 | 20-3 | 24-8 | 7-8 | 12-1 | 15-11 | 20-3 | 24-0 |
| | Douglas Fir-Larch #1 | 7-5 | 11-7 | 15-3 | 18-7 | 21-7 | 7-5 | 11-2 | 14-1 | 17-3 | 20-0 |
| | Douglas Fir-Larch #2 | 7-3 | 11-3 | 14-3 | 17-5 | 20-2 | 7-1 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Douglas Fir-Larch #3 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| | Hem-Fir SS | 7-3 | 11-5 | 15-0 | 19-2 | 23-4 | 7-3 | 11-5 | 15-0 | 19-2 | 23-4 |
| | Hem-Fir #1 | 7-1 | 11-2 | 14-8 | 18-1 | 21-0 | 7-1 | 10-10 | 13-9 | 16-9 | 19-5 |
| | Hem-Fir #2 | 6-9 | 10-8 | 14-0 | 17-2 | 19-11 | 6-9 | 10-3 | 13-0 | 15-10 | 18-5 |
| | Hem-Fir #3 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| | Southern Pine SS | 7-6 | 11-0 | 15-7 | 19-11 | 24-3 | 7-6 | 11-10 | 15-7 | 19-11 | 24-3 |
| | Southern Pine #1 | 7-5 | 11-7 | 15-4 | 19-7 | 23-9 | 7-5 | 11-7 | 15-4 | 18-9 | 22-4 |
| | Southern Pine #2 | 7-3 | 11-5 | 15-0 | 18-2 | 21-3 | 7-3 | 10-11 | 14-1 | 16-10 | 19-9 |
| | Southern Pine #3 | 6-2 | 9-2 | 11-8 | 13-9 | 16-4 | 5-9 | 8-5 | 10-9 | 12-9 | 15-2 |
| | Spruce-Pine-Fir SS | 7-1 | 11-2 | 14-8 | 18-9 | 22-10 | 7-1 | 11-2 | 14-8 | 18-9 | 22-4 |
| | Spruce-Pine-Fir #1 | 6-11 | 10-11 | 14-3 | 17-5 | 20-2 | 6-11 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Spruce-Pine-Fir #2 | 6-11 | 10-11 | 14-3 | 17-5 | 20-2 | 6-11 | 10-5 | 13-2 | 16-1 | 18-8 |
| | Spruce-Pine-Fir #3 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| 16 | Douglas Fir-Larch SS | 7-0 | 11-0 | 14-5 | 18-5 | 22-5 | 7-0 | 11-0 | 14-5 | 17-11 | 20-10 |
| | Douglas Fir-Larch #1 | 6-9 | 10-5 | 13-2 | 16-1 | 18-8 | 6-7 | 9-8 | 12-2 | 14-11 | 17-3 |
| | Douglas Fir-Larch #2 | 6-7 | 9-9 | 12-4 | 15-1 | 17-6 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 |
| | Douglas Fir-Larch #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-8 | 6-10 | 8-8 | 10-6 | 12-3 |
| | Hem-Fir SS | 6-7 | 10-4 | 13-8 | 17-5 | 21-2 | 6-7 | 10-4 | 13-8 | 17-5 | 20-5 |
| | Hem-Fir #1 | 6-5 | 10-2 | 12-10 | 15-8 | 18-2 | 6-5 | 9-5 | 11-11 | 14-6 | 16-10 |
| | Hem-Fir #2 | 6-2 | 9-7 | 12-2 | 14-10 | 17-3 | 6-1 | 8-11 | 11-3 | 13-9 | 15-11 |
| | Hem-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-8 | 6-10 | 8-8 | 10-6 | 12-3 |
| | Southern Pine SS | 6-10 | 10-9 | 14-2 | 18-1 | 22-0 | 6-10 | 10-9 | 14-2 | 18-1 | 22-0 |
| | Southern Pine #1 | 6-9 | 10-7 | 13-11 | 17-6 | 20-11 | 6-9 | 10-7 | 13-8 | 16-2 | 19-4 |
| | Southern Pine #2 | 6-7 | 10-2 | 13-2 | 15-9 | 18-5 | 6-7 | 9-5 | 12-2 | 14-7 | 17-1 |
| | Southern Pine #3 | 5-4 | 7-11 | 10-1 | 11-11 | 14-2 | 4-11 | 7-4 | 9-4 | 11-0 | 13-1 |
| | Spruce-Pine-Fir SS | 6-5 | 10-2 | 13-4 | 17-0 | 20-9 | 6-5 | 10-2 | 13-4 | 16-8 | 19-4 |
| | Spruce-Pine-Fir #1 | 6-4 | 9-9 | 12-4 | 15-1 | 17-6 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 |
| | Spruce-Pine-Fir #2 | 6-4 | 9-9 | 12-4 | 15-1 | 17-6 | 6-2 | 9-0 | 11-5 | 13-11 | 16-2 |
| | Spruce-Pine-Fir #3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 | 4-8 | 6-10 | 8-8 | 10-6 | 12-3 |

(continued)

TABLE 2308.10.3(6)—continued
RFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 pounds per square foot, Ceiling Attached to Rafters, $L/\Delta = 240$)

| RAFTER SPACING (inches) | SPECIES AND GRADE | DEAD LOAD = 10 pounds per square foot | | | | | DEAD LOAD = 20 pounds per square foot | | | | |
|-------------------------------|----------------------|---------------------------------------|-------|-------|--------|--------|---------------------------------------|-------|-------|--------|--------|
| | | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 4 | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 |
| | | Maximum rafter spans | | | | | | | | | |
| 19.2 | Douglas Fir-Larch SS | 6-7 | 10-4 | 13-7 | 17-4 | 20-6 | 6-7 | 10-4 | 13-5 | 16-5 | 19-0 |
| | Douglas Fir-Larch #1 | 6-4 | 9-6 | 12-0 | 14-8 | 17-1 | 6-0 | 8-10 | 11-2 | 13-7 | 15-9 |
| | Douglas Fir-Larch #2 | 6-1 | 8-11 | 11-3 | 13-9 | 15-11 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 |
| | Douglas Fir-Larch #3 | 4-7 | 6-9 | 8-6 | 10-5 | 12-1 | 4-3 | 6-3 | 7-11 | 9-7 | 11-2 |
| | Hem-Fir SS | 6-2 | 9-9 | 12-10 | 16-5 | 19-11 | 6-2 | 9-9 | 12-10 | 16-1 | 18-8 |
| | Hem-Fir #1 | 6-1 | 9-3 | 11-9 | 14-4 | 16-7 | 5-10 | 8-7 | 10-10 | 13-3 | 15-5 |
| | Hem-Fir #2 | 5-9 | 8-9 | 11-1 | 13-7 | 15-9 | 5-7 | 8-1 | 10-3 | 12-7 | 14-7 |
| | Hem-Fir #3 | 4-7 | 6-9 | 8-6 | 10-5 | 12-1 | 4-3 | 6-3 | 7-11 | 9-7 | 11-2 |
| | Southern Pine SS | 6-5 | 10-2 | 13-4 | 17-0 | 20-9 | 6-5 | 10-2 | 13-4 | 17-0 | 20-9 |
| | Southern Pine #1 | 6-4 | 9-11 | 13-1 | 16-0 | 19-1 | 6-4 | 9-11 | 12-5 | 14-10 | 17-8 |
| | Southern Pine #2 | 6-2 | 9-4 | 12-0 | 14-4 | 16-10 | 6-0 | 8-8 | 11-2 | 13-4 | 15-7 |
| | Southern Pine #3 | 4-11 | 7-3 | 9-2 | 10-10 | 12-11 | 4-6 | 6-8 | 8-6 | 10-1 | 12-0 |
| | Spruce-Pine-Fir SS | 6-1 | 9-6 | 12-7 | 16-0 | 19-1 | 6-1 | 9-6 | 12-5 | 15-3 | 17-8 |
| | Spruce-Pine-Fir #1 | 5-11 | 8-11 | 11-3 | 13-9 | 15-11 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 |
| | Spruce-Pine-Fir #2 | 5-11 | 8-11 | 11-3 | 13-9 | 15-11 | 5-7 | 8-3 | 10-5 | 12-9 | 14-9 |
| | Spruce-Pine-Fir #3 | 4-7 | 6-9 | 8-6 | 10-5 | 12-1 | 4-3 | 6-3 | 7-11 | 9-7 | 11-2 |
| 24 | Douglas Fir-Larch SS | 6-1 | 9-7 | 12-7 | 15-10 | 18-4 | 6-1 | 9-6 | 12-0 | 14-8 | 17-0 |
| | Douglas Fir-Larch #1 | 5-10 | 8-6 | 10-9 | 13-2 | 15-3 | 5-5 | 7-10 | 10-0 | 12-2 | 14-1 |
| | Douglas Fir-Larch #2 | 5-5 | 7-11 | 10-1 | 12-4 | 14-3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Douglas Fir-Larch #3 | 4-1 | 6-0 | 7-7 | 9-4 | 10-9 | 3-10 | 5-7 | 7-1 | 8-7 | 10-0 |
| | Hem-Fir SS | 5-9 | 9-1 | 11-11 | 15-12 | 18-0 | 5-9 | 9-1 | 11-9 | 14-5 | 16-8 |
| | Hem-Fir #1 | 5-8 | 8-3 | 10-6 | 12-10 | 14-10 | 5-3 | 7-8 | 9-9 | 11-10 | 13-9 |
| | Hem-Fir #2 | 5-4 | 7-10 | 9-11 | 12-1 | 14-1 | 4-11 | 7-3 | 9-2 | 11-3 | 13-0 |
| | Hem-Fir #3 | 4-1 | 6-0 | 7-7 | 9-4 | 10-9 | 3-10 | 5-7 | 7-1 | 8-7 | 10-0 |
| | Southern Pine SS | 6-0 | 9-5 | 12-5 | 15-10 | 19-3 | 6-0 | 9-5 | 12-5 | 15-10 | 19-3 |
| | Southern Pine #1 | 5-10 | 9-3 | 12-0 | 14-4 | 17-1 | 5-10 | 8-10 | 11-2 | 13-3 | 15-9 |
| | Southern Pine #2 | 5-9 | 8-4 | 10-9 | 12-10 | 15-1 | 5-5 | 7-9 | 10-0 | 11-11 | 13-11 |
| | Southern Pine #3 | 4-4 | 6-5 | 8-3 | 9-9 | 11-7 | 4-1 | 6-0 | 7-7 | 9-0 | 10-8 |
| | Spruce-Pine-Fir SS | 5-8 | 8-10 | 11-8 | 14-8 | 17-1 | 5-8 | 8-10 | 11-2 | 13-7 | 15-9 |
| | Spruce-Pine-Fir #1 | 5-5 | 7-11 | 10-1 | 12-4 | 14-3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Spruce-Pine-Fir #2 | 5-5 | 7-11 | 10-1 | 12-4 | 14-3 | 5-0 | 7-4 | 9-4 | 11-5 | 13-2 |
| | Spruce-Pine-Fir #3 | 4-1 | 6-0 | 7-7 | 9-4 | 10-9 | 3-10 | 5-7 | 7-1 | 8-7 | 10-0 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m².

**TABLE 2308.10.4.1
RAFTER TIE CONNECTIONS^a**

| RAFTER SLOPE | TIE SPACING (inches) | NO SNOW LOAD | | | | GROUND SNOW LOAD (pound per square foot) | | | | | | | |
|--|----------------------|------------------|----|----|----|--|----|----|----|---------------------------|----|----|----|
| | | | | | | 30 pounds per square foot | | | | 50 pounds per square foot | | | |
| | | Roof span (feet) | | | | | | | | | | | |
| | | 12 | 20 | 28 | 36 | 12 | 20 | 28 | 36 | 12 | 20 | 28 | 36 |
| Required number of 16d common ($3\frac{1}{2}'' \times 0.162''$) nails ^{a, b} per connection ^{c, d, e, f} | | | | | | | | | | | | | |
| 3:12 | 12 | 4 | 6 | 8 | 10 | 4 | 6 | 8 | 11 | 5 | 8 | 12 | 15 |
| | 16 | 5 | 7 | 10 | 13 | 5 | 8 | 11 | 14 | 6 | 11 | 15 | 20 |
| | 24 | 7 | 11 | 15 | 19 | 7 | 11 | 16 | 21 | 9 | 16 | 23 | 30 |
| | 32 | 10 | 14 | 19 | 25 | 10 | 16 | 22 | 28 | 12 | 27 | 30 | 40 |
| | 48 | 14 | 21 | 29 | 37 | 14 | 32 | 36 | 42 | 18 | 32 | 46 | 60 |
| 4:12 | 12 | 3 | 4 | 5 | 6 | 3 | 5 | 6 | 8 | 4 | 6 | 9 | 11 |
| | 16 | 3 | 5 | 7 | 8 | 4 | 6 | 8 | 11 | 5 | 8 | 12 | 15 |
| | 24 | 4 | 7 | 10 | 12 | 5 | 9 | 12 | 16 | 7 | 12 | 17 | 22 |
| | 32 | 6 | 9 | 13 | 16 | 8 | 12 | 16 | 22 | 10 | 16 | 24 | 30 |
| | 48 | 8 | 14 | 19 | 24 | 10 | 18 | 24 | 32 | 14 | 24 | 34 | 44 |
| 5:12 | 12 | 3 | 3 | 4 | 5 | 3 | 4 | 5 | 7 | 3 | 5 | 7 | 9 |
| | 16 | 3 | 4 | 5 | 7 | 3 | 5 | 7 | 9 | 4 | 7 | 9 | 12 |
| | 24 | 4 | 6 | 8 | 10 | 4 | 7 | 10 | 13 | 6 | 10 | 14 | 18 |
| | 32 | 5 | 8 | 10 | 13 | 6 | 10 | 14 | 18 | 8 | 14 | 18 | 24 |
| | 48 | 7 | 11 | 15 | 20 | 8 | 14 | 20 | 26 | 12 | 20 | 28 | 36 |
| 7:12 | 12 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 5 | 3 | 4 | 5 | 7 |
| | 16 | 3 | 3 | 4 | 5 | 3 | 4 | 5 | 6 | 3 | 5 | 7 | 9 |
| | 24 | 3 | 4 | 6 | 7 | 3 | 5 | 7 | 9 | 4 | 7 | 10 | 13 |
| | 32 | 4 | 6 | 8 | 10 | 4 | 8 | 10 | 12 | 6 | 10 | 14 | 18 |
| | 48 | 5 | 8 | 11 | 14 | 6 | 10 | 14 | 18 | 9 | 14 | 20 | 26 |
| 9:12 | 12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 5 |
| | 16 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 5 | 3 | 4 | 5 | 7 |
| | 24 | 3 | 3 | 5 | 6 | 3 | 4 | 6 | 7 | 3 | 6 | 8 | 10 |
| | 32 | 3 | 4 | 6 | 8 | 4 | 6 | 8 | 10 | 5 | 8 | 10 | 14 |
| | 48 | 4 | 6 | 9 | 11 | 5 | 8 | 12 | 14 | 7 | 12 | 16 | 20 |
| 12:12 | 12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 |
| | 16 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 5 |
| | 24 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 6 | 3 | 4 | 6 | 8 |
| | 32 | 3 | 3 | 4 | 5 | 3 | 5 | 6 | 8 | 4 | 6 | 8 | 10 |
| | 48 | 3 | 4 | 6 | 7 | 4 | 7 | 8 | 12 | 6 | 8 | 12 | 16 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m².

a. 40d box (5" × 0.162") or 16d sinker (3 $\frac{1}{4}$ " × 0.148") nails are permitted to be substituted for 16d common (3 $\frac{1}{2}$ " × 0.16") nails.

b. Nailing requirements are permitted to be reduced 25 percent if nails are clinched.

c. Rafter tie heel joint connections are not required where the ridge is supported by a load bearing wall, header or ridge beam.

d. When intermediate support of the rafter is provided by vertical struts or purlins to a load bearing wall, the tabulated heel joint connection requirements are permitted to be reduced proportionally to the reduction in span.

e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.

f. Connected members shall be of sufficient size to prevent splitting due to nailing.

g. For snow loads less than 30 pounds per square foot, the required number of nails is permitted to be reduced by multiplying by the ratio of actual snow load plus 10 divided by 40, but not less than the number required for no snow load.

2308.10.4.1 Ceiling joist and rafter connections. Ceiling joists and rafters shall be nailed to each other and the assembly shall be nailed to the top wall plate in accordance with Tables 2304.9.1 and 2308.10.1. Ceiling joists shall be continuous or securely joined where they meet over interior partitions and fastened to adjacent rafters in accordance with Tables 2308.10.4.1 and 2304.9.1 to provide a continuous rafter tie across the building where such joists are parallel to the rafters. Ceiling joists shall have a bearing surface of not less than $1\frac{1}{2}$ inches (38 mm) on the top plate at each end.

Where ceiling joists are not parallel to rafters, an equivalent rafter tie shall be installed in a manner to provide a continuous tie across the building, at a spacing of not more than 4 feet (1219 mm) o.c. The connections shall be in accordance with Tables 2308.10.4.1 and 2304.9.1, or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided at the top of the rafter support walls, the ridge formed by these rafters shall also be supported by a girder conforming to Section 2308.4.

Rafter ties shall be spaced not more than 4 feet (1219 mm) o.c. Rafter tie connections shall be based on the equivalent rafter spacing in Table 2308.10.4.1. Where rafter ties are spaced at 32 inches (813 mm) o.c., the number of 16d common nails shall be two times the number specified for rafters spaced 16 inches (406 mm) o.c., with a minimum of four 16d common nails where no snow loads are indicated. Where rafter ties are spaced at 48 inches (1219 mm) o.c., the number of 16d common nails shall be two times the number specified for rafters spaced 24 inches (610 mm) o.c., with a minimum of six 16d common nails where no snow loads are indicated. Rafter/ceiling joist connections and rafter/tie connections shall be of sufficient size and number to prevent splitting from nailing.

2308.10.4.2 Notches and holes. Notching at the ends of rafters or ceiling joists shall not exceed one-fourth the depth. Notches in the top or bottom of the rafter or ceiling joist shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span, except that a notch not exceeding one-third of the depth is permitted in the top of the rafter or ceiling joist not further from the face of the support than the depth of the member.

Holes bored in rafters or ceiling joists shall not be within 2 inches (51 mm) of the top and bottom and their diameter shall not exceed one-third the depth of the member.

2308.10.4.3 Framing around openings. Trimmer and header rafters shall be doubled, or of lumber of equivalent cross section, where the span of the header exceeds 4 feet (1219 mm). The ends of header rafters more than 6 feet (1829 mm) long shall be supported by framing anchors or rafter hangers unless bearing on a beam, partition or wall.

2308.10.5 Purlins. Purlins to support roof loads are permitted to be installed to reduce the span of rafters within allowable limits and shall be supported by struts to bearing walls. The maximum span of 2-inch by 4-inch (51 mm by 102 mm) purlins shall be 4 feet (1219 mm). The maximum span of the 2-inch by 6-inch (51 mm by 152 mm) purlin shall be 6 feet (1829 mm), but in no case shall the purlin be smaller than the supported rafter. Struts shall not be smaller than 2-inch by 4-inch (51 mm by 102 mm) members. The unbraced length of struts shall not exceed 8 feet (2438 mm) and the minimum slope of the struts shall not be less than 45 degrees (0.79 rad) from the horizontal.

2308.10.6 Blocking. Roof rafters and ceiling joists shall be supported laterally to prevent rotation and lateral displacement in accordance with the provisions of Section 2308.8.5.

2308.10.7 Engineered wood products. Prefabricated wood I-joints, structural glued-laminated timber and structural composite lumber shall not be notched or drilled except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a registered design professional.

2308.10.8 Roof sheathing. Roof sheathing shall be in accordance with Tables 2304.7(3) and 2304.7(5) for wood structural panels, and Tables 2304.7(1) and 2304.7(2) for lumber and shall comply with Section 2304.7.2.

2308.10.8.1 Joints. Joints in lumber sheathing shall occur over supports unless approved end-matched lumber is used, in which case each piece shall bear on at least two supports.

2308.10.9 Roof planking. Planking shall be designed in accordance with the general provisions of this code.

In lieu of such design, 2-inch (51 mm) tongue-and-groove planking is permitted in accordance with Table 2308.10.9. Joints in such planking are permitted to be randomly spaced, provided the system is applied to not less than three continuous spans, planks are center matched and end matched or splined, each plank bears on at least one support, and joints are separated by at least 24 inches (610 mm) in adjacent pieces.

2308.10.10 Wood trusses. Wood trusses shall be designed in accordance with Section 2303.4.

2308.10.11 Attic ventilation. For *attic* ventilation, see Section 1203.2.

2308.11 Additional requirements for conventional construction in Seismic Design Category B or C. Structures of conventional light-frame construction and assigned to Seismic Design Category B or C shall comply with Sections 2308.11.1 through 2308.11.3, in addition to the provisions of Sections 2308.1 through 2308.10.

2308.11.1 Number of stories. Structures of conventional light-frame construction and assigned to Seismic Design Category C shall not exceed two stories above grade plane.

**TABLE 2308.10.9
ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING**

| SPAN ^a (feet) | LIVE LOAD (pound per square foot) | DEFLECTION LIMIT | BENDING STRESS (f) (pound per square inch) | MODULUS OF ELASTICITY (E) (pound per square inch) |
|-----------------------------|--------------------------------------|------------------|---|--|
| Roofs | | | | |
| 4 | 20 | 1/240 1/360 | 160 | 170,000 256,000 |
| | 30 | 1/240 1/360 | 210 | 256,000 384,000 |
| | 40 | 1/240 1/360 | 270 | 340,000 512,000 |
| 4.5 | 20 | 1/240 1/360 | 200 | 242,000 305,000 |
| | 30 | 1/240 1/360 | 270 | 363,000 405,000 |
| | 40 | 1/240 1/360 | 350 | 484,000 725,000 |
| 5.0 | 20 | 1/240 1/360 | 250 | 332,000 500,000 |
| | 30 | 1/240 1/360 | 330 | 495,000 742,000 |
| | 40 | 1/240 1/360 | 420 | 660,000 1,000,000 |
| 5.5 | 20 | 1/240 1/360 | 300 | 442,000 660,000 |
| | 30 | 1/240 1/360 | 400 | 662,000 998,000 |
| | 40 | 1/240 1/360 | 500 | 884,000 1,330,000 |
| 6.0 | 20 | 1/240 1/360 | 360 | 575,000 862,000 |
| | 30 | 1/240 1/360 | 480 | 862,000 1,295,000 |
| | 40 | 1/240 1/360 | 600 | 1,150,000 1,730,000 |

(continued)

2308.11.2 Concrete or masonry. Concrete or masonry walls and stone or masonry veneer shall not extend above a basement.

Exceptions:

1. In structures assigned to Seismic Design Category B, stone and masonry veneer is permitted to be used in the first two stories above grade plane or the first three stories above grade plane where the lowest story has concrete or masonry walls, provided that structural use panel wall bracing is used and the length of bracing provided is one-and one-half times the required length as determined in Table 2308.9.3(1).
2. In structures assigned to Seismic Design Category B or C, stone and masonry veneer is permitted to be used in the first story above grade plane or the first two stories above grade plane where the lowest story has concrete or masonry walls.
3. In structures assigned to Seismic Design Category B or C, stone and masonry veneer is permitted to be used in both stories of buildings with

two stories above grade plane, provided the following criteria are met:

- 3.1. Type of brace per Section 2308.9.3 shall be Method 3 and the allowable shear capacity in accordance with Section 2306.3 shall be a minimum of 350 plf (5108 N/m).
- 3.2. Braced wall panels in the second story shall be located in accordance with Section 2308.9.3 and not more than 25 feet (7620 mm) on center, and the total length of braced wall panels shall be not less than 25 percent of the braced wall line length. Braced wall panels in the first story shall be located in accordance with Section 2308.9.3 and not more than 25 feet (7620 mm) on center, and the total length of braced wall panels shall be not less than 45 percent of the braced wall line length.
- 3.3. Hold-down connectors shall be provided at the ends of each braced wall panel for

**TABLE 2308.10.9—continued
ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING**

| SPAN ^a (feet) | LIVE LOAD (pound per square foot) | DEFLECTION LIMIT | BENDING STRESS (f) (pound per square inch) | MODULUS OF ELASTICITY (E) (pound per square inch) |
|-----------------------------|--------------------------------------|------------------|---|--|
| Roofs | | | | |
| 6.5 | 20 | 1/240 1/360 | 420 | 595,000 892,000 |
| | 30 | 1/240 1/360 | 560 | 892,000 1,340,000 |
| | 40 | 1/240 1/360 | 700 | 1,190,000 1,730,000 |
| 7.0 | 20 | 1/240 1/360 | 490 | 910,000 1,360,000 |
| | 30 | 1/240 1/360 | 650 | 1,370,000 2,000,000 |
| | 40 | 1/240 1/360 | 810 | 1,820,000 2,725,000 |
| 7.5 | 20 | 1/240 1/360 | 560 | 1,125,000 1,685,000 |
| | 30 | 1/240 1/360 | 750 | 1,685,000 2,530,000 |
| | 40 | 1/240 1/360 | 930 | 2,250,000 3,380,000 |
| 8.0 | 20 | 1/240 1/360 | 640 | 1,360,000 2,040,000 |
| | 30 | 1/240 1/360 | 850 | 2,040,000 3,060,000 |
| Floors | | | | |
| 4 | | | 840 | 1,000,000 |
| 4.5 | | | 950 | 1,300,000 |
| 5.0 | 40 | 1/360 | 1,060 | 1,600,000 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kN/m², 1 pound per square inch = 0.00689 N/mm².

a. Spans are based on simple beam action with 10 pounds per square foot dead load and provisions for a 300 pound concentrated load on a 12 inch width of decking. Random layup is permitted in accordance with the provisions of Section 2308.10.9. Lumber thickness is 1½ inches nominal.

the second story to first story connection with an allowable capacity of 2,000 pounds (8896 N). Hold-down connectors shall be provided at the ends of each braced wall panel for the first story to foundation connection with an allowable capacity of 3,900 pounds (17,347 N). In all cases, the hold-down connector force shall be transferred to the foundation.

3.4. Cripple walls shall not be permitted.

2308.11.3 Framing and connection details. Framing and connection details shall conform to Sections 2308.11.3.1 through 2308.11.3.3.

2308.11.3.1 Anchorage. Braced wall lines shall be anchored in accordance with Section 2308.6 at foundations.

2308.11.3.2 Stepped footings. Where the height of a required braced wall panel extending from foundation to floor above varies more than 4 feet (1219 mm), the following construction shall be used:

- Where the bottom of the footing is stepped and the lowest floor framing rests directly on a sill bolted to the footings, the sill shall be anchored as required in Section 2308.3.3.
- Where the lowest floor framing rests directly on a sill bolted to a footing not less than 8 feet (2438 mm) in length along a line of bracing, the line shall be considered to be braced. The double plate of the cripple stud wall beyond the segment of footing extending to the lowest framed floor shall be spliced to the sill plate with metal ties, one on each side of the sill and plate. The metal ties shall not be less than 0.058 inch [1.47 mm (16 galvanized gage)] by 1½ inches (38 mm) wide by 48 inches (1219 mm) with eight 16d common nails on each side of the splice location (see Figure 2308.11.3.2). The metal tie shall have a minimum yield of 33,000 pounds per square inch (psi) (227 MPa).
- Where cripple walls occur between the top of the footing and the lowest floor framing, the bracing requirements for a story shall apply.

2308.11.3.3 Openings in horizontal diaphragms. Openings in horizontal diaphragms with a dimension perpendicular to the joist that is greater than 4 feet (1219 mm) shall be constructed in accordance with the following:

1. Blocking shall be provided beyond headers.
2. Metal ties not less than 0.058 inch [1.47 mm (16 galvanized gage)] by $1\frac{1}{2}$ inches (38 mm) wide with eight 16d common nails on each side of the header-joist intersection shall be provided (see Figure 2308.11.3.3). The metal ties shall have a minimum yield of 33,000 psi (227 MPa).

2308.12 Additional requirements for conventional construction in Seismic Design Category D or E. Structures of conventional light-frame construction and assigned to Seismic Design Category D or E shall conform to Sections 2308.12.1 through 2308.12.9, in addition to the requirements for structures assigned to Seismic Design Category B or C in Section 2308.11.

2308.12.1 Number of stories. Structures of conventional light-frame construction and assigned to Seismic Design Category D or E shall not exceed one story above grade plane.

2308.12.2 Concrete or masonry. Concrete or masonry walls and stone or masonry veneer shall not extend above a basement.

Exception: In structures assigned to Seismic Design Category D, stone and masonry veneer is permitted to be used in the first story above grade plane, provided the following criteria are met:

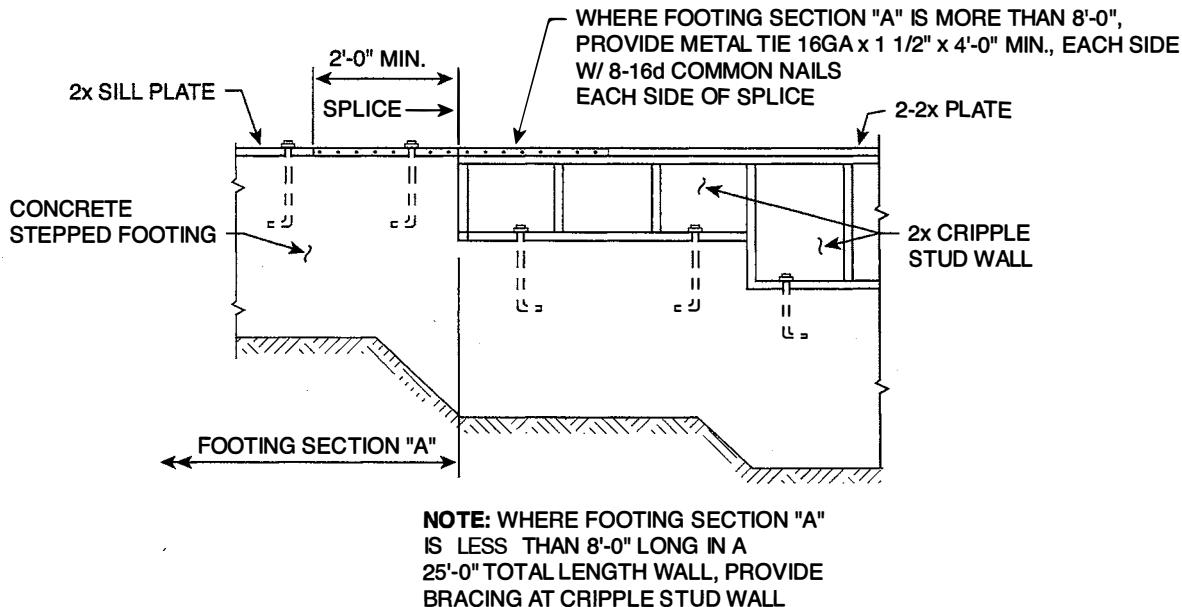
1. Type of brace in accordance with Section 2308.9.3 shall be Method 3 and the allowable shear capacity in accordance with Section 2306.3 shall be a minimum of 350 plf (5108 N/m).

2. The bracing of the first story shall be located at each end and at least every 25 feet (7620 mm) o.c. but not less than 45 percent of the braced wall line.
3. Hold-down connectors shall be provided at the ends of braced walls for the first floor to foundation with an allowable capacity of 2,100 pounds (9341 N).

4. Cripple walls shall not be permitted.

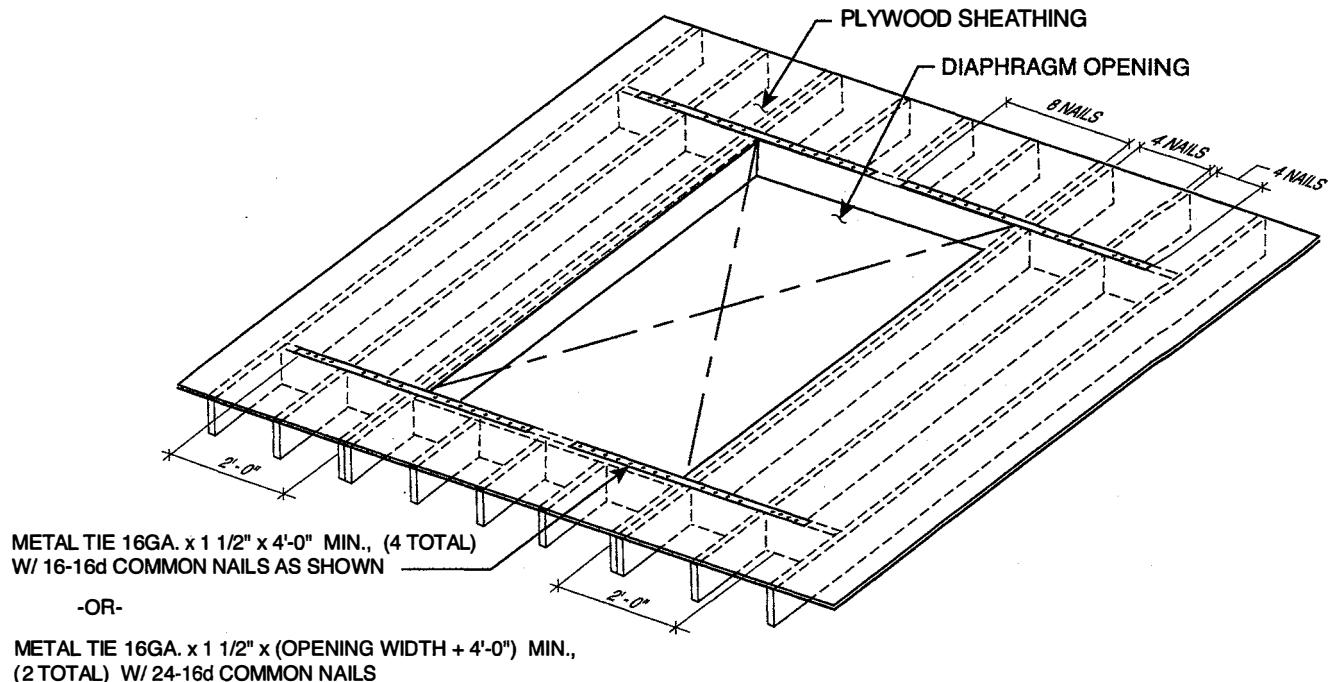
2308.12.3 Braced wall line spacing. Spacing between interior and exterior braced wall lines shall not exceed 25 feet (7620 mm).

2308.12.4 Braced wall line sheathing. Braced wall lines shall be braced by one of the types of sheathing prescribed by Table 2308.12.4 as shown in Figure 2308.9.3. The sum of lengths of braced wall panels at each braced wall line shall conform to the required percentage of wall length required to be braced per braced wall line in Table 2308.12.4. Braced wall panels shall be distributed along the length of the braced wall line and start at not more than 8 feet (2438 mm) from each end of the braced wall line. Panel sheathing joints shall occur over studs or blocking. Sheathing shall be fastened to studs, top and bottom plates and at panel edges occurring over blocking. Wall framing to which sheathing used for bracing is applied shall be nominal 2-inch-wide [actual $1\frac{1}{2}$ inch (38 mm)] or larger members.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2308.11.3.2
STEPPED FOOTING CONNECTION DETAILS**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2308.11.3.3
OPENINGS IN HORIZONTAL DIAPHRAGMS**

Cripple walls having a stud height exceeding 14 inches (356 mm) shall be considered a story for the purpose of this section and shall be braced as required for braced wall lines in accordance with the required percentage of wall length required to be braced per braced wall line in Table 2308.12.4. Where interior braced wall lines occur without a continuous foundation below, the length of parallel exterior cripple wall bracing shall be one and one-half times the lengths required by Table 2308.12.4. Where the cripple wall sheathing type used is Type S-W and this additional length of bracing cannot be provided, the capacity of Type S-W sheathing shall be increased by reducing the spacing of fasteners along the perimeter of each piece of sheathing to 4 inches (102 mm) o.c.

2308.12.4.1 Alternative bracing. An alternate braced wall panel constructed in accordance with Section 2308.9.3.1 or 2308.9.3.2 is permitted to be substituted for a braced wall panel in Section 2308.9.3 Items 2 through 8. For methods 2, 3, 4, 6, 7 and 8, each 48-inch (1219 mm) section or portion thereof required by Table 2308.12.4 is permitted to be replaced by one alternate braced wall panel constructed in accordance with Section 2308.9.3.1 or 2308.9.3.2. For method 5, each 96-inch (2438 mm) section (applied to one face) or 48-inch (1219 mm) section (applied to both faces) or portion thereof required by Table 2308.12.4 is permitted to be replaced by one alternate braced wall

panel constructed in accordance with Section 2308.9.3.1 or 2308.9.3.2.

2308.12.5 Attachment of sheathing. Fastening of braced wall panel sheathing shall not be less than that prescribed in Table 2308.12.4 or 2304.9.1. Wall sheathing shall not be attached to framing members by adhesives.

2308.12.6 Irregular structures. Conventional light-frame construction shall not be used in irregular portions of structures assigned to Seismic Design Category D or E. Such irregular portions of structures shall be designed to resist the forces specified in Chapter 16 to the extent such irregular features affect the performance of the conventional framing system. A portion of a structure shall be considered to be irregular where one or more of the conditions described in Items 1 through 6 below are present.

- Where exterior braced wall panels are not in one plane vertically from the foundation to the uppermost story in which they are required, the structure shall be considered to be irregular [see Figure 2308.12.6(1)].

Exception: Floors with cantilevers or setbacks not exceeding four times the nominal depth of the floor joists [see Figure 2308.12.6(2)] are permitted to support braced wall panels provided:

- Floor joists are 2 inches by 10 inches (51 mm by 254 mm) or larger and spaced not more than 16 inches (406 mm) o.c.

2. The ratio of the back span to the cantilever is at least 2:1.
 3. Floor joists at ends of braced wall panels are doubled.
 4. A continuous rim joist is connected to the ends of cantilevered joists. The rim joist is permitted to be spliced using a metal tie not less than 0.058 inch (1.47 mm) (16 galvanized gage) and $1\frac{1}{2}$ inches (38 mm) wide fastened with six 16d common nails on each side. The metal tie shall have a minimum yield of 33,000 psi (227 MPa).
 5. Joists at setbacks or the end of cantilevered joists shall not carry gravity loads from more than a single story having uniform wall and roof loads, nor carry the reactions from headers having a span of 8 feet (2438 mm) or more.
 2. Where a section of floor or roof is not laterally supported by braced wall lines on all edges and connected in accordance with Section 2308.3.2, the structure shall be considered to be irregular [see Figure 2308.12.6(3)].
- Exception:** Portions of roofs or floors that do not support braced wall panels above are permitted to extend up to 6 feet (1829 mm) beyond a braced wall line [see Figure 2308.12.6(4)] provided that the framing members are connected to the braced wall line below in accordance with Section 2308.3.2.
3. Where the end of a required braced wall panel extends more than 1 foot (305 mm) over an opening in the wall below, the structure shall be considered to be irregular. This requirement is applicable to braced wall panels offset in plane and to braced wall

panels offset out of plane as permitted by the exception to Item 1 above in this section [see Figure 2308.12.6(5)].

- Exception:** Braced wall panels are permitted to extend over an opening not more than 8 feet (2438 mm) in width where the header is a 4-inch by 12-inch (102 mm by 305 mm) or larger member.
4. Where portions of a floor level are vertically offset such that the framing members on either side of the offset cannot be lapped or tied together in an approved manner, the structure shall be considered to be irregular [see Figure 2308.12.6(6)].

Exception: Framing supported directly by foundations need not be lapped or tied directly together.

5. Where braced wall lines are not perpendicular to each other, the structure shall be considered to be irregular [see Figure 2308.12.6(7)].
6. Where openings in floor and roof diaphragms having a maximum dimension greater than 50 percent of the distance between lines of bracing or an area greater than 25 percent of the area between orthogonal pairs of braced wall lines are present, the structure shall be considered to be irregular [see Figure 2308.12.6(8)].

2308.12.7 Anchorage of exterior means of egress components. Exterior egress balconies, exterior exit stairways and similar means of egress components shall be positively anchored to the primary structure at not over 8 feet (2438 mm) o.c. or shall be designed for lateral forces. Such attachment shall not be accomplished by use of toenails or nails subject to withdrawal.

**TABLE 2308.12.4
WALL BRACING IN SEISMIC DESIGN CATEGORIES D AND E
(Minimum Percentage of Wall Bracing per each Braced Wall Line^a)**

| CONDITION | SHEATHING TYPE ^b | $S_{DS} < 0.50$ | $0.50 \leq S_{DS} < 0.75$ | $0.75 \leq S_{DS} \leq 1.00$ | $S_{DS} > 1.00$ |
|-----------|-----------------------------|-----------------|---------------------------|------------------------------|-----------------|
| One story | G-P ^c | 43 | 59 | 75 | 100 |
| | S-W | 21 | 32 | 37 | 48 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Minimum length of panel bracing of one face of the wall for S W sheathing or both faces of the wall for G P sheathing; h/w ratio shall not exceed 2:1. For S W panel bracing of the same material on two faces of the wall, the minimum length is permitted to be one half the tabulated value but the h/w ratio shall not exceed 2:1 and design for uplift is required. The 2:1 h/w ratio limitation does not apply to alternate braced wall panels constructed in accordance with Section 2308.9.3.1 or 2308.9.3.2.

b. G P = gypsum board, fiberboard, particleboard, lath and plaster or gypsum sheathing boards; S W = wood structural panels and diagonal wood sheathing.

c. Nailing as specified below shall occur at all panel edges at studs, at top and bottom plates and, where occurring, at blocking:

For $\frac{1}{2}$ inch gypsum board, 5d (0.113 inch diameter) cooler nails at 7 inches on center;

For $\frac{5}{8}$ inch gypsum board, No. 11 gage (0.120 inch diameter) at 7 inches on center;

For gypsum sheathing board, $1\frac{3}{4}$ inches long by $\frac{7}{16}$ inch head, diamond point galvanized nails at 4 inches on center;

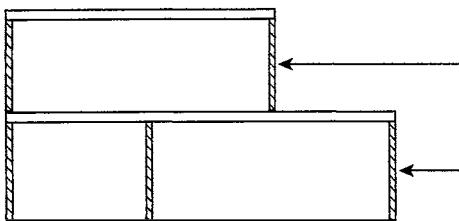
For gypsum lath, No. 13 gage (0.092 inch) by $1\frac{1}{8}$ inches long, $\frac{19}{64}$ inch head, plasterboard at 5 inches on center;

For Portland cement plaster, No. 11 gage (0.120 inch) by $1\frac{1}{2}$ inches long, $\frac{7}{16}$ inch head at 6 inches on center;

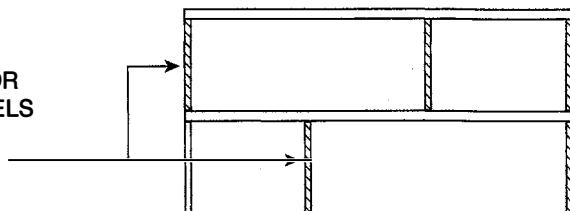
For fiberboard and particleboard, No. 11 gage (0.120 inch) by $1\frac{1}{2}$ inches long, $\frac{7}{16}$ inch head, galvanized nails at 3 inches on center.

2308.12.8 Sill plate anchorage. Sill plates shall be anchored with anchor bolts with steel plate washers between the foundation sill plate and the nut, or approved anchor straps load rated in accordance with Section 1716.1. Such washers shall be a minimum of 0.229 inch by 3 inches by 3 inches (5.82 mm by 76 mm by 76 mm) in size. The hole in the plate washer is permitted to be diagonally slotted with a width of up to $\frac{3}{16}$ inch (4.76 mm) larger than the bolt diameter and a slot length not to exceed $1\frac{3}{4}$ inches (44 mm), provided a standard cut washer is placed between the plate washer and the nut.

2308.12.9 Sill plate anchorage in Seismic Design Category E. In structures assigned to Seismic Design Category E, steel bolts with a minimum nominal diameter of $\frac{5}{8}$ inch (15.9 mm) or approved anchor straps load rated in accordance with Section 1711.1 and spaced to provide equivalent anchorage shall be used.

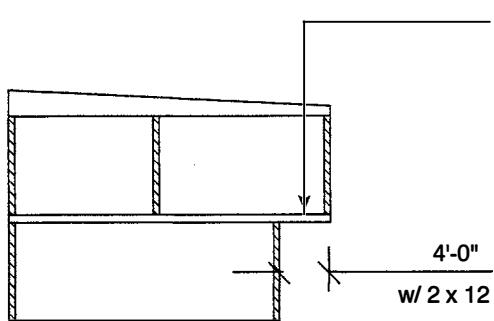


SECTION VIEW

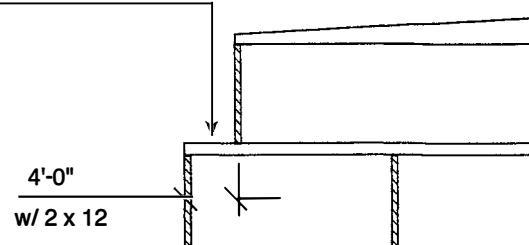


SECTION VIEW

FIGURE 2308.12.6(1)
BRACED WALL PANELS OUT OF PLANE



SECTION THRU CANTILEVER



SECTION THRU SET BACK

For SI: 1 foot = 304.8 mm.
FIGURE 2308.12.6(2)
BRACED WALL PANELS SUPPORTED BY CANTILEVER OR SET BACK

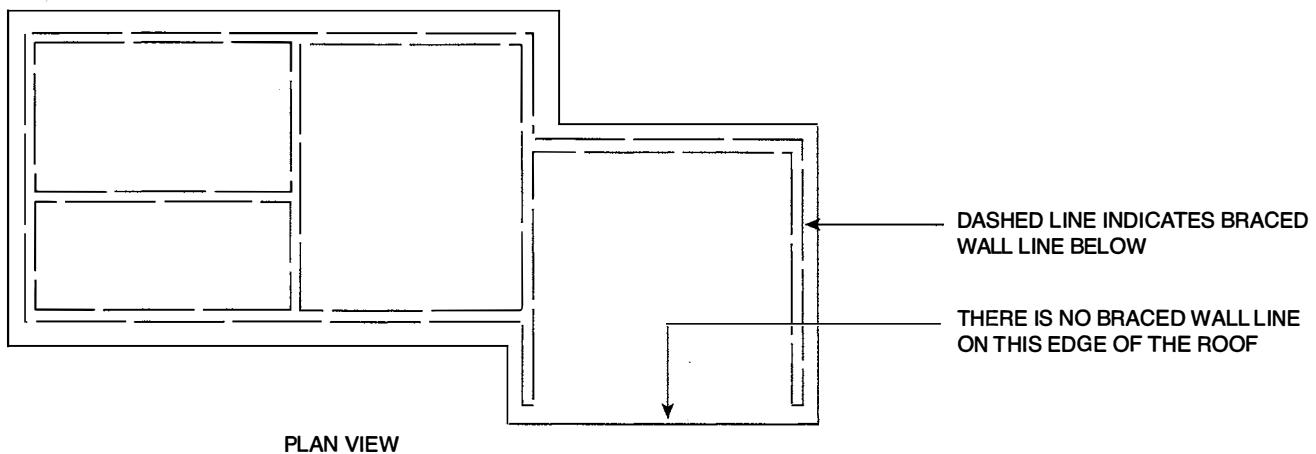
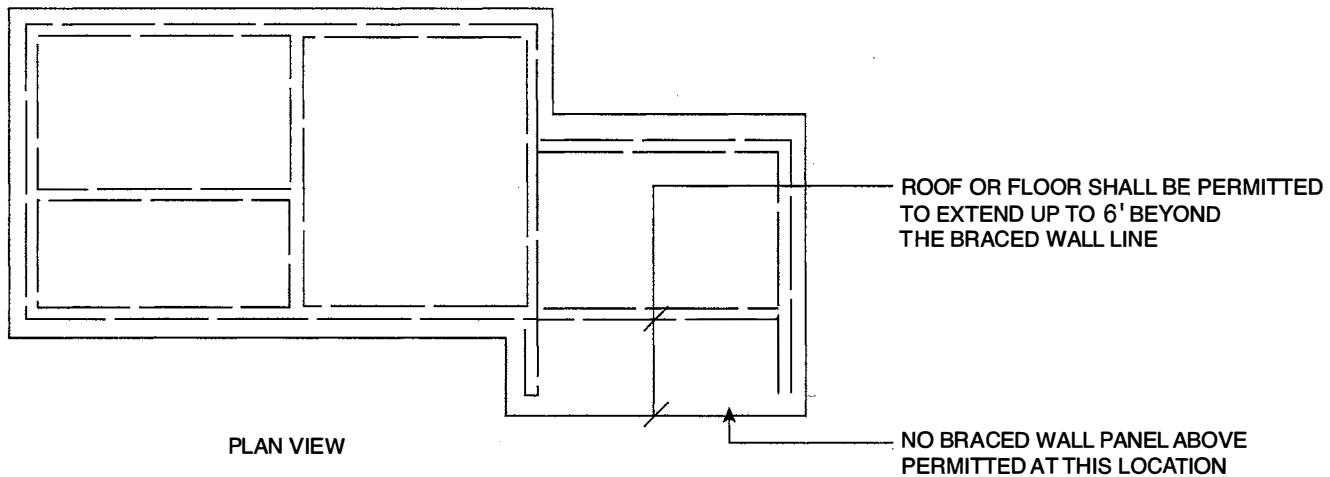
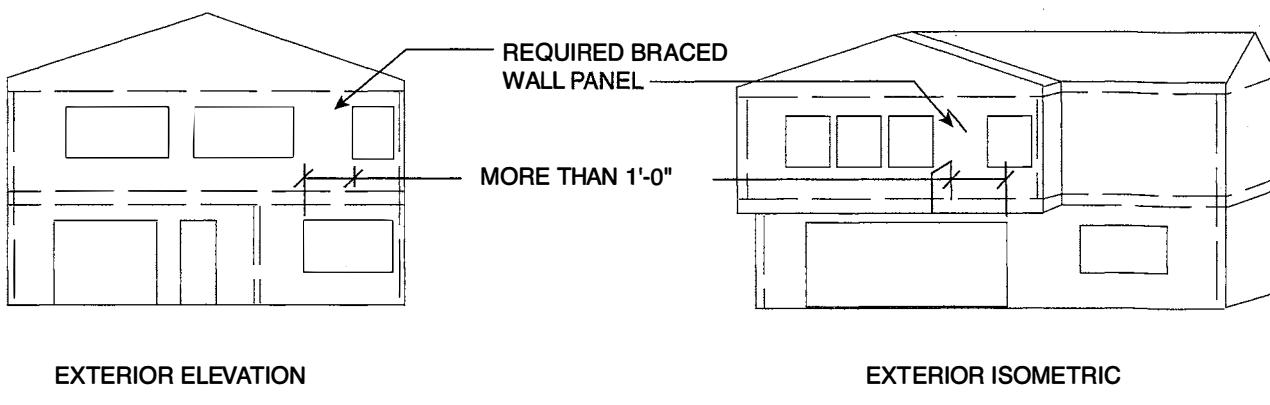


FIGURE 2308.12.6(3)
FLOOR OR ROOF NOT SUPPORTED ON ALL EDGES



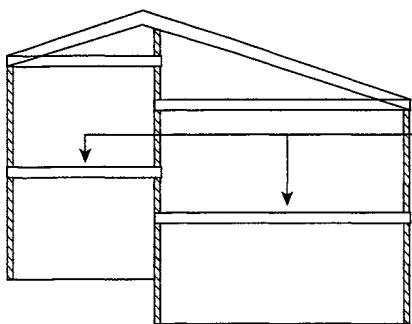
For SI: 1 foot = 304.8 mm.

FIGURE 2308.12.6(4)
ROOF OR FLOOR EXTENSION BEYOND BRACED WALL LINE

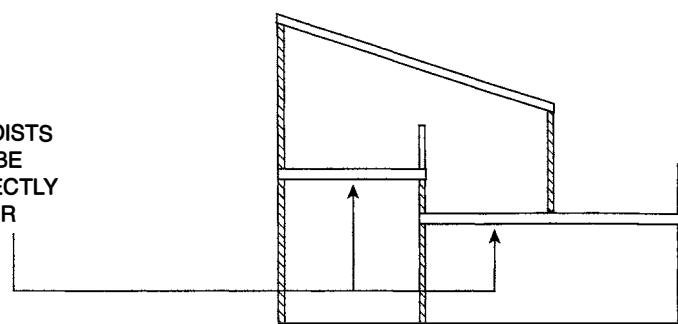


For SI: 1 foot = 304.8 mm.

FIGURE 2308.12.6(5)
BRACED WALL PANEL EXTENSION OVER OPENING

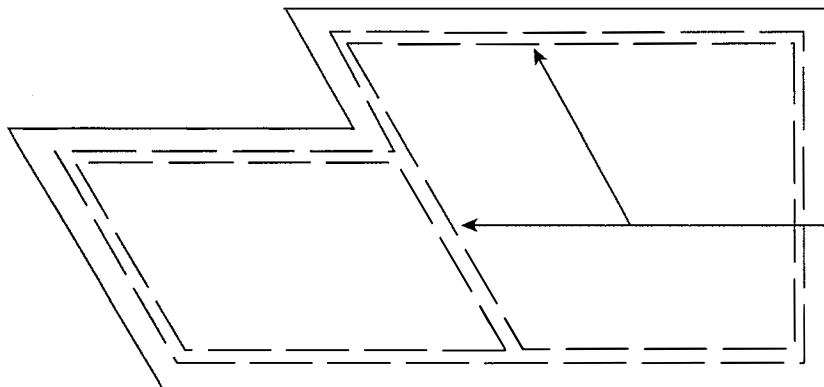


SECTION VIEW



SECTION VIEW

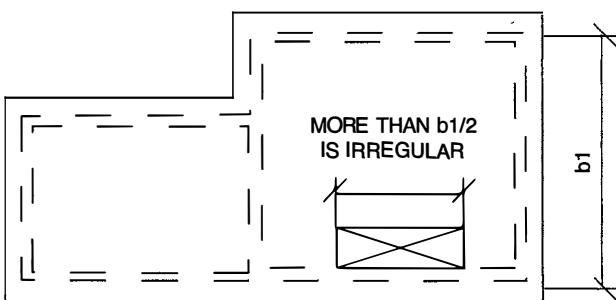
FIGURE 2308.12.6(6)
PORTIONS OF FLOOR LEVEL OFFSET VERTICALLY



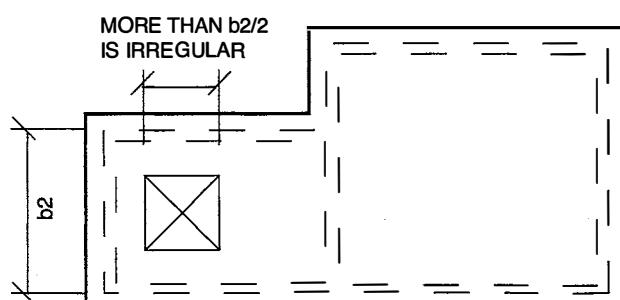
PLAN VIEW

BRACED WALL LINES ARE NOT
PERPENDICULAR

FIGURE 2308.12.6(7)
BRACED WALL LINES NOT PERPENDICULAR



PLAN VIEW



PLAN VIEW

FIGURE 2308.12.6(8)
OPENING LIMITATIONS FOR FLOOR AND ROOF DIAPHRAGMS

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 24 – GLASS AND GLAZING

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | X | X | | | | | | X | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | X | X | X | | | X | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 2403.2.1 | | | | | | | X | X | X | | | X | | | | | | | | |
| Table 2403.2.1 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2410 & Subsections | | | | | | | X | X | X | | | X | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

CHAPTER 24

GLASS AND GLAZING

SECTION 2401 GENERAL

2401.1 Scope. The provisions of this chapter shall govern the materials, design, construction and quality of glass, light-transmitting ceramic and light-transmitting plastic panels for exterior and interior use in both vertical and sloped applications in buildings and structures.

2401.2 Glazing replacement. The installation of replacement glass shall be as required for new installations.

SECTION 2402 DEFINITIONS

2402.1 Definitions. The following terms are defined in Chapter 2:

DALLE GLASS.

DECORATIVE GLASS.

SECTION 2403 GENERAL REQUIREMENTS FOR GLASS

2403.1 Identification. Each pane shall bear the manufacturer's mark designating the type and thickness of the glass or glazing material. The identification shall not be omitted unless approved and an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance

with approved construction documents that comply with the provisions of this chapter. Safety glazing shall be identified in accordance with Section 2406.3.

Each pane of tempered glass, except tempered spandrel glass, shall be permanently identified by the manufacturer. The identification mark shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

Tempered spandrel glass shall be provided with a removable paper marking by the manufacturer.

2403.2 Glass supports. Where one or more sides of any pane of glass are not firmly supported, or are subjected to unusual load conditions, detailed construction documents, detailed shop drawings and analysis or test data assuring safe performance for the specific installation shall be prepared by a registered design professional.

2403.2.1 Additional Requirements. [DSA-SS, DSA-SS/CC and OSHPD 1 & 4] In addition to the requirements of Section 2403.2, glass supports shall comply with the following:

1. The construction documents and analysis or test data required per Section 2403.2 shall be submitted to the enforcement agency for approval.
2. Glass firmly supported on all four edges shall be glazed with minimum laps and edge clearances set forth in Table 2403.2.1.

TABLE 2403.2.1
MINIMUM GLAZING REQUIREMENTS

| FIXED WINDOWS AND OPENABLE WINDOWS OTHER THAN HORIZONTAL SIDING | | | | | |
|---|----------------------------|------------------|------------------|------------------|-----------------|
| Glass Area | Up to 6 sq. ft. | 6 to 14 sq. ft. | 14 to 32 sq. ft. | 32 to 50 sq. ft. | Over 50 sq. ft. |
| $\times 0.0929 \text{ for m}^2, \times 25.4 \text{ for mm}$ | | | | | |
| 1. Minimum Frame Lap | $1/4"$ | $1/4"$ | $5/16"$ | $3/8"$ | $1/2"$ |
| 2. Minimum Glass Edge Clearance | $1/8^{1,2}$ | $1/8^{1,2}$ | $3/16^{1,1}$ | $1/4"$ | $1/4^{1,1}$ |
| 3. Continuous Glazing Rabbet and Glass Retainer ³ | Required | | | | |
| 4. Resilient Setting Material ⁴ | Not Required | Required | | | |
| SLIDING DOORS AND HORIZONTAL SLIDING WINDOWS | | | | | |
| Glass Area | Up to 14 sq. ft. | 14 to 32 sq. ft. | 32 to 50 sq. ft. | Over 50 sq. ft. | |
| $\times 0.0929 \text{ for m}^2, \times 25.4 \text{ for mm}$ | | | | | |
| 5. Minimum Glass Frame Lap | $1/4"$ | $5/16"$ | $3/8"$ | $1/2"$ | |
| 6. Minimum Glass Edge Clearance | $1/8^{1,2}$ | $3/16"$ | $1/4"$ | $1/4"$ | |
| 7. Continuous Glazing Rabbet and Glass Retainer ³ | Required above third story | Required | | | |
| 8. Resilient Setting Material ⁴ | Not Required | Required | | | |

1. Glass edge clearance in fixed openings shall not be less than required to provide for wind and earthquake drift.
2. Glass edge clearance at all sides of pane shall be a minimum of $3/16$ inch (4.8 mm) where height of glass exceeds 3 feet (914 mm).
3. Glass retainers such as metal, wood or vinyl face stops, glazing beads, gaskets, glazing clips and glazing channels shall be of sufficient strength and fixation to serve this purpose.
4. Resilient setting material shall include preformed rubber or vinyl plastic gaskets or other materials which are proved to the satisfaction of the building official to remain resilient.

2403.3 Framing. To be considered firmly supported, the framing members for each individual pane of glass shall be designed so the deflection of the edge of the glass perpendicular to the glass pane shall not exceed $\frac{1}{175}$ of the glass edge length or $\frac{3}{4}$ inch (19.1 mm), whichever is less, when subjected to the larger of the positive or negative load where loads are combined as specified in Section 1605.

2403.4 Interior glazed areas. Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall not be greater than the thickness of the panels when a force of 50 pounds per linear foot (plf) (730 N/m) is applied horizontally to one panel at any point up to 42 inches (1067 mm) above the walking surface.

2403.5 Louvered windows or jalousies. Float, wired and patterned glass in louvered windows and jalousies shall be no thinner than nominal $\frac{3}{16}$ inch (4.8 mm) and no longer than 48 inches (1219 mm). Exposed glass edges shall be smooth.

Wired glass with wire exposed on longitudinal edges shall not be used in louvered windows or jalousies.

Where other glass types are used, the design shall be submitted to the building official for approval.

SECTION 2404 WIND, SNOW, SEISMIC AND DEAD LOADS ON GLASS

2404.1 Vertical glass. Glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding. Glass in glazed curtain walls, glazed storefronts and glazed partitions shall meet the seismic requirements of ASCE 7, Section 13.5.9. The load resistance of glass under uniform load shall be determined in accordance with ASTM E 1300.

The design of vertical glazing shall be based on the following equation:

$$F_{gw} \leq F_{ga} \quad (\text{Equation 24-1})$$

where:

F_{gw} = Wind load on the glass computed in accordance with Section 1609.

F_{ga} = Short duration load on the glass as determined in accordance with ASTM E 1300.

2404.2 Sloped glass. Glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunrooms, sloped roofs and other exterior applications shall be designed to resist the most critical of the following combinations of loads.

$$F_g = W_o - D \quad (\text{Equation 24-2})$$

$$F_g = W_i + D + 0.5 S \quad (\text{Equation 24-3})$$

$$F_g = 0.5 W_i + D + S \quad (\text{Equation 24-4})$$

where:

D = Glass dead load psf (kN/m^2).

For glass sloped 30 degrees (0.52 rad) or less from horizontal,

$$= 13 t_g \quad (\text{For SI: } 0.0245 t_g)$$

For glass sloped more than 30 degrees (0.52 rad) from horizontal,

$$= 13 t_g \cos \theta \quad (\text{For SI: } 0.0245 t_g \cos \theta)$$

F_g = Total load, psf (kN/m^2) on glass.

S = Snow load, psf (kN/m^2) as determined in Section 1608.

t_g = Total glass thickness, inches (mm) of glass panes and plies.

W_i = Inward wind force, psf (kN/m^2) as calculated in Section 1609.

W_o = Outward wind force, psf (kN/m^2) as calculated in Section 1609.

θ = Angle of slope from horizontal.

Exception: Unit skylights shall be designed in accordance with Section 2405.5.

The design of sloped glazing shall be based on the following equation:

$$F_g \leq F_{ga} \quad (\text{Equation 24-5})$$

where:

F_g = Total load on the glass determined from the load combinations above.

F_{ga} = Short duration load resistance of the glass as determined according to ASTM E 1300 for Equations 24-2 and 24-3; or the long duration load resistance of the glass as determined according to ASTM E 1300 for Equation 24-4.

2404.3 Wired, patterned and sandblasted glass.

2404.3.1 Vertical wired glass. Wired glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$F_{gw} < 0.5 F_{ge} \quad (\text{Equation 24-6})$$

where:

F_{gw} = Is the wind load on the glass computed per Section 1609.

F_{ge} = Nonfactored load from ASTM E 1300 using a thickness designation for monolithic glass that is not greater than the thickness of wired glass.

2404.3.2 Sloped wired glass. Wired glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$$F_g < 0.5 F_{ge} \quad (\text{Equation 24-7})$$

For Equation 24-4:

$$F_g < 0.3 F_{ge} \quad (\text{Equation 24-8})$$

where:

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300.

2404.3.3 Vertical patterned glass. Patterned glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$F_{gw} < 1.0 F_{ge} \quad (\text{Equation 24-9})$$

where:

F_{gw} = Wind load on the glass computed per Section 1609.

F_{ge} = Nonfactored load from ASTM E 1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between nonfactored load charts in ASTM E 1300 shall be permitted.

2404.3.4 Sloped patterned glass. Patterned glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$$F_g < 1.0 F_{ge} \quad (\text{Equation 24-10})$$

For Equation 24-4:

$$F_g < 0.6 F_{ge} \quad (\text{Equation 24-11})$$

where

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between the nonfactored load charts in ASTM E 1300 shall be permitted.

2404.3.5 Vertical sandblasted glass. Sandblasted glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors, and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$F_g < 0.5 F_{ge} \quad (\text{Equation 24-12})$$

where:

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300. The value for sandblasted glass is for moderate levels of sandblasting.

2404.4 Other designs. For designs outside the scope of this section, an analysis or test data for the specific installation shall be prepared by a registered design professional.

SECTION 2405 SLOPED GLAZING AND SKYLIGHTS

2405.1 Scope. This section applies to the installation of glass and other transparent, translucent or opaque glazing material installed at a slope more than 15 degrees (0.26 rad) from the

vertical plane, including glazing materials in skylights, roofs and sloped walls.

2405.2 Allowable glazing materials and limitations. Sloped glazing shall be any of the following materials, subject to the listed limitations.

1. For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (0.76 mm) polyvinyl butyral (or equivalent) interlayer, wired glass, light-transmitting plastic materials meeting the requirements of Section 2607, heat-strengthened glass or fully tempered glass.
2. For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in Item 1 above.

Annealed glass is permitted to be used as specified within Exceptions 2 and 3 of Section 2405.3.

For additional requirements for plastic skylights, see Section 2610. Glass-block construction shall conform to the requirements of Section 2101.2.5.

2405.3 Screening. Where used in monolithic glazing systems, heat-strengthened glass and fully tempered glass shall have screens installed below the glazing material. The screens and their fastenings shall: (1) be capable of supporting twice the weight of the glazing; (2) be firmly and substantially fastened to the framing members and (3) be installed within 4 inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B&S gage (0.0808 inch) with mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent noncorrosive screen materials shall be used. Heat-strengthened glass, fully tempered glass and wired glass, when used in multiple-layer glazing systems as the bottom glass layer over the walking surface, shall be equipped with screening that conforms to the requirements for monolithic glazing systems.

Exception: In monolithic and multiple-layer sloped glazing systems, the following applies:

1. Fully tempered glass installed without protective screens where glazed between intervening floors at a slope of 30 degrees (0.52 rad) or less from the vertical plane shall have the highest point of the glass 10 feet (3048 mm) or less above the walking surface.
2. Screens are not required below any glazing material, including annealed glass, where the walking surface below the glazing material is permanently protected from the risk of falling glass or the area below the glazing material is not a walking surface.
3. Any glazing material, including annealed glass, is permitted to be installed without screens in the sloped glazing systems of commercial or detached noncombustible greenhouses used exclusively for growing plants and not open to the public, provided that the height of the greenhouse at the ridge does not exceed 30 feet (9144 mm) above grade.
4. Screens shall not be required within individual dwelling units in Groups R-2, R-3 and R-4 where

fully tempered glass is used as single glazing or as both panes in an insulating glass unit, and the following conditions are met:

- 4.1. Each pane of the glass is 16 square feet (1.5 m²) or less in area.
- 4.2. The highest point of the glass is 12 feet (3658 mm) or less above any walking surface or other accessible area.
- 4.3. The glass thickness is $\frac{3}{16}$ inch (4.8 mm) or less.
5. Screens shall not be required for laminated glass with a 15-mil (0.38 mm) polyvinyl butyral (or equivalent) interlayer used within individual dwelling units in Groups R-2, R-3 and R-4 within the following limits:
 - 5.1. Each pane of glass is 16 square feet (1.5 m²) or less in area.
 - 5.2. The highest point of the glass is 12 feet (3658 mm) or less above a walking surface or other accessible area.

2405.4 Framing. In Type I and II construction, sloped glazing and skylight frames shall be constructed of noncombustible materials. In structures where acid fumes deleterious to metal are incidental to the use of the buildings, approved pressure-treated wood or other approved noncorrosive materials are permitted to be used for sash and frames. Framing supporting sloped glazing and skylights shall be designed to resist the tributary roof loads in Chapter 16. Skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal plane shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame. Skylights shall not be installed in the plane of the roof where the roof pitch is less than 45 degrees (0.79 rad) from the horizontal.

Exception: Installation of a skylight without a curb shall be permitted on roofs with a minimum slope of 14 degrees (three units vertical in 12 units horizontal) in Group R-3 occupancies. All unit skylights installed in a roof with a pitch flatter than 14 degrees (0.25 rad) shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame unless otherwise specified in the manufacturer's installation instructions.

2405.5 Unit skylights. Unit skylights shall be tested and labeled as complying with AAMA/WDMA/CSA 101/I.S./A440. The label shall state the name of the manufacturer, the approved labeling agency, the product designation and the performance grade rating as specified in AAMA/WDMA/CSA 101/I.S.2/A440. If the product manufacturer has chosen to have the performance grade of the skylight rated separately for positive and negative design pressure, then the label shall state both performance grade ratings as specified in AAMA/WDMA/CSA 101/I.S.2/A440 and the skylight shall comply with Section 2405.5.2. If the skylight is not rated separately for positive and negative pressure, then the performance grade rating shown on the label shall be the performance grade rating determined in accordance with AAMA/WDMA/

CSA 101/I.S.2/A440 for both positive and negative design pressure and the skylight shall conform to Section 2405.5.1.

2405.5.1 Unit skylights rated for the same performance grade for both positive and negative design pressure. The design of unit skylights shall be based on the following equation:

$$F_g \leq PG \quad (\text{Equation 24-13})$$

where:

F_g = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

PG = Performance grade rating of the skylight.

2405.5.2 Unit skylights rated for separate performance grades for positive and negative design pressure. The design of unit skylights rated for performance grade for both positive and negative design pressures shall be based on the following equations:

$$F_{gi} \leq PG_{Po} \quad (\text{Equation 24-14})$$

$$F_{go} \leq PG_{Ne} \quad (\text{Equation 24-15})$$

where:

PG_{Pos} = Performance grade rating of the skylight under positive design pressure;

PG_{Neg} = Performance grade rating of the skylight under negative design pressure; and

F_{gi} and F_{go} are determined in accordance with the following:

For $W_o \geq D$,

where:

W_o = Outward wind force, psf (kN/m²) as calculated in Section 1609.

D = The dead weight of the glazing, psf (kN/m²) as determined in Section 2404.2 for glass, or by the weight of the plastic, psf (kN/m²) for plastic glazing.

F_{gi} = Maximum load on the skylight determined from Equations 24-3 and 24-4 in Section 2404.2.

F_{go} = Maximum load on the skylight determined from Equation 24-2.

For $W_o < D$,

where:

W_o = Is the outward wind force, psf (kN/m²) as calculated in Section 1609.

D = The dead weight of the glazing, psf (kN/m²) as determined in Section 2404.2 for glass, or by the weight of the plastic for plastic glazing.

F_{gi} = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

$F_{go} = 0$.

SECTION 2406 SAFETY GLAZING

2406.1 Human impact loads. Individual glazed areas, including glass mirrors, in hazardous locations as defined in Section 2406.4 shall comply with Sections 2406.1.1 through 2406.1.4.

Exception: Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.

2406.1.1 Impact test. Except as provided in Sections 2406.1.2 through 2406.1.4, all glazing shall pass the impact test requirements of Section 2406.2.

2406.1.2 Plastic glazing. Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

2406.1.3 Glass block. Glass-block walls shall comply with Section 2101.2.5.

2406.1.4 Louvered windows and jalousies. Louvered windows and jalousies shall comply with Section 2403.5.

2406.2 Impact test. Where required by other sections of this code, glazing shall be tested in accordance with CPSC 16 CFR Part 1201. Glazing shall comply with the test criteria for Category II, unless otherwise indicated in Table 2406.2(1).

Exception: Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers shall be permitted to be tested in accordance with ANSI Z97.1. Glazing shall comply with the test criteria for Class A, unless otherwise indicated in Table 2406.2(2).

2406.3 Identification of safety glazing. Except as indicated in Section 2406.3.1, each pane of safety glazing installed in hazardous locations shall be identified by a manufacturer's designation specifying who applied the designation, the manufacturer or installer and the safety glazing standard with which it complies, as well as the information specified in Section 2403.1. The designation shall be acid etched, sand

blasted, ceramic fired, laser etched, embossed or of a type that once applied, cannot be removed without being destroyed. A label as defined in Section 202 and meeting the requirements of this section shall be permitted in lieu of the manufacturer's designation.

Exceptions:

- For other than tempered glass, manufacturer's designations are not required, provided the building official approves the use of a certificate, affidavit or other evidence confirming compliance with this code.
- Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation

2406.3.1 Multi-pane assemblies. Multi-pane glazed assemblies having individual panes not exceeding 1 square foot (0.09 m^2) in exposed areas shall have at least one pane in the assembly marked as indicated in Section 2406.3. Other panes in the assembly shall be marked "CPSC 16 CFR Part 1201" or "ANSI Z97.1," as appropriate.

2406.4 Hazardous locations. The locations specified in Sections 2406.4.1 through 2406.4.7 shall be considered specific hazardous locations requiring safety glazing materials.

2406.4.1 Glazing in doors. Glazing in all fixed and operable panels of swinging, sliding, and bifold doors shall be considered a hazardous location.

Exceptions:

- Glazed openings of a size through which a 3-inch-diameter (76 mm) sphere is unable to pass.
- Decorative glazing.
- Glazing materials used as curved glazed panels in revolving doors.
- Commercial refrigerated cabinet glazed doors.

TABLE 2406.2(1)
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING CPSC 16 CFR PART 1201

| EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE | GLAZING IN STORM OR COMBINATION DOORS (Category class) | GLAZING IN DOORS (Category class) | GLAZED PANELS REGULATED BY SECTION 2406.4.3 (Category class) | GLAZED PANELS REGULATED BY SECTION 2406.4.2 (Category class) | DOORS AND ENCLOSURES REGULATED BY SECTION 2406.4.5 (Category class) | SLIDING GLASS DOORS PATIO TYPE (Category class) |
|--|--|-----------------------------------|--|--|---|---|
| 9 square feet or less | I | I | No requirement | I | II | II |
| More than 9 square feet | II | II | II | II | II | II |

For SI: 1 square foot = 0.0929 m^2 .

TABLE 2406.2(2)
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING ANSI Z97.1

| EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE | GLAZED PANELS REGULATED BY SECTION 2406.4.3 (Category class) | GLAZED PANELS REGULATED BY SECTION 2406.4.2 (Category class) | DOORS AND ENCLOSURES REGULATED BY SECTION 2406.4.5 ^a (Category class) |
|--|--|--|--|
| 9 square feet or less | No requirement | B | A |
| More than 9 square feet | A | A | A |

For SI: square foot = 0.0929 m^2 .

a. Use is only permitted by the exception to Section 2406.2.

2406.4.2 Glazing adjacent to doors. Glazing in an individual fixed or operable panel adjacent to a door where the nearest vertical edge of the glazing is within a 24-inch (610 mm) arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the walking surface shall be considered a hazardous location.

Exceptions:

1. Decorative glazing.
2. Where there is an intervening wall or other permanent barrier between the door and glazing.
3. Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth. Glazing in this application shall comply with Section 2406.4.3.
4. Glazing in walls on the latch side of and perpendicular to the plane of the door in a closed position in one- and two-family dwellings or within dwelling units in Group R-2.

2406.4.3 Glazing in windows. Glazing in an individual fixed or operable panel that meets all of the following conditions shall be considered a hazardous location:

1. The exposed area of an individual pane is greater than 9 square feet (0.84 m^2);
2. The bottom edge of the glazing is less than 18 inches (457 mm) above the floor;
3. The top edge of the glazing is greater than 36 inches (914 mm) above the floor; and
4. One or more walking surface(s) are within 36 inches (914 mm), measured horizontally and in a straight line, of the plane of the glazing.

Exceptions:

1. Decorative glazing.
2. Where a horizontal rail is installed on the accessible side(s) of the glazing 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and be a minimum of $1\frac{1}{2}$ inches (38 mm) in cross-sectional height.
3. Outboard panes in insulating glass units or multiple glazing where the bottom exposed edge of the glass is 25 feet (7620 mm) or more above any grade, roof, walking surface or other horizontal or sloped (within 45 degrees of horizontal) (0.78 rad) surface adjacent to the glass exterior.

2406.4.4 Glazing in guards and railings. Glazing in guards and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface shall be considered a hazardous location.

2406.4.5 Glazing and wet surfaces. Glazing in walls, enclosures or fences containing or facing hot tubs, spas, whirlpools, saunas, steam rooms, bathtubs, showers and indoor or outdoor swimming pools where the bottom

exposed edge of the glazing is less than 60 inches (1524 mm) measured vertically above any standing or walking surface shall be considered a hazardous location. This shall apply to single glazing and all panes in multiple glazing.

Exception: Glazing that is more than 60 inches (1524 mm), measured horizontally and in a straight line, from the water's edge of a bathtub, hot tub, spa, whirlpool, or swimming pool.

2406.4.6 Glazing adjacent to stairs and ramps. Glazing where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the plane of the adjacent walking surface of stairways, landings between flights of stairs, and ramps shall be considered a hazardous location.

Exceptions:

1. The side of a stairway, landing or ramp that has a guard complying with the provisions of Sections 1013 and 1607.8, and the plane of the glass is greater than 18 inches (457 mm) from the railing.
2. Glazing 36 inches (914 mm) or more measured horizontally from the walking surface.

2406.4.7 Glazing adjacent to the bottom stair landing. Glazing adjacent to the landing at the bottom of a stairway where the glazing is less than 36 inches (914 mm) above the landing and within 60 inches (1524 mm) horizontally of the bottom tread shall be considered a hazardous location.

Exception: Glazing that is protected by a guard complying with Sections 1013 and 1607.8 where the plane of the glass is greater than 18 inches (457 mm) from the guard.

2406.5 Fire department access panels. Fire department glass access panels shall be of tempered glass. For insulating glass units, all panes shall be tempered glass.

SECTION 2407 GLASS IN HANDRAILS AND GUARDS

2407.1 Materials. Glass used as a handrail assembly or a guard section shall be constructed of either single fully tempered glass, laminated fully tempered glass or laminated heat-strengthened glass. Glazing in railing in-fill panels shall be of an approved safety glazing material that conforms to the provisions of Section 2406.1.1. For all glazing types, the minimum nominal thickness shall be $\frac{1}{4}$ inch (6.4 mm). Fully tempered glass and laminated glass shall comply with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1.

2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in Section 1607.8. A safety factor of four shall be used.

2407.1.2 Support. Each handrail or guard section shall be supported by a minimum of three glass balusters or shall be otherwise supported to remain in place should one baluster panel fail. Glass balusters shall not be installed without an attached handrail or guard.

Exception: A top rail shall not be required where the glass balusters are laminated glass with two or more

glass plies of equal thickness and the same glass type when approved by the building official. The panels shall be designed to withstand the loads specified in Section 1607.8.

2407.1.3 Parking garages. Glazing materials shall not be installed in handrails or guards in parking garages except for pedestrian areas not exposed to impact from vehicles.

2407.1.4 Glazing in wind-borne debris regions. Glazing installed in in-fill panels or balusters in wind-borne debris regions shall comply with the following:

2407.1.4.1 Ballusters and in-fill panels. Glass installed in exterior railing in-fill panels or balusters shall be laminated glass complying with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1.

2407.1.4.2 Glass supporting top rail. When the top rail is supported by glass, the assembly shall be tested according to the impact requirements of Section 1609.1.2. The top rail shall remain in place after impact.

SECTION 2408 GLAZING IN ATHLETIC FACILITIES

2408.1 General. Glazing in athletic facilities and similar uses subject to impact loads, which forms whole or partial wall sections or which is used as a door or part of a door, shall comply with this section.

2408.2 Racquetball and squash courts.

2408.2.1 Testing. Test methods and loads for individual glazed areas in racquetball and squash courts subject to impact loads shall conform to those of CPSC 16 CFR Part 1201 or ANSI Z97.1 with impacts being applied at a height of 59 inches (1499 mm) above the playing surface to an actual or simulated glass wall installation with fixtures, fittings and methods of assembly identical to those used in practice.

Glass walls shall comply with the following conditions:

1. A glass wall in a racquetball or squash court, or similar use subject to impact loads, shall remain intact following a test impact.
2. The deflection of such walls shall not be greater than $1\frac{1}{2}$ inches (38 mm) at the point of impact for a drop height of 48 inches (1219 mm).

Glass doors shall comply with the following conditions:

1. Glass doors shall remain intact following a test impact at the prescribed height in the center of the door.
2. The relative deflection between the edge of a glass door and the adjacent wall shall not exceed the thickness of the wall plus $\frac{1}{2}$ inch (12.7 mm) for a drop height of 48 inches (1219 mm).

2408.3 Gymnasiums and basketball courts. Glazing in multipurpose gymnasiums, basketball courts and similar ath-

letic facilities subject to human impact loads shall comply with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1.

SECTION 2409 GLASS IN ELEVATOR HOISTWAYS AND ELEVATOR CARS

2409.1 Glass in elevator hoistway enclosures. Glass in elevator hoistway enclosures and hoistway doors shall be laminated glass conforming to ANSI Z97.1 or CPSC 16 CFR Part 1201.

2409.1.1 Fire-resistance-rated hoistways. Glass installed in hoistways and hoistway doors where the hoistway is required to have a fire-resistance rating shall also comply with Section 716.

2409.1.2 Glass hoistway doors. The glass in glass hoistway doors shall be not less than 60 percent of the total visible door panel surface area as seen from the landing side.

2409.2 Glass visions panels. Glass in vision panels in elevator hoistway doors shall be permitted to be any transparent glazing material not less than $\frac{1}{4}$ inches (0.64 mm) in thickness conforming to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201. The area of any single vision panel shall not be less than 24 square inches ($15\ 484\ mm^2$) and the total area of one or more vision panels in any hoistway door shall be not more than 85 square inches ($54\ 839\ mm^2$).

2409.3 Glass in elevator cars.

2409.3.1 Glass types. Glass in elevator car enclosures, glass elevator car doors and glass used for lining walls and ceilings of elevator cars shall be laminated glass conforming to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201.

Exception: Tempered glass shall be permitted to be used for lining walls and ceilings of elevator cars provided:

1. The glass is bonded to a nonpolymeric coating, sheeting or film backing having a physical integrity to hold the fragments when the glass breaks.
2. The glass is not subjected to further treatment such as sandblasting; etching; heat treatment or painting that could alter the original properties of the glass.
3. The glass is tested to the acceptance criteria for laminated glass as specified for Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201.

2409.3.2 Surface area. The glass in glass elevator car doors shall be not less than 60 percent of the total visible door panel surface area as seen from the car side of the doors.

SECTION 2410 [DSA-SS, DSA-SS/CC, OSHPD 1 & 4] STRUCTURAL SEALANT GLAZING (SSG)

2410.1 General. The requirements of this section address the use of structural sealant glazing (SSG). These requirements shall not be used for butt joint glazing, point supported glass, and glass fins.

Design, construction, testing, and inspection shall satisfy the requirements of this code except as modified in Sections 2410.1.1 through 2410.1.4.

2410.1.1 Design. Design of structural sealant glazing (SSG) shall satisfy the following requirements:

1. SSG shall be weather tight and serviceable under design story drifts associated with the design earthquake and no glass fallout shall occur at the drifts determined by ASCE 7, Section 13.5.9.
2. The sealant utilized in the insulated glass units used in SSG shall be designed in accordance with ASTM C 1249. The insulated glass unit design shall be in accordance with ASTM C 1249, Section 6.7.2.
3. Allowable stress for SSG shall not exceed 20 psi and shall have a minimum factor of safety of 5 as required by ASTM C 1401.
4. Design methodology shall address seismic movement in accordance with ASTM C 1401, Section 30.3.4.
5. SSG systems shall be supported for self-weight and lateral loading at each floor level of the building.
6. Unitized SSG framing shall be anchored to the building floor bearing plate by screws or bolts and shall not rely upon gravity or frictional forces for attachment.
7. Framing shall satisfy the out-of-plane deflection requirements of this code.

2410.1.2 Testing and inspection. Testing and inspection of structural sealant glazing (SSG) shall satisfy the following requirements:

- a. The seismic drift capability of structural sealant glazing shall be determined by tests in accordance with AAMA 501.6, AAMA 501.4 and ASCE 7, Section 13.5.9.2.
- b. The applicability of the specific AAMA 501.6 and AAMA 501.4 testing shall be subject to approval by the building official.
- c. The panel test specimens used in the AAMA 501.6 and AAMA 501.4 testing shall include all glass types (annealed, heat strengthened, laminated, tempered) and insulated glass units that comprise more than 5 percent of the total glass curtain wall area used in the building.
- d. AAMA 501.4 test specimen shall include the same materials, sections, connections, and attachment details to the test apparatus as used in the building.
- e. Serviceability tests of SSG test specimen shall be performed in accordance with AAMA 501.4 after seismic displacement tests to the design story drift.

f. The window wall system using structural sealant by different manufacturer/product category shall be qualified in accordance with AAMA 501.6 and AAMA 501.4 testing for the seismic drift required. Analysis as an alternative to testing is not acceptable for the purposes of satisfying the seismic drift requirements of the SSG system.

- g. Where unitized SSG is used with horizontal stack joints at each floor level and split vertical mullions that can move independently, only a story height single unit need to be tested under AAMA 501.6. Where continuous horizontal bands of SSG are used in the building, either two or four sided, the aspect ratio (height-to-length) of the test specimen shall be less than 1.0, contain not less than two interior vertical joints and all joints (vertical in the case of two sided), including the perimeter of the glass, shall be glazed with SSG.
- h. Where SSG continues around corners, the AAMA 501.4 test specimen shall include one corner panel to verify the kinematics of the corner condition under seismic drift.
- i. Quality assurance and inspection requirements shall include formalized post-installation tests using the point load testing procedure in accordance with ASTM C 1392. The point load tests shall be done after the initial installation, then once every year for 3 years, not less than one test per elevation each time.

Exception: [DSA-SS, DSA-SS/CC] For two-sided SSG systems where the horizontal edges are mechanically attached to mullions, the yearly point load test for 3 years is not required.

- j. Where the SSG is field assembled, hand pull tab tests in accordance with ASTM C 1401, Section X2.1, one test every 100 linear feet, but not less than one test for each building elevation view shall be required.

Existing AAMA 501.4 and 501.6 test results satisfying the requirements of this section shall be permitted, in lieu of project specific tests, when approved by the building official.

2410.1.3 Monitoring. Short- and long-term periodic performance monitoring shall be provided in accordance with ASTM C 1401, C 1392 and C 1394. Inspection frequencies recommended in ASTM C 1392 Section 5.1 shall be followed.

After every significant seismic event, where the ground shaking acceleration at the site exceeds 0.3g, or the acceleration at any monitored building level (if any) exceeds 0.8g, as measured by the seismic monitoring system in the building, the owner shall retain a structural engineer to make an inspection of the SSG system. The inspection shall include viewing the performance of the panel, structural sealant, glass, reviewing the strong motion records, and a visual examination of the overall performance for deterioration, offset or physical damage. A report for each

inspection, including conclusions on the continuing adequacy of the SSG system, shall be submitted to the enforcement agency.

Exception: [DSA-SS, DSA-SS/CC] *The inspection requirements triggered by specific ground shaking acceleration or measured building acceleration is not required.*

2410.1.4 Construction documents. Complete design of the SSG system for gravity, wind and seismic forces shall be subject to review by the enforcement agency. Construction documents shall show structural details of glass and curtain wall system including:

1. *A design narrative explaining how the SSG is supported by the building and the mechanism used to accommodate seismic racking.*
2. *Type of SSG and whether field or shop built.*
3. *The means of supporting the glass during structural sealant curing time shall be shown in the construction documents.*
4. *Typical curtain wall panel elevation, plan view and sections.*
5. *Details of building corner joint to verify how the corner vertical mullion will move to accommodate the seismic drift.*
6. *Joints between panel and floors at top and bottom.*
7. *Joint between panels – including vertical and horizontal stack joints at intermediate and edge mullion.*
8. *Member sizes for curtain wall panels.*
9. *Glass pane sizes, thickness and type of glass.*
10. *Contact width of structural sealant and sealant materials for shop and field installation/reglazing.*
11. *Glass to aluminum joints (including primers, if any).*
12. *Maximum roof/floor dead and live load deflection of the roof/floor framing members supporting the exterior curtain wall system.*
13. *Required seismic separation or gap distance between the structural sealant glazing curtain wall and other adjacent cladding units.*
14. *Mitigation of galvanic reactions between the roof/floor slab anchors, steel screw connections of aluminum sections and the aluminum anchorage components, if any.*

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 25 – GYPSUM BOARD AND PLASTER

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.

See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | X | X | | | | | X | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | X | | | X | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 2501.2 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2503.2 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2504.2 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2504.2.1 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2505.3 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2507.3 | | | | | | | X | X | X | | | X | | | | | | | | |
| 2508.5.6 | | | | | | | X | X | X | | | X | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 25

GYPSUM BOARD AND PLASTER

SECTION 2501 GENERAL

2501.1 Scope.

2501.1.1 General. Provisions of this chapter shall govern the materials, design, construction and quality of gypsum board, lath, gypsum plaster and cement plaster.

2501.1.2 Performance. Lathing, plastering and gypsum board construction shall be done in the manner and with the materials specified in this chapter, and when required for fire protection, shall also comply with the provisions of Chapter 7.

2501.1.3 Other materials. Other approved wall or ceiling coverings shall be permitted to be installed in accordance with the recommendations of the manufacturer and the conditions of approval.

2501.2 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1 & 4] Details of attachment for wall and ceiling coverings which are not provided for in these regulations shall be detailed in the approved construction documents.

SECTION 2502 DEFINITIONS

2502.1 Definitions. The following terms are defined in Chapter 2:

CEMENT PLASTER.

EXTERIOR SURFACES.

GYPSUM BOARD.

GYPSUM PLASTER.

GYPSUM VENEER PLASTER.

INTERIOR SURFACES.

WEATHER-EXPOSED SURFACES.

WIRE BACKING.

SECTION 2503 INSPECTION

2503.1 Inspection. Lath and gypsum board shall be inspected in accordance with Section 110.3.5, *Chapter 1, Division II*.

2503.2 Additional requirements for inspection and testing. [DSA-S, DSA-SS/CC and OSHPD 1 & 4]

1. *Lath and gypsum board shall be inspected in accordance with Chapter 17A and the California Administrative Code.*
2. *No lath or gypsum wallboard or their attachments shall be covered or finished until it has been inspected and*

approved by the inspector of record and/or special inspector.

3. *The enforcement agency may require tests in accordance with Table 2506.2 to determine compliance with the provisions of these regulations.*
4. *The testing of gypsum and gypsum products shall conform with standards listed in Table 2506.2*

SECTION 2504 VERTICAL AND HORIZONTAL ASSEMBLIES

2504.1 Scope. The following requirements shall be met where construction involves gypsum board, lath and plaster in vertical and horizontal assemblies.

2504.1.1 Wood framing. Wood supports for lath or gypsum board, as well as wood stripping or furring, shall not be less than 2 inches (51 mm) nominal thickness in the least dimension.

Exception: The minimum nominal dimension of wood furring strips installed over solid backing shall not be less than 1 inch by 2 inches (25 mm by 51 mm).

2504.1.2 Studless partitions. The minimum thickness of vertically erected studless solid plaster partitions of $\frac{3}{8}$ -inch (9.5 mm) and $\frac{3}{4}$ -inch (19.1 mm) rib metal lath or $\frac{1}{2}$ -inch thick (12.7 mm) long-length gypsum lath and gypsum board partitions shall be 2 inches (51 mm).

2504.2 Additional requirements. [DSA-SS, DSA-SS/CC and OSHPD 1 & 4] In addition to the requirements of this section, the horizontal and vertical assemblies of plaster or gypsum board shall be designed to resist the loads specified in this code. For suspended acoustical ceiling systems, see Section 2506. For gypsum construction see Section 2508.

2504.2.1 Wood furring strips. Wood furring strips for ceilings fastened to floor or ceiling joist shall be nailed at each bearing with two common wire nails, one of which shall be a slant nail and the other a face nail, or by one nail having spirally grooved or annular grooved shanks approved by the enforcement agency for this purpose. All stripping nails shall penetrate not less than $1\frac{1}{4}$ inches (44.5 mm) into the member receiving the point. Holes in stripping at joints shall be subdrilled to prevent splitting.

Where common wire nails are used to support horizontal wood stripping for plaster ceilings, such stripping shall be wire tied to the joists 4 feet (1219 mm) on center with two strands of No. 18 W&M gage galvanized annealed wire to an 8d common wire nail driven into each side of the joist 2 inches (51 mm) above the bottom of the joist or to each end of a 16d common wire nail driven horizontally through the joist 2 inches (51 mm) above the bottom of the joist, and the ends of the wire secured together with three twists of the wire.

SECTION 2505 SHEAR WALL CONSTRUCTION

2505.1 Resistance to shear (wood framing). Wood-framed shear walls sheathed with gypsum board, lath and plaster shall be designed and constructed in accordance with Section 2306.3 and are permitted to resist wind and seismic loads. Walls resisting seismic loads shall be subject to the limitations in Section 12.2.1 of ASCE 7.

2505.2 Resistance to shear (steel framing). Cold-formed steel-framed shear walls sheathed with gypsum board and constructed in accordance with the materials and provisions of Section 2211.6 are permitted to resist wind and seismic loads. Walls resisting seismic loads shall be subject to the limitations in Section 12.2.1 of ASCE 7.

2505.3 [DSA-SS & DSA-SS/CC and OSHPD 1 & 4] Section 2505.1 and 2505.2 are not permitted.

SECTION 2506 GYPSUM BOARD MATERIALS

2506.1 General. Gypsum board materials and accessories shall be identified by the manufacturer's designation to indicate compliance with the appropriate standards referenced in this section and stored to protect such materials from the weather.

2506.2 Standards. Gypsum board materials shall conform to the appropriate standards listed in Table 2506.2 and Chapter 35 and, where required for fire protection, shall conform to the provisions of Chapter 7.

2506.2.1 Other materials. Metal suspension systems for acoustical and lay-in panel ceilings shall conform with ASTM C 635 listed in Chapter 35 and Section 13.5.6 of ASCE 7 for installation in high seismic areas.

**TABLE 2506.2
GYPSUM BOARD MATERIALS AND ACCESSORIES**

| MATERIAL | STANDARD |
|--|---------------------------|
| Accessories for gypsum board | ASTM C 1047 |
| Adhesives for fastening gypsum wallboard | ASTM C 557 |
| Elastomeric joint sealants | ASTM C 920 |
| Fiber-reinforced gypsum panels | ASTM C 1278 |
| Glass mat gypsum backing panel | ASTM C 1178 |
| Glass mat gypsum panel | ASTM C 1658 |
| Glass mat gypsum substrate | ASTM C 1177 |
| Joint reinforcing tape and compound | ASTM C 474; C 475 |
| Nails FOR gypsum boards | ASTM C 514, F 547, F 1667 |
| Steel screws | ASTM C 954; C 1002 |
| Steel studs, load-bearing | ASTM C 955 |
| Steel studs, nonload-bearing | ASTM C 645 |
| Standard specification for gypsum board | ASTM C 1396 |
| Testing gypsum and gypsum products | ASTM C 22; C 472; C 473 |

SECTION 2507 LATHING AND PLASTERING

2507.1 General. Lathing and plastering materials and accessories shall be marked by the manufacturer's designation to indicate compliance with the appropriate standards referenced in this section and stored in such a manner to protect them from the weather.

2507.2 Standards. Lathing and plastering materials shall conform to the standards listed in Table 2507.2 and Chapter 35 and, where required for fire protection, shall also conform to the provisions of Chapter 7.

**TABLE 2507.2
LATH, PLASTERING MATERIALS AND ACCESSORIES**

| MATERIAL | STANDARD |
|------------------------------------|--------------------|
| Accessories for gypsum veneer base | ASTM C 1047 |
| Blended cement | ASTM C 595 |
| Exterior plaster bonding compounds | ASTM C 932 |
| Gypsum casting and molding plaster | ASTM C 59 |
| Gypsum Keene's cement | ASTM C 61 |
| Gypsum plaster | ASTM C 28 |
| Gypsum veneer plaster | ASTM C 587 |
| Interior bonding compounds, gypsum | ASTM C 631 |
| Lime plasters | ASTM C 5; C 206 |
| Masonry cement | ASTM C 91 |
| Metal lath | ASTM C 847 |
| Plaster aggregates | |
| Sand | ASTM C 35; C 897 |
| Perlite | ASTM C 35 |
| Vermiculite | ASTM C 35 |
| Plastic cement | ASTM C 1328 |
| Portland cement | ASTM C 150 |
| Steel screws | ASTM C 1002; C 954 |
| Steel studs and track | ASTM C 645; C 955 |
| Welded wire lath | ASTM C 933 |
| Woven wire plaster base | ASTM C 1032 |

2507.3 Lath attachment to horizontal wood supports. [DSA-SS & DSA-SS/CC and OSHPD 1 & 4] Where interior or exterior lath is attached to horizontal wood supports, either of the following attachments shall be used in addition to the methods of attachment described in referenced standards listed in Table 2507.2.

1. Secure lath to alternate supports with ties consisting of a double strand of No. 18 W & M gage galvanized annealed wire at one edge of each sheet of lath. Wire ties shall be installed not less than 3 inches (76 mm) back from the edge of each sheet and shall be looped around stripping, or attached to an 8d common wire nail driven into each side of the joist 2 inches (51 mm) above the bottom of the joist or to each end of a 16d common wire nail driven horizontally through the joist 2 inches (51 mm) above the bottom of the joist and the

ends of the wire secured together with three twists of the wire.

2. *Secure lath to each support with $\frac{1}{2}$ -inch-wide (12.7 mm), $1\frac{1}{2}$ -inch-long (38mm) No. 9 W & M gage, ring shank, hook staple placed around a 10d common nail laid flat under the surface of the lath not more than 3 inches (76 mm) from edge of each sheet. Such staples may be placed over ribs of $\frac{3}{8}$ -inch (9.5 mm) rib lath or over back wire of welded wire fabric or other approved lath, omitting the 10d nails.*

SECTION 2508 GYPSUM CONSTRUCTION

2508.1 General. Gypsum board and gypsum plaster construction shall be of the materials listed in Tables 2506.2 and 2507.2. These materials shall be assembled and installed in compliance with the appropriate standards listed in Tables 2508.1 and 2511.1.1, and Chapter 35.

TABLE 2508.1
INSTALLATION OF GYPSUM CONSTRUCTION

| MATERIAL | STANDARD |
|---------------------------------|--------------------|
| Gypsum board | GA-216; ASTM C 840 |
| Gypsum sheathing | ASTM C 1280 |
| Gypsum veneer base | ASTM C 844 |
| Interior lathing and furring | ASTM C 841 |
| Steel framing for gypsum boards | ASTM C 754; C 1007 |

2508.2 Limitations. Gypsum wallboard or gypsum plaster shall not be used in any exterior surface where such gypsum construction will be exposed directly to the weather. Gypsum wallboard shall not be used where there will be direct exposure to water or continuous high humidity conditions. Gypsum sheathing shall be installed on exterior surfaces in accordance with ASTM C 1280.

2508.2.1 Weather protection. Gypsum wallboard, gypsum lath or gypsum plaster shall not be installed until weather protection for the installation is provided.

2508.3 Single-ply application. Edges and ends of gypsum board shall occur on the framing members, except those edges and ends that are perpendicular to the framing mem-

bers. Edges and ends of gypsum board shall be in moderate contact except in concealed spaces where fire-resistance-rated construction, shear resistance or diaphragm action is not required.

2508.3.1 Floating angles. Fasteners at the top and bottom plates of vertical assemblies, or the edges and ends of horizontal assemblies perpendicular to supports, and at the wall line are permitted to be omitted except on shear resisting elements or fire-resistance-rated assemblies. Fasteners shall be applied in such a manner as not to fracture the face paper with the fastener head.

2508.4 Joint treatment. Gypsum board fire-resistance-rated assemblies shall have joints and fasteners treated.

Exception: Joint and fastener treatment need not be provided where any of the following conditions occur:

1. Where the gypsum board is to receive a decorative finish such as wood paneling, battens, acoustical finishes or any similar application that would be equivalent to joint treatment.
2. On single-layer systems where joints occur over wood framing members.
3. Square edge or tongue-and-groove edge gypsum board (V-edge), gypsum backing board or gypsum sheathing.
4. On multilayer systems where the joints of adjacent layers are offset from one to another.
5. Assemblies tested without joint treatment.

2508.5 Horizontal gypsum board diaphragm ceilings. Gypsum board shall be permitted to be used on wood joists to create a horizontal diaphragm ceiling in accordance with Table 2508.5.

2508.5.1 Diaphragm proportions. The maximum allowable diaphragm proportions shall be $1\frac{1}{2}:1$ between shear resisting elements. Rotation or cantilever conditions shall not be permitted.

2508.5.2 Installation. Gypsum board used in a horizontal diaphragm ceiling shall be installed perpendicular to ceiling framing members. End joints of adjacent courses of gypsum board shall not occur on the same joist.

TABLE 2508.5
SHEAR CAPACITY FOR HORIZONTAL WOOD FRAMED GYPSUM BOARD DIAPHRAGM CEILING ASSEMBLIES

| MATERIAL | THICKNESS OF MATERIAL (MINIMUM) (inches) | SPACING OF FRAMING MEMBERS (MAXIMUM) (inches) | SHEAR VALUE ^{a, b} (plf of ceiling) | MIMIMUM FASTENER SIZE |
|--------------|--|---|--|---|
| Gypsum board | $\frac{1}{2}$ | 16 o.c. | 90 | 5d cooler or wallboard nail; $1\frac{5}{8}$ -inch long; 0.086-inch shank; $\frac{15}{64}$ -inch head ^c |
| Gypsum board | $\frac{1}{2}$ | 24 o.c. | 70 | 5d cooler or wallboard nail; $1\frac{5}{8}$ -inch long; 0.086-inch shank; $\frac{15}{64}$ -inch head ^c |

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.59 N/m.

- a. Values are not cumulative with other horizontal diaphragm values and are for short term loading due to wind or seismic loading. Values shall be reduced 25 percent for normal loading.
- b. Values shall be reduced 50 percent in Seismic Design Categories D, E and F.
- c. $1\frac{1}{4}$ inch, No. 6 Type S or W screws are permitted to be substituted for the listed nails.

2508.5.3 Blocking of perimeter edges. All perimeter edges shall be blocked using a wood member not less than 2-inch by 6-inch (51 mm by 159 mm) nominal dimension. Blocking material shall be installed flat over the top plate of the wall to provide a nailing surface not less than 2 inches (51 mm) in width for the attachment of the gypsum board.

2508.5.4 Fasteners. Fasteners used for the attachment of gypsum board to a horizontal diaphragm ceiling shall be as defined in Table 2508.5. Fasteners shall be spaced not more than 7 inches (178 mm) on center (o.c.) at all supports, including perimeter blocking, and not more than $\frac{3}{8}$ inch (9.5 mm) from the edges and ends of the gypsum board.

2508.5.5 Lateral force restrictions. Gypsum board shall not be used in diaphragm ceilings to resist lateral forces imposed by masonry or concrete construction.

2508.5.6 Diaphragm ceiling connection to partitions. [DSA-SS & DSA-SS/CC and OSHPD 1 & 4] Gypsum board shall not be used in diaphragm ceilings to resist lateral forces imposed by partitions. Connection of diaphragm ceiling to the vertical lateral force resisting elements shall be designed and detailed to transfer lateral forces.

SECTION 2509 GYPSUM BOARD IN SHOWERS AND WATER CLOSETS

2509.1 Wet areas. Showers and public toilet walls shall conform to Section 1210.2.

2509.2 Base for tile. Glass mat water-resistant gypsum backing panels, discrete nonasbestos fiber-cement interior substrate sheets or nonasbestos fiber-mat reinforced cementitious backer units in compliance with ASTM C 1178, C 1288 or C 1325 and installed in accordance with manufacturer recommendations shall be used as a base for wall tile in tub and shower areas and wall and ceiling panels in shower areas. Water-resistant gypsum backing board shall be used as a base for tile in water closet compartment walls when installed in accordance with GA-216 or ASTM C 840 and manufacturer recommendations. Regular gypsum wallboard is permitted under tile or wall panels in other wall and ceiling areas when installed in accordance with GA-216 or ASTM C 840.

2509.3 Limitations. Water-resistant gypsum backing board shall not be used in the following locations:

1. Over a vapor retarder in shower or bathtub compartments.
2. Where there will be direct exposure to water or in areas subject to continuous high humidity.
3. On ceilings where frame spacing exceeds 12 inches (305 mm) o.c. for $\frac{1}{2}$ -inch thick (12.7 mm) water-resistant gypsum backing board and more than 16 inches (406 mm) o.c. for $\frac{5}{8}$ -inch thick (15.9 mm) water-resistant gypsum backing board.

SECTION 2510 LATHING AND FURRING FOR CEMENT PLASTER (STUCCO)

2510.1 General. Exterior and interior cement plaster and lathing shall be done with the appropriate materials listed in Table 2507.2 and Chapter 35.

2510.2 Weather protection. Materials shall be stored in such a manner as to protect such materials from the weather.

2510.3 Installation. Installation of these materials shall be in compliance with ASTM C 926 and ASTM C 1063.

2510.4 Corrosion resistance. Metal lath and lath attachments shall be of corrosion-resistant material.

2510.5 Backing. Backing or a lath shall provide sufficient rigidity to permit plaster applications.

2510.5.1 Support of lath. Where lath on vertical surfaces extends between rafters or other similar projecting members, solid backing shall be installed to provide support for lath and attachments.

2510.5.2 Use of gypsum backing board.

2510.5.2.1 Use of gypsum board as a backing board. Gypsum lath or gypsum wallboard shall not be used as a backing for cement plaster.

Exception: Gypsum lath or gypsum wallboard is permitted, with a water-resistive barrier, as a backing for self-furred metal lath or self-furred wire fabric lath and cement plaster where either of the following conditions occur:

1. On horizontal supports of ceilings or roof soffits.
2. On interior walls.

2510.5.2.2 Use of gypsum sheathing backing. Gypsum sheathing is permitted as a backing for metal or wire fabric lath and cement plaster on walls. A water-resistive barrier shall be provided in accordance with Section 2510.6.

2510.5.3 Backing not required. Wire backing is not required under expanded metal lath or paperbacked wire fabric lath.

2510.6 Water-resistive barriers. Water-resistive barriers shall be installed as required in Section 1404.2 and, where applied over wood-based sheathing, shall include a water-resistive vapor-permeable barrier with a performance at least equivalent to two layers of Grade D paper. The individual layers shall be installed independently such that each layer provides a separate continuous plane and any flashing (installed in accordance with Section 1405.4) intended to drain to the water-resistive barrier is directed between the layers.

Exception: Where the water-resistive barrier that is applied over wood-based sheathing has a water resistance equal to or greater than that of 60-minute Grade D paper and is separated from the stucco by an intervening, substantially nonwater-absorbing layer or drainage space.

2510.7 Preparation of masonry and concrete. Surfaces shall be clean, free from efflorescence, sufficiently damp and

rough for proper bond. If the surface is insufficiently rough, approved bonding agents or a Portland cement dash bond coat mixed in proportions of not more than two parts volume of sand to one part volume of Portland cement or plastic cement shall be applied. The dash bond coat shall be left undisturbed and shall be moist cured not less than 24 hours.

SECTION 2511 INTERIOR PLASTER

2511.1 General. Plastering gypsum plaster or cement plaster shall not be less than three coats where applied over metal lath or wire fabric lath and not less than two coats where applied over other bases permitted by this chapter.

Exception: Gypsum veneer plaster and cement plaster specifically designed and approved for one-coat applications.

2511.1.1 Installation. Installation of lathing and plaster materials shall conform with Table 2511.1.1 and Section 2507.

TABLE 2511.1.1
INSTALLATION OF PLASTER CONSTRUCTION

| MATERIAL | STANDARD |
|---|--------------------|
| Cement plaster | ASTM C 926 |
| Gypsum plaster | ASTM C 842 |
| Gypsum veneer plaster | ASTM C 843 |
| Interior lathing and furring (gypsum plaster) | ASTM C 841 |
| Lathing and furring (cement plaster) | ASTM C 1063 |
| Steel framing | ASTM C 754; C 1007 |

2511.2 Limitations. Plaster shall not be applied directly to fiber insulation board. Cement plaster shall not be applied directly to gypsum lath or gypsum plaster except as specified in Sections 2510.5.1 and 2510.5.2.

2511.3 Grounds. Where installed, grounds shall ensure the minimum thickness of plaster as set forth in ASTM C 842 and ASTM C 926. Plaster thickness shall be measured from the face of lath and other bases.

2511.4 Interior masonry or concrete. Condition of surfaces shall be as specified in Section 2510.7. Approved specially prepared gypsum plaster designed for application to concrete surfaces or approved acoustical plaster is permitted. The total thickness of base coat plaster applied to concrete ceilings shall be as set forth in ASTM C 842 or ASTM C 926. Should ceiling surfaces require more than the maximum thickness permitted in ASTM C 842 or ASTM C 926, metal lath or wire fabric lath shall be installed on such surfaces before plastering.

2511.5 Wet areas. Showers and public toilet walls shall conform to Sections 1210.2 and 1210.3. When wood frame walls and partitions are covered on the interior with cement plaster or tile of similar material and are subject to water splash, the framing shall be protected with an approved moisture barrier.

SECTION 2512 EXTERIOR PLASTER

2512.1 General. Plastering with cement plaster shall be not less than three coats when applied over metal lath or wire fabric lath or gypsum board backing as specified in Section 2510.5 and shall be not less than two coats when applied over masonry or concrete. If the plaster surface is to be completely covered by veneer or other facing material, or is completely concealed by another wall, plaster application need only be two coats, provided the total thickness is as set forth in ASTM C 926.

2512.1.1 On-grade floor slab. On wood framed or steel stud construction with an on-grade concrete floor slab system, exterior plaster shall be applied in such a manner as to cover, but not to extend below, the lath and paper. The application of lath, paper and flashing or drip screeds shall comply with ASTM C 1063.

2512.1.2 Weep screeds. A minimum 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed with a minimum vertical attachment flange of $3\frac{1}{2}$ inches (89 mm) shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C 926. The weep screed shall be placed a minimum of 4 inches (102 mm) above the earth or 2 inches (51 mm) above paved areas and be of a type that will allow trapped water to drain to the exterior of the building. The water-resistive barrier shall lap the attachment flange. The exterior lath shall cover and terminate on the attachment flange of the weep screed.

2512.2 Plasticity agents. Only approved plasticity agents and approved amounts thereof shall be added to Portland cement or blended cements. When plastic cement or masonry cement is used, no additional lime or plasticizers shall be added. Hydrated lime or the equivalent amount of lime putty used as a plasticizer is permitted to be added to cement plaster or cement and lime plaster in an amount not to exceed that set forth in ASTM C 926.

2512.3 Limitations. Gypsum plaster shall not be used on exterior surfaces.

2512.4 Cement plaster. Plaster coats shall be protected from freezing for a period of not less than 24 hours after set has occurred. Plaster shall be applied when the ambient temperature is higher than 40°F (4°C), unless provisions are made to keep cement plaster work above 40°F (4°C) during application and 48 hours thereafter.

2512.5 Second-coat application. The second coat shall be brought out to proper thickness, rodded and floated sufficiently rough to provide adequate bond for the finish coat. The second coat shall have no variation greater than $\frac{1}{4}$ inch (6.4 mm) in any direction under a 5-foot (1524 mm) straight edge.

2512.6 Curing and interval. First and second coats of cement plaster shall be applied and moist cured as set forth in ASTM C 926 and Table 2512.6.

**TABLE 2512.6
CEMENT PLASTERS**

| COAT | MINIMUM PERIOD MOIST CURING | MINIMUM INTERVAL BETWEEN COATS |
|--------|--------------------------------|-----------------------------------|
| First | 48 hours ^a | 48 hours ^b |
| Second | 48 hours | 7 days ^c |
| Finish | — | Note c |

- a. The first two coats shall be as required for the first coats of exterior plaster, except that the moist curing time period between the first and second coats shall not be less than 24 hours. Moist curing shall not be required where job and weather conditions are favorable to the retention of moisture in the cement plaster for the required time period.
- b. Twenty four hour minimum interval between coats of interior cement plaster. For alternative method of application, see Section 2512.8.
- c. Finish coat plaster is permitted to be applied to interior cement plaster base coats after a 48 hour period.

2512.7 Application to solid backings. Where applied over gypsum backing as specified in Section 2510.5 or directly to unit masonry surfaces, the second coat is permitted to be applied as soon as the first coat has attained sufficient hardness.

2512.8 Alternate method of application. The second coat is permitted to be applied as soon as the first coat has attained sufficient rigidity to receive the second coat.

2512.8.1 Admixtures. When using this method of application, calcium aluminate cement up to 15 percent of the weight of the Portland cement is permitted to be added to the mix.

2512.8.2 Curing. Curing of the first coat is permitted to be omitted and the second coat shall be cured as set forth in ASTM C 926 and Table 2512.6.

2512.9 Finish coats. Cement plaster finish coats shall be applied over base coats that have been in place for the time periods set forth in ASTM C 926. The third or finish coat shall be applied with sufficient material and pressure to bond and to cover the brown coat and shall be of sufficient thickness to conceal the brown coat.

SECTION 2513 EXPOSED AGGREGATE PLASTER

2513.1 General. Exposed natural or integrally colored aggregate is permitted to be partially embedded in a natural or colored bedding coat of cement plaster or gypsum plaster, subject to the provisions of this section.

2513.2 Aggregate. The aggregate shall be applied manually or mechanically and shall consist of marble chips, pebbles or similar durable, moderately hard (three or more on the Mohs hardness scale), nonreactive materials.

2513.3 Bedding coat proportions. The bedding coat for interior or exterior surfaces shall be composed of one part Portland cement and one part Type S lime; or one part blended cement and one part Type S lime; or masonry cement; or plastic cement, and a maximum of three parts of

graded white or natural sand by volume. The bedding coat for interior surfaces shall be composed of 100 pounds (45.4 kg) of neat gypsum plaster and a maximum of 200 pounds (90.8 kg) of graded white sand. A factory-prepared bedding coat for interior or exterior use is permitted. The bedding coat for exterior surfaces shall have a minimum compressive strength of 1,000 pounds per square inch (psi) (6895 kPa).

2513.4 Application. The bedding coat is permitted to be applied directly over the first (scratch) coat of plaster, provided the ultimate overall thickness is a minimum of $\frac{7}{8}$ inch (22 mm), including lath. Over concrete or masonry surfaces, the overall thickness shall be a minimum of $\frac{1}{2}$ inch (12.7 mm).

2513.5 Bases. Exposed aggregate plaster is permitted to be applied over concrete, masonry, cement plaster base coats or gypsum plaster base coats installed in accordance with Section 2511 or 2512.

2513.6 Preparation of masonry and concrete. Masonry and concrete surfaces shall be prepared in accordance with the provisions of Section 2510.7.

2513.7 Curing of base coats. Cement plaster base coats shall be cured in accordance with ASTM C 926. Cement plaster bedding coats shall retain sufficient moisture for hydration (hardening) for 24 hours minimum or, where necessary, shall be kept damp for 24 hours by light water spraying.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 26 – PLASTIC

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | X | X | X | | | X | X | X | X | X | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 26

PLASTIC

SECTION 2601 GENERAL

2601.1 Scope. These provisions shall govern the materials, design, application, construction and installation of foam plastic, foam plastic insulation, plastic veneer, interior plastic finish and trim and light-transmitting plastics. See Chapter 14 for requirements for exterior wall finish and trim.

SECTION 2602 DEFINITIONS

2602.1 Definitions. The following terms are defined in Chapter 2:

FIBER-REINFORCED POLYMER.

FOAM PLASTIC INSULATION.

LIGHT-DIFFUSING SYSTEM.

LIGHT-TRANSMITTING PLASTIC ROOF PANELS.

LIGHT-TRANSMITTING PLASTIC WALL PANELS.

PLASTIC, APPROVED.

PLASTIC GLAZING.

THERMOPLASTIC MATERIAL.

THERMOSETTING MATERIAL.

SECTION 2603 FOAM PLASTIC INSULATION

2603.1 General. The provisions of this section shall govern the requirements and uses of foam plastic insulation in buildings and structures.

2603.2 Labeling and identification. Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the label of an approved agency showing the manufacturer's name, product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

2603.3 Surface-burning characteristics. Unless otherwise indicated in this section, foam plastic insulation and foam plastic cores of manufactured assemblies shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in the maximum thickness intended for use in accordance with ASTM E 84 or UL 723. Loose fill-type foam plastic insulation shall be tested as board stock for the flame spread and smoke-developed indexes.

Exceptions:

1. Smoke-developed index for interior trim as provided for in Section 2604.2.
2. In cold storage buildings, ice plants, food plants, food processing rooms and similar areas, foam plas-

tic insulation where tested in a thickness of 4 inches (102 mm) shall be permitted in a thickness up to 10 inches (254 mm) where the building is equipped throughout with an automatic fire sprinkler system in accordance with Section 903.3.1.1. The approved automatic sprinkler system shall be provided in both the room and that part of the building in which the room is located.

3. Foam plastic insulation that is a part of a Class A, B or C roof-covering assembly provided the assembly with the foam plastic insulation satisfactorily passes FM 4450 or UL 1256. The smoke-developed index shall not be limited for roof applications.
4. Foam plastic insulation greater than 4 inches (102 mm) in thickness shall have a maximum flame spread index of 75 and a smoke-developed index of 450 where tested at a minimum thickness of 4 inches (102 mm), provided the end use is approved in accordance with Section 2603.10 using the thickness and density intended for use.
5. Flame spread and smoke-developed indexes for foam plastic interior signs in covered and open mall buildings provided the signs comply with Section 402.6.4.

2603.4 Thermal barrier. Except as provided for in Sections 2603.4.1 and 2603.10, foam plastic shall be separated from the interior of a building by an approved thermal barrier of $\frac{1}{2}$ -inch (12.7 mm) gypsum wallboard or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275. Combustible concealed spaces shall comply with Section 718.

2603.4.1 Thermal barrier not required. The thermal barrier specified in Section 2603.4 is not required under the conditions set forth in Sections 2603.4.1.1 through 2603.4.1.14.

2603.4.1.1 Masonry or concrete construction. A thermal barrier is not required for foam plastic installed in a masonry or concrete wall, floor or roof system where the foam plastic insulation is covered on each face by a minimum of 1-inch (25 mm) thickness of masonry or concrete.

2603.4.1.2 Cooler and freezer walls. Foam plastic installed in a maximum thickness of 10 inches (254 mm) in cooler and freezer walls shall:

1. Have a flame spread index of 25 or less and a smoke-developed index of not more than 450, where tested in a minimum 4-inch (102 mm) thickness.
2. Have flash ignition and self-ignition temperatures of not less than 600°F and 800°F (316°C and 427°C), respectively.

3. Have a covering of not less than 0.032-inch (0.8 mm) aluminum or corrosion-resistant steel having a base metal thickness not less than 0.0160 inch (0.4 mm) at any point.
4. Be protected by an automatic sprinkler system in accordance with Section 903.3.1.1. Where the cooler or freezer is within a building, both the cooler or freezer and that part of the building in which it is located shall be sprinklered.

2603.4.1.3 Walk-in coolers. In nonsprinklered buildings, foam plastic having a thickness that does not exceed 4 inches (102 mm) and a maximum flame spread index of 75 is permitted in walk-in coolers or freezer units where the aggregate floor area does not exceed 400 square feet (37 m^2) and the foam plastic is covered by a metal facing not less than 0.032-inch-thick (0.81 mm) aluminum or corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm). A thickness of up to 10 inches (254 mm) is permitted where protected by a thermal barrier.

2603.4.1.4 Exterior walls-one-story buildings. For one-story buildings, foam plastic having a flame spread index of 25 or less, and a smoke-developed index of not more than 450, shall be permitted without thermal barriers in or on exterior walls in a thickness not more than 4 inches (102 mm) where the foam plastic is covered by a thickness of not less than 0.032-inch-thick (0.81 mm) aluminum or corrosion-resistant steel having a base metal thickness of 0.0160 inch (0.41 mm) and the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

2603.4.1.5 Roofing. Foam plastic insulation under a roof assembly or roof covering that is installed in accordance with the code and the manufacturer's instructions shall be separated from the interior of the building by wood structural panel sheathing not less than 0.47 inch (11.9 mm) in thickness bonded with exterior glue, with edges supported by blocking, tongue-and-groove joints or other approved type of edge support, or an equivalent material. A thermal barrier is not required for foam plastic insulation that is a part of a Class A, B or C roof-covering assembly, provided the assembly with the foam plastic insulation satisfactorily passes FM 4450 or UL 1256.

2603.4.1.6 Attics and crawl spaces. Within an attic or crawl space where entry is made only for service of utilities, foam plastic insulation shall be protected against ignition by $1\frac{1}{2}$ -inch-thick (38 mm) mineral fiber insulation; $\frac{1}{4}$ -inch-thick (6.4 mm) wood structural panel, particleboard or hardboard; $\frac{3}{8}$ -inch (9.5 mm) gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch (0.4 mm) or other approved material installed in such a manner that the foam plastic insulation is not exposed. The protective covering shall be consistent with the requirements for the type of construction.

2603.4.1.7 Doors not required to have a fire protection rating. Where pivoted or side-hinged doors are

permitted without a fire protection rating, foam plastic insulation, having a flame spread index of 75 or less and a smoke-developed index of not more than 450, shall be permitted as a core material where the door facing is of metal having a minimum thickness of 0.032-inch (0.8 mm) aluminum or steel having a base metal thickness of not less than 0.016 inch (0.4 mm) at any point.

2603.4.1.8 Exterior doors in buildings of Group R-2 or R-3. In occupancies classified as Group R-2 or R-3, foam-filled exterior entrance doors to individual dwelling units that do not require a fire-resistance rating shall be faced with wood or other approved materials.

2603.4.1.9 Garage doors. Where garage doors are permitted without a fire-resistance rating and foam plastic is used as a core material, the door facing shall be metal having a minimum thickness of 0.032-inch (0.8 mm) aluminum or 0.010-inch (0.25 mm) steel or the facing shall be minimum 0.125-inch-thick (3.2 mm) wood. Garage doors having facings other than those described above shall be tested in accordance with, and meet the acceptance criteria of, DASMA 107.

Exception: Garage doors using foam plastic insulation complying with Section 2603.3 in detached and attached garages associated with one- and two-family dwellings need not be provided with a thermal barrier.

2603.4.1.10 Siding backer board. Foam plastic insulation of not more than 2,000 British thermal units per square feet (Btu/sq. ft.) (22.7 mJ/m²) as determined by NFPA 259 shall be permitted as a siding backer board with a maximum thickness of $\frac{1}{2}$ inch (12.7 mm), provided it is separated from the interior of the building by not less than 2 inches (51 mm) of mineral fiber insulation or equivalent or where applied as insulation with residing over existing wall construction.

2603.4.1.11 Interior trim. Foam plastic used as interior trim in accordance with Section 2604 shall be permitted without a thermal barrier.

2603.4.1.12 Interior signs. Foam plastic used for interior signs in covered mall buildings in accordance with Section 402.6.4 shall be permitted without a thermal barrier. Foam plastic signs that are not affixed to interior building surfaces shall comply with Chapter 8 of the *California Fire Code*.

2603.4.1.13 Type V construction. Foam plastic spray applied to a sill plate and header of Type V construction is subject to all of the following:

1. The maximum thickness of the foam plastic shall be $3\frac{1}{4}$ inches (82.6 mm).
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pcf (24 to 32 kg/m³).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying smoke-developed index of 450 or less when tested in accordance with ASTM E 84 or UL 723.

2603.4.1.14 Floors. The thermal barrier specified in Section 2603.4 is not required to be installed on the walking surface of a structural floor system that contains foam plastic insulation when the foam plastic is covered by a minimum nominal $\frac{1}{2}$ -inch-thick (12.7 mm) wood structural panel or approved equivalent. The thermal barrier specified in Section 2603.4 is required on the underside of the structural floor system that contains foam plastic insulation when the underside of the structural floor system is exposed to the interior of the building.

Exception: Foam plastic used as part of an interior floor finish.

2603.5 Exterior walls of buildings of any height. Exterior walls of buildings of Type I, II, III or IV construction of any height shall comply with Sections 2603.5.1 through 2603.5.7. Exterior walls of cold storage buildings required to be constructed of noncombustible materials, where the building is more than one story in height, shall also comply with the provisions of Sections 2603.5.1 through 2603.5.7. Exterior walls of buildings of Type V construction shall comply with Sections 2603.2, 2603.3 and 2603.4.

2603.5.1 Fire-resistance-rated walls. Where the wall is required to have a fire-resistance rating, data based on tests conducted in accordance with ASTM E 119 or UL 263 shall be provided to substantiate that the fire-resistance rating is maintained.

2603.5.2 Thermal barrier. Any foam plastic insulation shall be separated from the building interior by a thermal barrier meeting the provisions of Section 2603.4, unless special approval is obtained on the basis of Section 2603.10.

Exception: One-story buildings complying with Section 2603.4.1.4.

2603.5.3 Potential heat. The potential heat of foam plastic insulation in any portion of the wall or panel shall not exceed the potential heat expressed in Btu per square feet (mJ/m^2) of the foam plastic insulation contained in the wall assembly tested in accordance with Section 2603.5.5. The potential heat of the foam plastic insulation shall be determined by tests conducted in accordance with NFPA 259 and the results shall be expressed in Btu per square feet (mJ/m^2).

Exception: One-story buildings complying with Section 2603.4.1.4.

2603.5.4 Flame spread and smoke-developed indexes. Foam plastic insulation, exterior coatings and facings shall be tested separately in the thickness intended for use, but not to exceed 4 inches (102 mm), and shall each have a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E 84 or UL 723.

Exception: Prefabricated or factory-manufactured panels having minimum 0.020-inch (0.51 mm) aluminum facings and a total thickness of $\frac{1}{4}$ inch (6.4 mm) or less are permitted to be tested as an assembly where the

foam plastic core is not exposed in the course of construction.

2603.5.5 Vertical and lateral fire propagation. The exterior wall assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.

Exception: One-story buildings complying with Section 2603.4.1.4.

2603.5.6 Label required. The edge or face of each piece, package or container of foam plastic insulation shall bear the label of an approved agency. The label shall contain the manufacturer's or distributor's identification, model number, serial number or definitive information describing the product or materials' performance characteristics and approved agency's identification.

2603.5.7 Ignition. Exterior walls shall not exhibit sustained flaming where tested in accordance with NFPA 268. Where a material is intended to be installed in more than one thickness, tests of the minimum and maximum thickness intended for use shall be performed.

Exception: Assemblies protected on the outside with one of the following:

1. A thermal barrier complying with Section 2603.4.
2. A minimum 1 inch (25 mm) thickness of concrete or masonry.
3. Glass-fiber-reinforced concrete panels of a minimum thickness of $\frac{3}{8}$ inch (9.5 mm).
4. Metal-faced panels having minimum 0.019-inch-thick (0.48 mm) aluminum or 0.016-inch-thick (0.41 mm) corrosion-resistant steel outer facings.
5. A minimum $\frac{7}{8}$ -inch (22.2 mm) thickness of stucco complying with Section 2510.

2603.6 Roofing. Foam plastic insulation meeting the requirements of Sections 2603.2, 2603.3 and 2603.4 shall be permitted as part of a roof-covering assembly, provided the assembly with the foam plastic insulation is a Class A, B or C roofing assembly where tested in accordance with ASTM E 108 or UL 790.

2603.7 Interior finish in plenums. Foam plastic insulation used as interior wall or ceiling finish in plenums shall comply with one or more of the following:

1. The foam plastic insulation shall be separated from the plenum by a thermal barrier complying with Section 2603.4 and shall exhibit a flame spread index of 75 or less and a smoke-developed index of 450 or less when tested in accordance with ASTM E 84 or UL 723 at the thickness and density intended for use.
2. The foam plastic insulation shall exhibit a flame spread index of 25 or less and a smoke-developed index of 50 or less when tested in accordance with ASTM E 84 or UL 723 at the thickness and density intended for use and shall meet the acceptance criteria of Section 803.1.2 when tested in accordance with NFPA 286.
3. The foam plastic insulation shall be covered by corrosion-resistant steel having a base metal thickness of not

less than 0.0160 inch (0.4 mm) and shall exhibit a flame spread index of 75 or less and a smoke-developed index of 450 or less when tested in accordance with ASTM E 84 or UL 723 at the thickness and density intended for use.

2603.8 Interior trim in plenums. Foam plastic insulation used as interior trim in plenums shall comply with the requirements of Section 2603.7.

2603.9 Protection against termites. In areas where the probability of termite infestation is very heavy in accordance with Figure 2603.9, extruded and expanded polystyrene, polyisocyanurate and other foam plastics shall not be installed on the exterior face or under interior or exterior foundation walls or slab foundations located below grade. The clearance between foam plastics installed above grade and exposed earth shall be at least 6 inches (152 mm).

Exceptions:

1. Buildings where the structural members of walls, floors, ceilings and roofs are entirely of noncombustible materials or preservative-treated wood.
2. An approved method of protecting the foam plastic and structure from subterranean termite damage is provided.
3. On the interior side of basement walls.

2603.10 Special approval. Foam plastic shall not be required to comply with the requirements of Sections 2603.4 through 2603.8 where specifically approved based on large-scale tests such as, but not limited to, NFPA 286 (with the acceptance

criteria of Section 803.2), FM 4880, UL 1040 or UL 1715. Such testing shall be related to the actual end-use configuration and be performed on the finished manufactured foam plastic assembly in the maximum thickness intended for use. Foam plastics that are used as interior finish on the basis of special tests shall also conform to the flame spread and smoke-developed requirements of Chapter 8. Assemblies tested shall include seams, joints and other typical details used in the installation of the assembly and shall be tested in the manner intended for use.

2603.10.1 Exterior walls. Testing based on Section 2603.10 shall not be used to eliminate any component of the construction of an exterior wall assembly when that component was included in the construction that has met the requirements of Section 2603.5.5.

SECTION 2604 INTERIOR FINISH AND TRIM

2604.1 General. Plastic materials installed as interior finish or trim shall comply with Chapter 8. Foam plastics shall only be installed as interior finish where approved in accordance with the special provisions of Section 2603.10. Foam plastics that are used as interior finish shall also meet the flame-spread index requirements for interior finish in accordance with Chapter 8. Foam plastics installed as interior trim shall comply with Section 2604.2.

[F] 2604.2 Interior trim. Foam plastic used as interior trim shall comply with Sections 2604.2.1 through 2604.2.4.

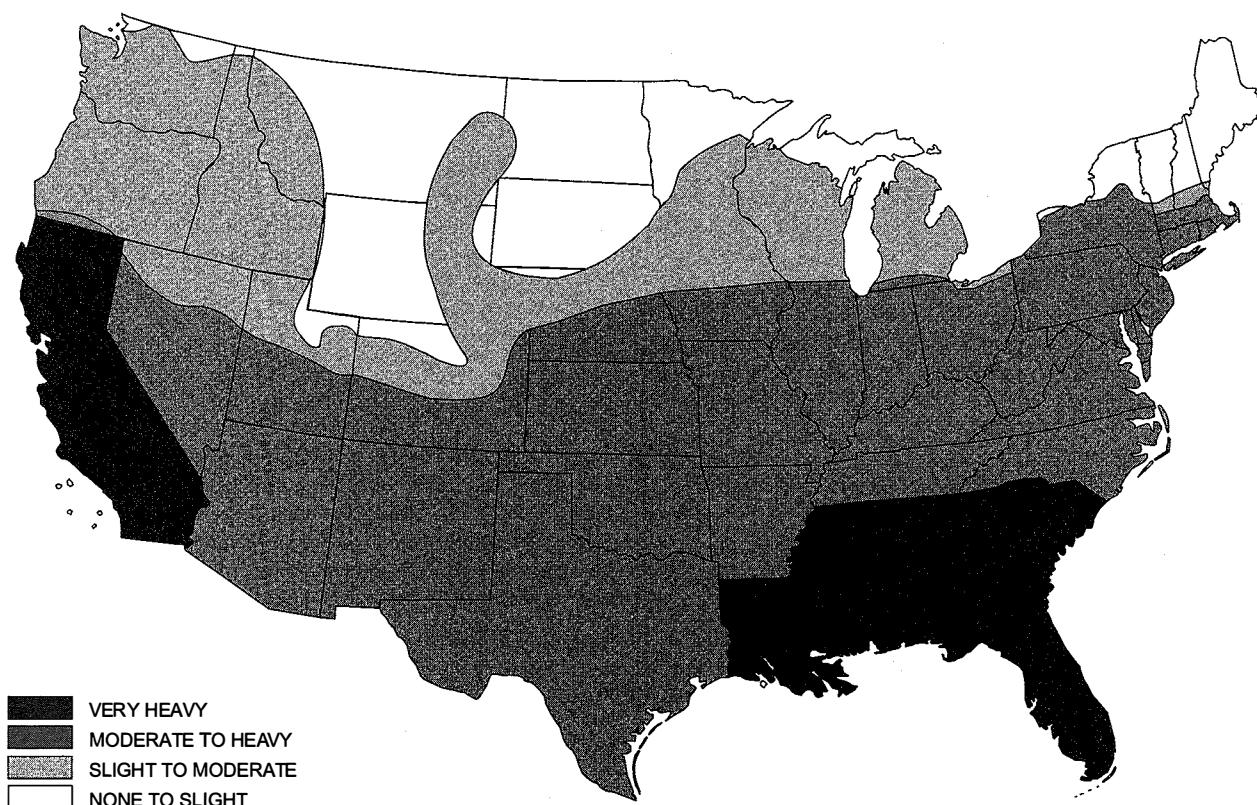


FIGURE 2603.9
TERMIT INFESTATION PROBABILITY MAP

[F] 2604.2.1 Density. The minimum density of the interior trim shall be 20pcf (320 kg/m³).

[F] 2604.2.2 Thickness. The maximum thickness of the interior trim shall be $\frac{1}{2}$ inch (12.7 mm) and the maximum width shall be 8 inches (204 mm).

[F] 2604.2.3 Area limitation. The interior trim shall not constitute more than 10 percent of the specific wall or ceiling areas to which it is attached.

[F] 2604.2.4 Flame spread. The flame spread index shall not exceed 75 where tested in accordance with ASTM E 84 or UL 723. The smoke-developed index shall not be limited.

Exception: When the interior trim material has been tested as an interior finish in accordance with NFPA 286 and complies with the acceptance criteria in Section 803.1.2.1, it shall not be required to be tested for flame spread index in accordance with ASTM E 84 or UL 723.

SECTION 2605 PLASTIC VENEER

2605.1 Interior use. Where used within a building, plastic veneer shall comply with the interior finish requirements of Chapter 8.

2605.2 Exterior use. Exterior plastic veneer, other than plastic siding, shall be permitted to be installed on the exterior walls of buildings of any type of construction in accordance with all of the following requirements:

1. Plastic veneer shall comply with Section 2606.4.
2. Plastic veneer shall not be attached to any exterior wall to a height greater than 50 feet (15 240 mm) above grade.
3. Sections of plastic veneer shall not exceed 300 square feet (27.9 m²) in area and shall be separated by a minimum of 4 feet (1219 mm) vertically.

Exception: The area and separation requirements and the smoke-density limitation are not applicable to plastic veneer applied to buildings constructed of Type VB construction, provided the walls are not required to have a fire-resistance rating.

2605.3 Plastic siding. Plastic siding shall comply with the requirements of Sections 1404 and 1405.

SECTION 2606 LIGHT-TRANSMITTING PLASTICS

2606.1 General. The provisions of this section and Sections 2607 through 2611 shall govern the quality and methods of application of light-transmitting plastics for use as light-transmitting materials in buildings and structures. Foam plastics shall comply with Section 2603. Light-transmitting plastic materials that meet the other code requirements for walls

and roofs shall be permitted to be used in accordance with the other applicable chapters of the code.

2606.2 Approval for use. Sufficient technical data shall be submitted to substantiate the proposed use of any light-transmitting material, as approved by the building official and subject to the requirements of this section.

2606.3 Identification. Each unit or package of light-transmitting plastic shall be identified with a mark or decal satisfactory to the building official, which includes identification as to the material classification.

2606.4 Specifications. Light-transmitting plastics, including thermoplastic, thermosetting or reinforced thermosetting plastic material, shall have a self-ignition temperature of 650°F (343°C) or greater where tested in accordance with ASTM D 1929; a smoke-developed index not greater than 450 where tested in the manner intended for use in accordance with ASTM E 84 or UL 723, or a maximum average smoke density rating not greater than 75 where tested in the thickness intended for use in accordance with ASTM D 2843 and shall conform to one of the following combustibility classifications:

Class CC1: Plastic materials that have a burning extent of 1 inch (25 mm) or less where tested at a nominal thickness of 0.060 inch (1.5 mm), or in the thickness intended for use, in accordance with ASTM D 635.

Class CC2: Plastic materials that have a burning rate of $2\frac{1}{2}$ inches per minute (1.06 mm/s) or less where tested at a nominal thickness of 0.060 inch (1.5 mm), or in the thickness intended for use, in accordance with ASTM D 635.

2606.5 Structural requirements. Light-transmitting plastic materials in their assembly shall be of adequate strength and durability to withstand the loads indicated in Chapter 16. Technical data shall be submitted to establish stresses, maximum unsupported spans and such other information for the various thicknesses and forms used as deemed necessary by the building official.

2606.6 Fastening. Fastening shall be adequate to withstand the loads in Chapter 16. Proper allowance shall be made for expansion and contraction of light-transmitting plastic materials in accordance with accepted data on the coefficient of expansion of the material and other material in conjunction with which it is employed.

2606.7 Light-diffusing systems. Unless the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, light-diffusing systems shall not be installed in the following occupancies and locations:

1. Group A with an occupant load of 1,000 or more.
2. Theaters with a stage and proscenium opening and an occupant load of 700 or more.
3. Group I-2.
4. Group I-3.
5. Interior exit stairways and ramps and exit passageways. |

2606.7.1 Support. Light-transmitting plastic diffusers shall be supported directly or indirectly from ceiling or roof construction by use of noncombustible hangers. Hangers shall be at least No. 12 steel-wire gage (0.106 inch) galvanized wire or equivalent.

2606.7.2 Installation. Light-transmitting plastic diffusers shall comply with Chapter 8 unless the light-transmitting plastic diffusers will fall from the mountings before igniting, at an ambient temperature of at least 200°F (111°C) below the ignition temperature of the panels. The panels shall remain in place at an ambient room temperature of 175°F (79°C) for a period of not less than 15 minutes.

2606.7.3 Size limitations. Individual panels or units shall not exceed 10 feet (3048 mm) in length nor 30 square feet (2.79 m^2) in area.

2606.7.4 Fire suppression system. In buildings that are equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, plastic light-diffusing systems shall be protected both above and below unless the sprinkler system has been specifically approved for installation only above the light-diffusing system. Areas of light-diffusing systems that are protected in accordance with this section shall not be limited.

2606.7.5 Electrical luminaires. Light-transmitting plastic panels and light-diffuser panels that are installed in approved electrical luminaires shall comply with the requirements of Chapter 8 unless the light-transmitting plastic panels conform to the requirements of Section 2606.7.2. The area of approved light-transmitting plastic materials that are used in required exits or corridors shall not exceed 30 percent of the aggregate area of the ceiling in which such panels are installed, unless the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

2606.8 Partitions. Light-transmitting plastics used in or as partitions shall comply with the requirements of Chapters 6 and 8.

2606.9 Bathroom accessories. Light-transmitting plastics shall be permitted as glazing in shower stalls, shower doors, bathtub enclosures and similar accessory units. Safety glazing shall be provided in accordance with Chapter 24.

2606.10 Awnings, patio covers and similar structures. Awnings constructed of light-transmitting plastics shall be constructed in accordance with the provisions specified in Section 3105 and Chapter 32 for projections. Patio covers constructed of light-transmitting plastics shall comply with Section 2606. Light-transmitting plastics used in canopies at motor fuel-dispensing facilities shall comply with Section 2606, except as modified by Section 406.7.2.

2606.11 Greenhouses. Light-transmitting plastics shall be permitted in lieu of plain glass in greenhouses.

2606.12 Solar collectors. Light-transmitting plastic covers on solar collectors having noncombustible sides and bottoms shall be permitted on buildings not over three stories above

grade plane or 9,000 square feet (836.1 m^2) in total floor area, provided the light-transmitting plastic cover does not exceed 33.33 percent of the roof area for CC1 materials or 25 percent of the roof area for CC2 materials.

Exception: Light-transmitting plastic covers having a thickness of 0.010 inch (0.3 mm) or less or shall be permitted to be of any plastic material provided the area of the solar collectors does not exceed 33.33 percent of the roof area.

SECTION 2607 LIGHT-TRANSMITTING PLASTIC WALL PANELS

2607.1 General. Light-transmitting plastics shall not be used as wall panels in exterior walls in occupancies in Groups A-1, A-2, H, I-2 and I-3. In other groups, light-transmitting plastics shall be permitted to be used as wall panels in exterior walls, provided that the walls are not required to have a fire-resistance rating and the installation conforms to the requirements of this section. Such panels shall be erected and anchored on a foundation, waterproofed or otherwise protected from moisture absorption and sealed with a coat of mastic or other approved waterproof coating. Light-transmitting plastic wall panels shall also comply with Section 2606.

2607.2 Installation. Exterior wall panels installed as provided for herein shall not alter the type of construction classification of the building.

2607.3 Height limitation. Light-transmitting plastics shall not be installed more than 75 feet (22 860 mm) above grade plane, except as allowed by Section 2607.5.

2607.4 Area limitation and separation. The maximum area of a single wall panel and minimum vertical and horizontal separation requirements for exterior light-transmitting plastic wall panels shall be as provided for in Table 2607.4. The maximum percentage of wall area of any story in light-transmitting plastic wall panels shall not exceed that indicated in Table 2607.4 or the percentage of unprotected openings permitted by Section 705.8, whichever is smaller.

Exceptions:

1. In structures provided with approved flame barriers extending 30 inches (760 mm) beyond the exterior wall in the plane of the floor, a vertical separation is not required at the floor except that provided by the vertical thickness of the flame barrier projection.
2. Veneers of approved weather-resistant light-transmitting plastics used as exterior siding in buildings of Type V construction in compliance with Section 1406.
3. The area of light-transmitting plastic wall panels in exterior walls of greenhouses shall be exempt from the area limitations of Table 2607.4 but shall be limited as required for unprotected openings in accordance with Section 704.8.

**TABLE 2607.4
AREA LIMITATION AND SEPARATION REQUIREMENTS FOR LIGHT-TRANSMITTING PLASTIC WALL PANELS^a**

| FIRE SEPARATION DISTANCE (feet) | CLASS OF PLASTIC | MAXIMUM PERCENTAGE AREA OF EXTERIOR WALL IN PLASTIC WALL PANELS | MAXIMUM SINGLE AREA OF PLASTIC WALL PANELS (square feet) | MINIMUM SEPARATION OF PLASTIC WALL PANELS (feet) | |
|---|------------------|---|--|--|------------|
| | | | | Vertical | Horizontal |
| Less than 6 | — | Not Permitted | Not Permitted | — | — |
| 6 or more but less than 11 | CC1 | 10 | 50 | 8 | 4 |
| | CC2 | Not Permitted | Not Permitted | — | — |
| 11 or more but less than or equal to 30 | CC1 | 25 | 90 | 6 | 4 |
| | CC2 | 15 | 70 | 8 | 4 |
| Over 30 | CC1 | 50 | Not Limited | 3 ^b | 0 |
| | CC2 | 50 | 100 | 6 ^b | 3 |

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m².

a. For combinations of plastic glazing and plastic wall panel areas permitted, see Section 2607.6.

b. For reductions in vertical separation allowed, see Section 2607.4.

2607.5 Automatic sprinkler system. Where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the maximum percentage area of exterior wall in any story in light-transmitting plastic wall panels and the maximum square footage of a single area given in Table 2607.4 shall be increased 100 percent, but the area of light-transmitting plastic wall panels shall not exceed 50 percent of the wall area in any story, or the area permitted by Section 705.8 for unprotected openings, whichever is smaller. These installations shall be exempt from height limitations.

2607.6 Combinations of glazing and wall panels. Combinations of light-transmitting plastic glazing and light-transmitting plastic wall panels shall be subject to the area, height and percentage limitations and the separation requirements applicable to the class of light-transmitting plastic as prescribed for light-transmitting plastic wall panel installations.

SECTION 2608 LIGHT-TRANSMITTING PLASTIC GLAZING

2608.1 Buildings of Type VB construction. Openings in the exterior walls of buildings of Type VB construction, where not required to be protected by Section 705, shall be permitted to be glazed or equipped with light-transmitting plastic. Light-transmitting plastic glazing shall also comply with Section 2606.

2608.2 Buildings of other types of construction. Openings in the exterior walls of buildings of types of construction other than Type VB, where not required to be protected by Section 705, shall be permitted to be glazed or equipped with light-transmitting plastic in accordance with Section 2606 and all of the following:

1. The aggregate area of light-transmitting plastic glazing shall not exceed 25 percent of the area of any wall face of the story in which it is installed. The area of a single pane of glazing installed above the first story above grade plane shall not exceed 16 square feet (1.5 m²) and the vertical dimension of a single pane shall not exceed 4 feet (1219 mm).

Exception: Where an automatic sprinkler system is provided throughout in accordance with Section 903.3.1.1, the area of allowable glazing shall be

increased to a maximum of 50 percent of the wall face of the story in which it is installed with no limit on the maximum dimension or area of a single pane of glazing.

2. Approved flame barriers extending 30 inches (762 mm) beyond the exterior wall in the plane of the floor, or vertical panels not less than 4 feet (1219 mm) in height, shall be installed between glazed units located in adjacent stories.

Exception: Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

3. Light-transmitting plastics shall not be installed more than 75 feet (22 860 mm) above grade level.

Exception: Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

SECTION 2609 LIGHT-TRANSMITTING PLASTIC ROOF PANELS

2609.1 General. Light-transmitting plastic roof panels shall comply with this section and Section 2606. Light-transmitting plastic roof panels shall not be installed in Groups H, I-2 and I-3. In all other groups, light-transmitting plastic roof panels shall comply with any one of the following conditions:

1. The building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. The roof construction is not required to have a fire-resistance rating by Table 601.
3. The roof panels meet the requirements for roof coverings in accordance with Chapter 15.

2609.2 Separation. Individual roof panels shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

Exceptions:

1. The separation between roof panels is not required in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

2. The separation between roof panels is not required in low-hazard occupancy buildings complying with the conditions of Section 2609.4, Exception 2 or 3.

2609.3 Location. Where exterior wall openings are required to be protected by Section 705.8, a roof panel shall not be installed within 6 feet (1829 mm) of such exterior wall.

2609.4 Area limitations. Roof panels shall be limited in area and the aggregate area of panels shall be limited by a percentage of the floor area of the room or space sheltered in accordance with Table 2609.4.

Exceptions:

1. The area limitations of Table 2609.4 shall be permitted to be increased by 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. Low-hazard occupancy buildings, such as swimming pool shelters, shall be exempt from the area limitations of Table 2609.4, provided that the buildings do not exceed 5,000 square feet (465 m^2) in area and have a minimum fire separation distance of 10 feet (3048 mm).
3. Greenhouses that are occupied for growing plants on a production or research basis, without public access, shall be exempt from the area limitations of Table 2609.4 provided they have a minimum fire separation distance of 4 feet (1220 mm).
4. Roof coverings over terraces and patios in occupancies in Group R-3 shall be exempt from the area limitations of Table 2609.4 and shall be permitted with light-transmitting plastics.

**TABLE 2609.4
AREA LIMITATIONS FOR LIGHT-TRANSMITTING
PLASTIC ROOF PANELS**

| CLASS OF PLASTIC | MAXIMUM AREA OF INDIVIDUAL ROOF PANELS (square feet) | MAXIMUM AGGREGATE AREA OF ROOF PANELS (percent of floor area) |
|------------------|--|---|
| CC1 | 300 | 30 |
| CC2 | 100 | 25 |

For SI: 1 square foot = 0.0929 m².

SECTION 2610 LIGHT-TRANSMITTING PLASTIC SKYLIGHT GLAZING

2610.1 Light-transmitting plastic glazing of skylight assemblies. Skylight assemblies glazed with light-transmitting plastic shall conform to the provisions of this section and Section 2606. Unit skylights glazed with light-transmitting plastic shall also comply with Section 2405.5.

Exception: Skylights in which the light-transmitting plastic conforms to the required roof-covering class in accordance with Section 1505.

2610.2 Mounting. The light-transmitting plastic shall be mounted above the plane of the roof on a curb constructed in accordance with the requirements for the type of construction classification, but at least 4 inches (102 mm) above the plane of the roof. Edges of the light-transmitting plastic skylights or

domes shall be protected by metal or other approved noncombustible material, or the light transmitting plastic dome or skylight shall be shown to be able to resist ignition where exposed at the edge to a flame from a Class B brand as described in ASTM E 108 or UL 790. The Class B brand test shall be conducted on a skylight that is elevated to a height as specified in the manufacturer's installation instructions, but not less than 4 inches (102 mm).

Exceptions:

1. Curbs shall not be required for skylights used on roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) in occupancies in Group R-3 and on buildings with a nonclassified roof covering.
2. The metal or noncombustible edge material is not required where nonclassified roof coverings are permitted.

2610.3 Slope. Flat or corrugated light-transmitting plastic skylights shall slope at least four units vertical in 12 units horizontal (4:12). Dome-shaped skylights shall rise above the mounting flange a minimum distance equal to 10 percent of the maximum width of the dome but not less than 3 inches (76 mm).

Exception: Skylights that pass the Class B Burning Brand Test specified in ASTM E 108 or UL 790.

2610.4 Maximum area of skylights. Each skylight shall have a maximum area within the curb of 100 square feet (9.3 m^2).

Exception: The area limitation shall not apply where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or the building is equipped with smoke and heat vents in accordance with Section 910.

2610.5 Aggregate area of skylights. The aggregate area of skylights shall not exceed $33\frac{1}{3}$ percent of the floor area of the room or space sheltered by the roof in which such skylights are installed where Class CC1 materials are utilized, and 25 percent where Class CC2 materials are utilized.

Exception: The aggregate area limitations of light-transmitting plastic skylights shall be increased 100 percent beyond the limitations set forth in this section where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or the building is equipped with smoke and heat vents in accordance with Section 910.

2610.6 Separation. Skylights shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

Exceptions:

1. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. In Group R-3, multiple skylights located above the same room or space with a combined area not exceeding the limits set forth in Section 2610.4.

2610.7 Location. Where exterior wall openings are required to be protected in accordance with Section 705, a skylight shall not be installed within 6 feet (1829 mm) of such exterior wall.

2610.8 Combinations of roof panels and skylights. Combinations of light-transmitting plastic roof panels and skylights shall be subject to the area and percentage limitations and separation requirements applicable to roof panel installations.

SECTION 2611 LIGHT-TRANSMITTING PLASTIC INTERIOR SIGNS

2611.1 General. Light-transmitting plastic interior wall signs shall be limited as specified in Sections 2611.2 through 2611.4. Light-transmitting plastic interior wall signs in covered and open mall buildings shall comply with Section 402.16. Light-transmitting plastic interior signs shall also comply with Section 2606.

2611.2 Aggregate area. The sign shall not exceed 20 percent of the wall area.

2611.3 Maximum area. The sign shall not exceed 24 square feet (2.23 m²).

2611.4 Encasement. Edges and backs of the sign shall be fully encased in metal.

SECTION 2612 FIBER-REINFORCED POLYMER

2612.1 General. The provisions of this section shall govern the requirements and uses of fiber-reinforced polymer in and on buildings and structures.

2612.2 Labeling and identification. Packages and containers of fiber-reinforced polymer and their components delivered to the job site shall bear the label of an approved agency showing the manufacturer's name, product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

2612.3 Interior finishes. Fiber-reinforced polymer used as interior finishes, decorative materials or trim shall comply with Chapter 8.

2612.3.1 Foam plastic cores. Fiber-reinforced polymer used as interior finish and which contains foam plastic cores shall comply with Chapter 8 and Chapter 26.

2612.4 Light-transmitting materials. Fiber-reinforced polymer used as light-transmitting materials shall comply with Sections 2606 through 2611 as required for the specific application.

2612.5 Exterior use. Fiber-reinforced polymer shall be permitted to be installed on the exterior walls of buildings of any type of construction when such polymers meet the requirements of Section 2603.5. Fireblocking shall be installed in accordance with Section 718.

Exceptions:

1. Compliance with Section 2603.5 is not required when all of the following conditions are met:

1.1. The fiber-reinforced polymer shall not exceed an aggregate total of 20 percent of the area of the specific wall to which it is attached, and no single architectural element shall exceed 10 percent of the area of the specific wall to which it is attached, and no contiguous set of architectural elements shall exceed 10 percent of the area of the specific wall to which they are attached.

1.2. The fiber-reinforced polymer shall have a flame spread index of 25 or less. The flame spread index requirement shall not be required for coatings or paints having a thickness of less than 0.036 inch (0.9 mm) that are applied directly to the surface of the fiber-reinforced polymer.

1.3. Fireblocking complying with Section 718.2.6 shall be installed.

1.4. The fiber-reinforced polymer shall be installed directly to a noncombustible substrate or be separated from the exterior wall by one of the following materials: corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm) at any point, aluminum having a minimum thickness of 0.019 inch (0.5 mm) or other approved noncombustible material.

2. Compliance with Section 2603.5 is not required when the fiber-reinforced polymer is installed on buildings that are 40 feet (12 190 mm) or less above grade when all of the following conditions are met:

2.1. The fiber-reinforced polymer shall meet the requirements of Section 1406.2.

2.2. Where the fire separation distance is 5 feet (1524 mm) or less, the area of the fiber-reinforced polymer shall not exceed 10 percent of the wall area. Where the fire separation distance is greater than 5 feet (1524 mm), there shall be no limit on the area of the exterior wall coverage using fiber-reinforced polymer.

2.3. The fiber-reinforced polymer shall have a flame spread index of 200 or less. The flame spread index requirements do not apply to coatings or paints having a thickness of less than 0.036 inch (0.9 mm) that are applied directly to the surface of the fiber-reinforced polymer.

2.4. Fireblocking complying with Section 718.2.6 shall be installed.

SECTION 2613 REFLECTIVE PLASTIC CORE INSULATION

2613.1 General. The provisions of this section shall govern the requirements and uses of reflective plastic core insulation in buildings and structures. Reflective plastic core insulation

shall comply with the requirements of Section 2613.2 and of one of the following: Section 2613.3 or 2613.4.

2613.2 Identification. Packages and containers of reflective plastic core insulation delivered to the job site shall show the manufacturer's or supplier's name, product identification and information sufficient to determine that the end use will comply with the code requirements.

2613.3 Surface-burning characteristics. Reflective plastic core insulation shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 450 when tested in accordance with ASTM E 84 or UL 723. The reflective plastic core insulation shall be tested at the maximum thickness intended for use. Test specimen preparation and mounting shall be in accordance with ASTM E 2599.

2613.4 Room corner test heat release. Reflective plastic core insulation shall comply with the acceptance criteria of Section 803.1.2.1 when tested in accordance with NFPA 286 or UL 1715 in the manner intended for use and at the maximum thickness intended for use.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 27 – ELECTRICAL

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | X | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | X | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 2702.2.5 | | | | | | X | | | | | | | | | | | | | | |
| 2702.2.6 | | | | | | | X | | | | | | | | | | | | | |
| 2702.2.15 | | X | | | | | | | | | | | | | | | | | | |
| 2702.2.21 | | X | | | | | | | | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 27

ELECTRICAL

SECTION 2701 GENERAL

2701.1 Scope. This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment and systems shall be designed and constructed in accordance with the provisions of *California Electrical Code*.

SECTION 2702 EMERGENCY AND STANDBY POWER SYSTEMS

[F] 2702.1 Installation. Emergency and standby power systems required by this code or the *California Fire Code* shall be installed in accordance with this code, NFPA 110 and 111.

[F] 2702.1.1 Stationary generators. Stationary emergency and standby power generators required by this code shall be listed in accordance with UL 2200.

[F] 2702.2 Where required. Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.20.

[F] 2702.2.1 Group A occupancies. Emergency power shall be provided for emergency voice/alarm communication systems in Group A occupancies in accordance with Section 907.5.2.2.4.

[F] 2702.2.2 Smoke control systems. Standby power shall be provided for smoke control systems in accordance with Section 909.11.

[F] 2702.2.3 Exit signs. Emergency power shall be provided for exit signs in accordance with Section 1011.6.3.

[F] 2702.2.4 Means of egress illumination. Emergency power shall be provided for means of egress illumination in accordance with Section 1006.3.

[F] 2702.2.5 Accessible means of egress elevators. Standby power shall be provided for elevators that are part of an accessible means of egress in accordance with Section 1007.4.

[F] 2702.2.6 Accessible means of egress platform lifts. Standby power in accordance with this section or ASME A 18.1 shall be provided for platform lifts that are part of an accessible means of egress in accordance with Section 1007.5.

[F] 2702.2.7 Horizontal sliding doors. Standby power shall be provided for horizontal sliding doors in accordance with Section 1008.1.4.3.

[F] 2702.2.8 Semiconductor fabrication facilities. Emergency power shall be provided for semiconductor fabrication facilities in accordance with Section 415.10.10.

[F] 2702.2.9 Membrane structures. Standby power shall be provided for auxiliary inflation systems in accordance with Section 3102.8.2. Emergency power shall be pro-

vided for exit signs in temporary tents and membrane structures in accordance with the *California Fire Code*.

[F] 2702.2.10 Hazardous materials. Emergency or standby power shall be provided in occupancies with hazardous materials in accordance with Section 414.5.3.

[F] 2702.2.11 Highly toxic and toxic materials. Emergency power shall be provided for occupancies with highly toxic or toxic materials in accordance with the *California Fire Code*.

[F] 2702.2.12 Organic peroxides. Standby power shall be provided for occupancies with silane gas in accordance with the *California Fire Code*.

[F] 2702.2.13 Pyrophoric materials. Emergency power shall be provided for occupancies with silane gas in accordance with the *California Fire Code*.

[F] 2702.2.14 Covered and open mall buildings. Standby power shall be provided for voice/alarm communication systems in covered and open mall buildings in accordance with Section 402.7.3.

[F] 2702.2.15 High-rise buildings and Group I-2 occupancies having occupied floors located more than 75 feet above the lowest level of fire department vehicle access. Emergency and standby power shall be provided in high-rise buildings and Group I-2 occupancies having occupied floors located more than 75 feet above the lowest level of fire department vehicle access in accordance with Sections 403.4.7 and 403.4.8.

[F] 2702.2.16 Underground buildings. Emergency and standby power shall be provided in underground buildings in accordance with Sections 405.8 and 405.9.

[F] 2702.2.17 Group I-3 occupancies. Emergency power shall be provided for doors in Group I-3 occupancies in accordance with Section 408.4.2.

[F] 2702.2.18 Airport traffic control towers. Standby power shall be provided in airport traffic control towers in accordance with Section 412.3.4.

[F] 2702.2.19 Elevators. Standby power for elevators shall be provided as set forth in Sections 3003.1, 3007.9 and 3008.9.

[F] 2702.2.20 Smokeproof enclosures. Standby power shall be provided for smokeproof enclosures as required by Section 909.20.6.2.

2702.2.21 Group L-Occupancy. Emergency power shall be provided in Group L occupancies in accordance with this chapter and Section 443.4.6.1.

[F] 2702.3 Maintenance. Emergency and standby power systems shall be maintained and tested in accordance with the *California Fire Code*.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 28 – MECHANICAL SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | X | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 2802 | | X | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 28

MECHANICAL SYSTEMS

SECTION 2801

GENERAL

[M] **2801.1 Scope.** Mechanical appliances, equipment and systems shall be constructed, installed and maintained in accordance with the *California Mechanical Code*. Masonry chimneys, fireplaces and barbecues shall comply with the *California Mechanical Code* and Chapter 21 of this code.

2802 Spark Arrester. [SFM] All chimneys attached to any appliance or fireplace that burns solid fuel shall be equipped with an approved spark arrester. The spark arrestor shall meet all of the following requirements:

1. *The net free area of the spark arrester shall not be less than four times the net free area of the outlet of the chimney flue it serves.*
2. *The spark arrester screen shall have heat and corrosion resistance equivalent to 19-gage galvanized steel or 24-gage stainless steel.*
3. *Openings shall not permit the passage of spheres having a diameter larger than $\frac{1}{2}$ inch (12.7 mm) and shall not block the passage of spheres having a diameter of less than $\frac{3}{8}$ inch (9.5 mm).*
4. *The spark arrestor shall be accessible for cleaning and the screen or chimney cap shall be removable to allow for cleaning of the chimney flue.*



CHAPTER 29

PLUMBING SYSTEMS

(Not Adopted by the State of California)

Refer to California Plumbing Code, Title 24, Part 5

SECTION 2901 GENERAL

[P] 2901.1 Scope. The provisions of this chapter and the *California Plumbing Code* shall govern the erection, installation, alteration, repairs, relocation, replacement, addition to, use or maintenance of plumbing equipment and systems. Toilet and bathing rooms shall be constructed in accordance with Section 1210. Plumbing systems and equipment shall be constructed, installed and maintained in accordance with the *California Plumbing Code*. Private sewage disposal systems shall conform to the *California Private Sewage Disposal Code*.

For minimum plumbing fixture requirements, see Table 422.1 of the *California Plumbing Code*.

SECTION 2902 MINIMUM PLUMBING FACILITIES

[P] 2902.1 Minimum number of fixtures. Plumbing fixtures shall be provided for the type of occupancy and in the minimum number shown in Table 2902.1. Types of occupancies

not shown in Table 2902.1 shall be considered individually by the building official. The number of occupants shall be determined by this code. Occupancy classification shall be determined in accordance with Chapter 3.

[P] 2902.1.1 Fixture calculations. To determine the occupant load of each sex, the total occupant load shall be divided in half. To determine the required number of fixtures, the fixture ratio or ratios for each fixture type shall be applied to the occupant load of each sex in accordance with Table 2902.1. Fractional numbers resulting from applying the fixture ratios of Table 2902.1 shall be rounded up to the next whole number. For calculations involving multiple occupancies, such fractional numbers for each occupancy shall first be summed and then rounded up to the next whole number.

Exception: The total occupant load shall not be required to be divided in half where approved statistical data indicate a distribution of the sexes of other than 50 percent of each sex.

**[P] TABLE 2902.1
MINIMUM NUMBER OF REQUIRED PLUMBING FIXTURES^a
(See Sections 2902.2 and 2902.3)**

| No. | CLASSIFICATION | OCCUPANCY | DESCRIPTION | WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE CALIFORNIA PLUMBING CODE) | | LAVATORIES | | BATHTUBS/ SHOWERS | DRINKING FOUNTAINS, ^b (SEE SECTION 410.1 OF THE CALIFORNIA PLUMBING CODE) | OTHER |
|-----|-------------------------|------------------|---|---|-----------|------------|--------|----------------------|--|-------|
| | | | | MALE | FEMALE | MALE | FEMALE | | | |
| 1 | Assembly (continued) | A-1 ^d | Theaters and other buildings for the performing arts and motion pictures | 1 per 125 | 1 per 65 | 1 per 200 | — | 1 per 500 | 1 service sink | |
| | | A-2 ^d | Nightclubs, bars, taverns, dance halls and buildings for similar purposes | 1 per 40 | 1 per 40 | 1 per 75 | — | 1 per 500 | 1 service sink | |
| | | A-3 ^d | Restaurants, banquet halls and food courts | 1 per 75 | 1 per 75 | 1 per 200 | — | 1 per 500 | 1 service sink | |
| | | | Auditoriums without permanent seating, art galleries, exhibition halls, museums, lecture halls, libraries, arcades and gymnasiums | 1 per 125 | 1 per 65 | 1 per 200 | — | 1 per 500 | 1 service sink | |
| | | | Passenger terminals and transportation facilities | 1 per 500 | 1 per 500 | 1 per 750 | — | 1 per 1,000 | 1 service sink | |
| | | | Places of worship and other religious services | 1 per 150 | 1 per 75 | 1 per 200 | — | 1 per 1,000 | 1 service sink | |

(continued)

PLUMBING SYSTEMS

[P] TABLE 2902.1—(continued)
MINIMUM NUMBER OF REQUIRED PLUMBING FIXTURES^a
(See Sections 2902.2 and 2902.3)

| No. | CLASSIFICATION | OCCUPANCY | DESCRIPTION | WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE INTERNATIONAL PLUMBING CODE) | | LAVATORIES | | BATHTUBS/ SHOWERS | DRINKING FOUNTAINS ^{a, f} (SEE SECTION 410.1 OF THE INTERNATIONAL PLUMBING CODE) | OTHER |
|-----|------------------------|-------------|--|--|---|------------|-----------|---|---|-----------------------------|
| | | | | MALE | FEMALE | MALE | FEMALE | | | |
| 1 | Assembly | A-4 | Coliseums, arenas, skating rinks, pools and tennis courts for indoor sporting events and activities | 1 per 75 for the first 1,500 and 1 per 120 for the remainder exceeding 1,500 | 1 per 40 for the first 1,520 and 1 per 60 for the remainder exceeding 1,520 | 1 per 200 | 1 per 150 | — | 1 per 1,000 | 1 service sink |
| | | A-5 | Stadiums, amusement parks, bleachers and grandstands for outdoor sporting events and activities | 1 per 75 for the first 1,500 and 1 per 120 for the remainder exceeding 1,500 | 1 per 40 for the first 1,520 and 1 per 60 for the remainder exceeding 1,520 | 1 per 200 | 1 per 150 | — | 1 per 1,000 | 1 service sink |
| 2 | Business | B | Buildings for the transaction of business, professional services, other services involving merchandise, office buildings, banks, light industrial and similar uses | 1 per 25 for the first 50 and 1 per 50 for the remainder exceeding 50 | 1 per 40 for the first 80 and 1 per 80 for the remainder exceeding 80 | — | — | — | 1 per 100 | 1 service sink ^g |
| 3 | Educational | E | Educational facilities | 1 per 50 | 1 per 50 | — | — | — | 1 per 100 | 1 service sink |
| 4 | Factory and industrial | F-1 and F-2 | Structures in which occupants are engaged in work fabricating, assembly or processing of products or materials | 1 per 100 | 1 per 100 | — | — | See Section 411 of the California Plumbing Code | 1 per 400 | 1 service sink |
| 5 | Institutional | I-1 | Residential care | 1 per 10 | 1 per 10 | 1 per 8 | 1 per 100 | 1 per 100 | 1 service sink | — |
| | | I-2 | Hospitals, ambulatory nursing home care recipient ^b | 1 per per room ^c | 1 per per room ^c | 1 per 15 | 1 per 100 | 1 per 100 | 1 service sink | — |
| | | | Employees, other than residential care ^b | 1 per 25 | 1 per 35 | — | 1 per 100 | — | — | — |
| | | | Visitors, other than residential care | 1 per 75 | 1 per 100 | — | 1 per 500 | — | — | — |
| | | I-3 | Prisons ^b | 1 per cell | 1 per cell | 1 per 15 | 1 per 100 | 1 per 100 | 1 service sink | — |
| | | I-3 | Reformatories, detention centers and correctional centers ^b | 1 per 15 | 1 per 15 | 1 per 15 | 1 per 100 | 1 per 100 | 1 service sink | — |
| | | | Employees ^b | 1 per 25 | 1 per 35 | — | 1 per 100 | — | — | — |
| | | I-4 | Adult day care and child day care | 1 per 15 | 1 per 15 | 1 | 1 per 100 | 1 per 100 | 1 service sink | — |

(continued)

[P] TABLE 2902.1 continued
MINIMUM NUMBER OF REQUIRED PLUMBING FIXTURES^a
(See Sections 2902.2 and 2902.3)

| No. | CLASSIFICATION | OCCUPANCY | DESCRIPTION | WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE CALIFORNIA PLUMBING CODE) | | LAVATORIES | | BATHTUBS OR SHOWERS | DRINKING FOUNTAINS ^{e,f} (SEE SECTION 410.1 OF THE CALIFORNIA PLUMBING CODE) | OTHER |
|-----|----------------|------------|--|---|--------|---------------------|--------|---|--|---|
| | | | | MALE | FEMALE | MALE | FEMALE | | | |
| 6 | Mercantile | M | Retail stores, service stations, shops, salesrooms, markets and shopping centers | 1 per 500 | | 1 per 750 | | — | 1 per 1,000 | 1 service sink ^g |
| 7 | Residential | R-1 | Hotels, motels, boarding houses (transient) | 1 per sleeping unit | | 1 per sleeping unit | | 1 per sleeping unit | — | 1 service sink |
| | | R-2 | Dormitories, fraternities, sororities and boarding houses (not transient) | 1 per 10 | | 1 per 10 | | 1 per 8 | 1 per 100 | 1 service sink |
| | | R-2 | Apartment house | 1 per dwelling unit | | 1 per dwelling unit | | 1 per dwelling unit | — | 1 kitchen sink per dwelling unit; 1 automatic clothes washer connection per 20 dwelling units |
| | | R-3 | One- and two-family dwellings | 1 per dwelling unit | | 1 per 10 | | 1 per dwelling unit | — | 1 kitchen sink per dwelling unit; 1 automatic clothes washer connection per dwelling unit |
| | | R-3 | Congregate living facilities with 16 or fewer persons | 1 per 10 | | 1 per 10 | | 1 per 8 | 1 per 100 | 1 service sink |
| | | R-4 | Congregate living facilities with 16 or fewer persons | 1 per 10 | | 1 per 10 | | 1 per 8 | 1 per 100 | 1 service sink |
| 8 | Storage | S-1 S-2 | Structures for the storage of goods, warehouses, storehouses and freight depots, low and moderate hazard | 1 per 100 | | 1 per 100 | | See Section 411 of the California Plumbing Code | 1 per 1,000 | 1 service sink |

- a. The fixtures shown are based on one fixture being the minimum required for the number of persons indicated or any fraction of the number of persons indicated. The number of occupants shall be determined by this code.
- b. Toilet facilities for employees shall be separate from facilities for inmates or care recipients.
- c. A single occupant toilet room with one water closet and one lavatory serving not more than two adjacent patient sleeping units shall be permitted where such room is provided with direct access from each patient sleeping unit and with provisions for privacy.
- d. The occupant load for seasonal outdoor seating and entertainment areas shall be included when determining the minimum number of facilities required.
- e. The minimum number of required drinking fountains shall comply with Table 2902.1 and Chapter 11.
- f. Drinking fountains are not required for an occupant load of 15 or fewer.
- g. For business and mercantile occupancies with an occupant load of 15 or fewer, service sinks shall not be required.

[P] 2902.1.2 Family or assisted-use toilet and bath fixtures. Fixtures located within family or assisted-use toilet and bathing rooms required by Section 1109.2.1 are permitted to be included in the number of required fixtures for either the male or female occupants in assembly and mercantile occupancies.

[P] 2902.2 Separate facilities. Where plumbing fixtures are required, separate facilities shall be provided for each sex.

Exceptions:

1. Separate facilities shall not be required for dwelling units and sleeping units.
2. Separate facilities shall not be required in structures or tenant spaces with a total occupant load, including both employees and customers, of 15 or less.
3. Separate facilities shall not be required in mercantile occupancies in which the maximum occupant load is 100 or less.

[P] 2902.2.1 Family or assisted-use toilet facilities serving as separate facilities. Where a building or tenant space requires a separate toilet facility for each sex and each toilet facility is required to have only one water closet, two family/assisted-use toilet facilities shall be permitted to serve as the required separate facilities. Family or assisted-use toilet facilities shall not be required to be identified for exclusive use by either sex as required by Section 2902.4.

[P] 2902.3 Employee and public toilet facilities. Customers, patrons and visitors shall be provided with public toilet facilities in structures and tenant spaces intended for public utilization. The number of plumbing fixtures located within the required toilet facilities shall be provided in accordance with Section 2902.1 for all users. Employees shall be provided with toilet facilities in all occupancies. Employee toilet facilities shall either be separate or combined employee and public toilet facilities.

Exception: Public toilet facilities shall not be required in open or enclosed parking garages. Toilet facilities shall not be required in parking garages where there are no parking attendants.

[P] 2902.3.1 Access. The route to the public toilet facilities required by Section 2902.3 shall not pass through kitchens, storage rooms or closets. Access to the required facilities shall be from within the building or from the exterior of the building. All routes shall comply with the accessibility requirements of this code. The public shall have access to the required toilet facilities at all times that the building is occupied.

[P] 2902.3.2 Location of toilet facilities in occupancies other than malls. In occupancies other than covered and open mall buildings, the required public and employee toilet facilities shall be located not more than one story above or below the space required to be provided with toilet facilities, and the path of travel to such facilities shall not exceed a distance of 500 feet (152 m).

Exception: The location and maximum travel distances to required employee facilities in factory and industrial occupancies are permitted to exceed that required by this section, provided that the location and maximum travel distance are approved.

[P] 2902.3.3 Location of toilet facilities in malls. In covered and open mall buildings, the required public and employee toilet facilities shall be located not more than one story above or below the space required to be provided with toilet facilities, and the path of travel to such facilities shall not exceed a distance of 300 feet (91 440 mm). In mall buildings, the required facilities shall be based on total square footage (m^2) within a covered mall building or within the perimeter line of an open mall building, and facilities shall be installed in each individual store or in a central toilet area located in accordance with this section. The maximum travel distance to central toilet facilities in mall buildings shall be measured from the main entrance of any store or tenant space. In mall buildings, where employees' toilet facilities are not provided in the individual store, the maximum travel distance shall be measured from the employees' work area of the store or tenant space.

[P] 2902.3.4 Pay facilities. Where pay facilities are installed, such facilities shall be in excess of the required minimum facilities. Required facilities shall be free of charge.

[P] 2902.3.5 Door locking. Where a toilet room is provided for the use of multiple occupants, the egress door for the room shall not be lockable from the inside of the room. This section does not apply to family or assisted-use toilet rooms.

[P] 2902.4 Signage. Required public facilities shall be designated by a legible sign for each sex. Signs shall be readily visible and located near the entrance to each toilet facility. Signs for accessible toilet facilities shall comply with Section 1110.

[P] 2902.4.1 Directional signage. Directional signage indicating the route to the public facilities shall be posted in accordance with Section 3107. Such signage shall be located in a corridor or aisle, at the entrance to the facilities for customers and visitors.

[P] 2902.5 Drinking fountain location. Drinking fountains shall not be required to be located in individual tenant spaces provided that public drinking fountains are located within a travel distance of 500 feet of the most remote location in the tenant space and not more than one story above or below the tenant space. Where the tenant space is in a covered or open mall, such distance shall not exceed 300 feet. Drinking fountains shall be located on an accessible route.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 30 – ELEVATORS AND CONVEYING SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | | | | | X | X | | X | X | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | X | | | | | | | | | | |
| Adopt only those sections that are listed below | | | X | X | X | X | X | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 3001.1 | | | | X | | X | | | | | | | | | | | | | | |
| 3001.1w/ Exception | | | | | | | | X | | | | | | | | | | | | |
| 3001.2 | | X | | | | | | | | | | | | | | | | | | |
| 3001.3 | | | X | X | X | X | | | | | | | | | | | | | | |
| 3001.4 | | | | | | | | | | | | | | | | | | | | |
| 3001.5 | | X | | | | | | | | | | | | | | | | | | |
| 3002.4a – 3002.4.7a | | X | | | | | | | | | | | | | | | | | | |
| 3002.5 | | X | | | | | | | | | | | | | | | | | | |
| 3002.9 – 3002.9.5 | | X | | | | | | | | | | | | | | | | | | |
| 3003.2 – 3003.2.1.2 | | X | | | | | | | | | | | | | | | | | | |
| 3003.3 | | X | | | | | | | | | | | | | | | | | | |
| 3004.1 | | X | | | | | | | | | | | | | | | | | | |
| 3004.3.1 | | X | | | | | | | | | | | | | | | | | | |
| 3006.4.1 | | X | | | | | | | | | | | | | | | | | | |
| 3006.5 | | X | | | | | | | | | | | | | | | | | | |
| 3007.1 | | X | | | | | | | | | | | | | | | | | | |
| 3007.7.1 | | X | | | | | | | | | | | | | | | | | | |
| 3007.7.4 | | X | | | | | | | | | | | | | | | | | | |
| 3007.2 | | X | | | | | | | | | | | | | | | | | | |
| 3008.1.2 | | X | | | | | | | | | | | | | | | | | | |
| 3008.2 | | X | | | | | | | | | | | | | | | | | | |
| > 3008.2.1 | | X | | | | | | | | | | | | | | | | | | |
| 3008.3.1 | | X | | | | | | | | | | | | | | | | | | |
| 3008.6 | | X | | | | | | | | | | | | | | | | | | |
| > 3008.8.1 | | X | | | | | | | | | | | | | | | | | | |
| 3009 | | | | | | | | | X | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 30

ELEVATORS AND CONVEYING SYSTEMS

SECTION 3001 GENERAL

3001.1 Scope. This chapter governs the design, construction, installation, alteration and repair of elevators and conveying systems and their components.

> **Exception:** [DSA-AC] For accessibility requirements for platform lifts and elevators, see California Code of Regulations, Title 8 and Title 24, Part 2, Chapter 11B, Sections 11B-206.6, 11B-206.7, 11B-407 and 11B-410.

3001.2 Referenced standards. Except as otherwise provided for in this code, the design, construction, installation, alteration, repair and maintenance of elevators and conveying systems and their components shall conform to *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*, ASME A90.1, ASME B20.1, ALI ALCTV, and ASCE 24 for construction in flood hazard areas established in Section 1612.3.

3001.3 Accessibility. Passenger elevators and platform (wheelchair) lifts required to be accessible by Chapter 11A or 11B shall conform to Chapter 11A for applications listed in Section 1.8.2.1.2 regulated by the Department of Housing and Community Development or Chapter 11B for applications listed in Section 1.9.1 regulated by the Division of the State Architect—Access Compliance.

3001.4 Change in use. A change in use of an elevator from freight to passenger, passenger to freight, or from one freight class to another freight class shall comply with *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*.

3001.5 Elevators utilized to transport hazardous materials. Elevators utilized to transport hazardous materials shall also comply with the *California Fire Code* Section 2703.10.4

SECTION 3002 HOISTWAY ENCLOSURES

3002.1 Hoistway enclosure protection. Elevator, dumbwaiter and other hoistway enclosures shall be shaft enclosures complying with Section 713.

3002.1.1 Opening protectives. Openings in hoistway enclosures shall be protected as required in Chapter 7.

Exception: The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with Section 3003.2 shall be permitted to remain open during Phase I Emergency Recall Operation.

3002.1.2 Hardware. Hardware on opening protectives shall be of an approved type installed as tested, except that approved interlocks, mechanical locks and electric contacts, door and gate electric contacts and door-operating

mechanisms shall be exempt from the fire test requirements.

3002.2 Number of elevator cars in a hoistway. Where four or more elevator cars serve all or the same portion of a building, the elevators shall be located in no fewer than two separate hoistways. Not more than four elevator cars shall be located in any single hoistway enclosure.

3002.3 Emergency signs. An approved pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit stairways and not to use the elevators in case of fire. The sign shall read: IN CASE OF FIRE, ELEVATORS ARE OUT OF SERVICE. USE EXIT STAIRS.

Exceptions:

1. The emergency sign shall not be required for elevators that are part of an accessible means of egress complying with Section 1007.4.
2. The emergency sign shall not be required for elevators that are used for occupant self-evacuation in accordance with Section 3008.

3002.4 Elevator car to accommodate ambulance stretcher. Where elevators are provided in buildings four or more stories above, or four or more stories below, grade plane, at least one elevator shall be provided for fire department emergency access to all floors. The elevator car shall be of such a size and arrangement to accommodate an ambulance stretcher 24 inches by 84 inches (610 mm by 2134 mm) with not less than 5-inch (127 mm) radius corners, in the horizontal, open position and shall be identified by the international symbol for emergency medical services (star of life). The symbol shall not be less than 3 inches (76 mm) in height and shall be placed inside on both sides of the hoistway door frame.

The following California sections replace the corresponding model code section for applications specified in section 1.11 for the Office of the State Fire Marshal.

3002.4a General stretcher requirements. All buildings and structures with one or more passenger service elevators shall be provided with not less than one medical emergency service elevator to all landings meeting the provisions of Section 3002.4a.

Exceptions:

1. Elevators in structures used only by maintenance and operating personnel.
2. Elevators in jails and penal institutions.
3. Elevators in buildings or structures where each landing is at ground level or is accessible at grade level or by a ramp.
4. Elevator(s) in two-story buildings or structures equipped with stairs of a configuration that will

accommodate the carrying of the gurney or stretcher as permitted by the local jurisdictional authority.

5. Elevators in buildings or structures less than four stories in height for which the local jurisdictional authority has granted an exception in the form of a written document.

3002.4.1a Gurney size. The medical emergency service elevator shall accommodate the loading and transport of an ambulance gurney or stretcher [maximum size 24 inches by 84 inches (610 mm by 2134 mm) with not less than 5-inch (127 mm) radius corners] in the horizontal position.

3002.4.2a Hoistway doors. The hoistway landing openings shall be provided with power-operated doors.

3002.4.3a Elevator entrance openings and car size. The elevator car shall be of such a size and arrangement to accommodate a 24-inch by 84-inch (610 mm by 2134 mm) ambulance gurney or stretcher with not less than 5-inch (127 mm) radius corners, in the horizontal, open position, shall be provided with a minimum clear distance between walls or between walls and door excluding return panels not less than 80 inches by 54 inches (2032 mm by 1372 mm), and a minimum distance from wall to return panel not less than 51 inches (1295 mm) with a 42-inch (1067 mm) side slide door.

Exception: The elevator car dimensions and/or the clear entrance opening dimensions may be altered where it can be demonstrated to the local jurisdictional authority's satisfaction that the proposed configuration will handle the designated gurney or stretcher with equivalent ease. Documentation from the local authority shall be provided to the Occupational Safety and Health Standards Board.

3002.4.4a Elevator recall. The elevator(s) designated the medical emergency elevator shall be equipped with a key switch to recall the elevator nonstop to the main floor. For the purpose of this section, elevators in compliance with Section 3003.2 shall be acceptable.

3002.4.5a Designation. Medical emergency elevators shall be identified by the international symbol (Star of Life) for emergency medical services.

3002.4.6a Symbol size. The symbol shall not be less than 3 inches (76 mm) in size.

3002.4.7a Symbol location. A symbol shall be permanently attached to each side of the hoistway door frame on the portion of the frame at right angles to the hallway or landing area. Each symbol shall be not less than 78 inches (1981 mm) and not more than 84 inches (2134 mm) above the floor level at the threshold.

- > **3002.5 Emergency doors.** Emergency doors in blind hoistways as described in ASME A17.1-2004, section 2.11.1.2, and access panels as described in ASME A17.1-2004, section 2.11.1.4, are prohibited in accordance with California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders.

3002.6 Prohibited doors. Doors, other than hoistway doors and the elevator car door, shall be prohibited at the point of access to an elevator car unless such doors are readily openable from the car side without a key, tool, special knowledge or effort.

3002.7 Common enclosure with stairway. Elevators shall not be in a common shaft enclosure with a stairway.

Exception: Elevators within open parking garages need not be separated from stairway enclosures.

3002.8 Glass in elevator enclosures. Glass in elevator enclosures shall comply with Section 2409.1.

3002.9 Photoelectric tube bypass switch.

3002.9.1 Elevators equipped with photoelectric tube devices which control the closing of automatic, power-operated car or hoistway doors, or both, shall have a switch in the car which, when actuated, will render the photoelectric tube device ineffective.

3002.9.2 The switch shall be constant-pressure type, requiring not less than 10 pounds (44.5N) or more than 15 pounds (66.7 N) pressure to actuate.

3002.9.3 The switch shall be located not less than 6 feet (1829 mm) or more than 6 feet 6 inches (1981 mm) above the car floor and shall be located in or adjacent to the operating panel.

3002.9.4 The switch shall be clearly labeled TO BE USED IN CASE OF FIRE ONLY.

3002.9.5 Switches shall be kept in working order or be removed when existing installations are arranged to comply with Section 3002.9.5, Exception 1 or 2.

Exceptions:

1. Elevators installed and maintained in compliance with Section 3003.
2. Where alternate means acceptable to the fire authority having jurisdiction are provided that will ensure the doors can close under adverse smoke conditions.

SECTION 3003 EMERGENCY OPERATIONS

[F] 3003.1 Standby power. In buildings and structures where standby power is required or furnished to operate an elevator, the operation shall be in accordance with Sections 3003.1.1 through 3003.1.4.

[F] 3003.1.1 Manual transfer. Standby power shall be manually transferable to all elevators in each bank.

[F] 3003.1.2 One elevator. Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

[F] 3003.1.3 Two or more elevators. Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate

all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, at least one elevator shall remain operable from the standby power source.

[F] 3003.1.4 Venting. Where standby power is connected to elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

[F] 3003.2 Fire-fighters' emergency operation. Elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*.

3003.2.1 Floor numbers. *Elevator hoistways shall have a floor number not less than 4 inches (102 mm) in height, placed on the walls and/or doors of the hoistway at intervals such that a person in a stalled elevator, upon opening the car door, can determine the floor position.*

3003.2.1.1 Fire signs. *All automatic elevators shall have not less than one sign at each landing printed on a contrasting background in letters not less than $\frac{1}{2}$ inch (12.7 mm) high to read: IN CASE OF FIRE USE STAIRWAY FOR EXIT. DO NOT USE ELEVATOR.*

3003.2.1.2 Call and car operation buttons. *Automatic passenger elevators shall have call and car operation buttons within 60 inches (1524 mm) of the floor. Emergency telephones shall also be within 60 inches (1524 mm) of the floor.*

[F] 3003.3 Standardized fire service elevator keys. All elevators shall be equipped to operate with a standardized fire service elevator key in accordance with the *California Fire Code*.

SECTION 3004 HOISTWAY VENTING

3004.1 Vents required. Hoistways of elevators and dumbwaiters penetrating more than three stories shall be provided with a means for venting smoke and hot gases to the outer air in case of fire.

Exception: Venting is not required for the following elevators and hoistways:

1. In occupancies of other than Groups R-1, R-2, R-2.1, I-2 and similar occupancies with overnight sleeping units, where the building is equipped throughout with an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.
2. Sidewalk elevator hoistways.
3. Elevators contained within and serving open parking garages only.
4. Elevators within individual residential dwelling units.

3004.2 Location of vents. Vents shall be located at the top of the hoistway and shall open either directly to the outer air or through noncombustible ducts to the outer air. Noncombustible ducts shall be permitted to pass through the elevator machine room, provided that portions of the ducts located outside the hoistway or machine room are enclosed by construction having not less than the fire-resistance rating required for the hoistway. Holes in the machine room floors for the passage of ropes, cables or other moving elevator equipment shall be limited as not to provide greater than 2 inches (51 mm) of clearance on all sides.

3004.3 Area of vents. Except as provided for in Section 3004.3.1, the area of the vents shall be not less than $3\frac{1}{2}$ percent of the area of the hoistway nor less than 3 square feet (0.28 m^2) for each elevator car, and not less than $3\frac{1}{2}$ percent nor less than 0.5 square feet (0.047 m^2) for each dumbwaiter car in the hoistway, whichever is greater. Of the total required vent area, not less than one-third shall be permanently open. Closed portions of the required vent area shall consist of openings glazed with annealed glass not greater than $\frac{1}{8}$ inch (3.2 mm) in thickness.

Exception: The total required vent area shall not be required to be permanently open where all the vent openings automatically open upon detection of smoke in the elevator lobbies or hoistway, upon power failure and upon activation of a manual override control. The manual override control shall be capable of opening and closing the vents and shall be located in an approved location.

3004.3.1 Reduced vent area. Where mechanical ventilation conforming to the *California Mechanical Code* is provided, a reduction in the required vent area is allowed provided that all of the following conditions are met:

1. The occupancy is not in Group R-1, R-2, R-2.1 or I-2 or of a similar occupancy with overnight sleeping units.
2. The vents required by Section 3004.2 do not have outside exposure.
3. The hoistway does not extend to the top of the building.
4. The hoistway and machine room exhaust fan is automatically reactivated by thermostatic means.
5. Equivalent venting of the hoistway is accomplished.

3004.4 Plumbing and mechanical systems. Plumbing and mechanical systems shall not be located in an elevator hoistway enclosure.

Exception: Floor drains, sumps and sump pumps shall be permitted at the base of the hoistway enclosure provided they are indirectly connected to the plumbing system.

SECTION 3005 CONVEYING SYSTEMS

3005.1 General. Escalators, moving walks, conveyors, personnel hoists and material hoists shall comply with the provisions of Sections 3005.2 through 3005.4.

3005.2 Escalators and moving walks. Escalators and moving walks shall be constructed of approved noncombustible and fire-retardant materials. This requirement shall not apply to electrical equipment, wiring, wheels, handrails and the use of $\frac{1}{28}$ -inch (0.9 mm) wood veneers on balustrades backed up with noncombustible materials.

3005.2.1 Enclosure. Escalator floor openings shall be enclosed with shaft enclosures complying with Section 713.

3005.2.2 Escalators. Where provided in below-grade transportation stations, escalators shall have a clear width of not less than 32 inches (815 mm).

Exception: The clear width is not required in existing facilities undergoing alterations.

3005.3 Conveyors. Conveyors and conveying systems shall comply with ASME B20.1.

3005.3.1 Enclosure. Conveyors and related equipment connecting successive floors or levels shall be enclosed with shaft enclosures complying with Section 713.

3005.3.2 Conveyor safeties. Power-operated conveyors, belts and other material-moving devices shall be equipped with automatic limit switches which will shut off the power in an emergency and automatically stop all operation of the device.

3005.4 Personnel and material hoists. Personnel and material hoists shall be designed utilizing an approved method that accounts for the conditions imposed during the intended operation of the hoist device. The design shall include, but is not limited to, anticipated loads, structural stability, impact, vibration, stresses and seismic restraint. The design shall account for the construction, installation, operation and inspection of the hoist tower, car, machinery and control equipment, guide members and hoisting mechanism. Additionally, the design of personnel hoists shall include provisions for field testing and maintenance which will demonstrate that the hoist device functions in accordance with the design. Field tests shall be conducted upon the completion of an installation or following a major alteration of a personnel hoist.

SECTION 3006 MACHINE ROOMS

3006.1 Access. An approved means of access shall be provided to elevator machine rooms and overhead machinery spaces.

3006.2 Venting. Elevator machine rooms that contain solid-state equipment for elevator operation shall be provided with an independent ventilation or air-conditioning system to protect against the overheating of the electrical equipment. The system shall be capable of maintaining temperatures within the range established for the elevator equipment.

3006.3 Pressurization. The elevator machine room serving a pressurized elevator hoistway shall be pressurized upon activation of a heat or smoke detector located in the elevator machine room.

3006.4 Machine rooms and machinery spaces. Elevator machine rooms and machinery spaces shall be enclosed with fire barriers constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 711, or both. The fire-resistance rating shall be not less than the required rating of the hoistway enclosure served by the machinery. Openings in the fire barriers shall be protected with assemblies having a fire protection rating not less than that required for the hoistway enclosure doors.

Exceptions:

- Where machine rooms and machinery spaces do not abut and have no openings to the hoistway enclosure they serve the fire barriers constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 711, or both, shall be permitted to be reduced to a 1-hour fire-resistance rating.
- In buildings four stories or less above grade plane where machine room and machinery spaces do not abut and have no openings to the hoistway enclosure they serve, the machine room and machinery spaces are not required to be fire-resistance rated.

3006.4.1 Automatic sprinkler system. Automatic sprinklers shall not be required to be installed in the elevator hoistway, elevator machine room, elevator machinery space, elevator control space, or elevator control room where all the following are met:

- Approved smoke detectors shall be installed in the elevator hoistway, elevator machine room, elevator machinery spaces, elevator control spaces, or elevator control rooms and connected to the building fire alarm system in accordance with Section 907.
- Activation of any smoke detector located in the elevator hoistway, elevator machine room, elevator machinery space, elevator control space, or elevator control room shall cause the actuation of the building fire alarm notification appliances in accordance with Section 907.
- Activation of any smoke detector located in the elevator hoistway, elevator machine room, elevator machinery space, elevator control space, or elevator control room shall cause all elevators having any equipment located in that elevator hoistway, elevator machine room, elevator machinery space, elevator control space, or elevator control room to recall nonstop to the appropriate designated floor in accordance with CCR Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders.
- The elevator machine room, elevator machinery space, elevator control space, or elevator control room shall be enclosed with fire barriers constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 712, or both. The fire-resistance rating shall not be less than the required rating of the hoistway enclosure served by the machinery. Openings in the fire barriers shall be protected with assemblies hav-

ing a fire protection rating not less than that required for the hoistway enclosure doors. The exceptions to Section 3006.4 shall not apply.

5. The building fire alarm system shall be monitored by an approved supervising station in accordance with Section 907.
6. An approved sign shall be permanently displayed in the elevator machine room, elevator machinery space, elevator control space, or elevator control room in a conspicuous location with a minimum of 1½-inch letters on a contrasting background, stating:

**NO COMBUSTIBLE STORAGE
PERMITTED IN THIS ROOM**

By Order of the Fire Marshal [or name of fire authority]

3006.5 Shunt trip. Where elevator hoistways or elevator machine rooms containing elevator control equipment are protected with automatic sprinklers, a means installed in accordance with NFPA 72, Section 21.4, Elevator Shutdown, shall be provided to disconnect automatically the main line power supply to the affected elevator prior to the application of water. This means shall not be self-resetting. The activation of sprinklers outside the hoistway or machine room shall not disconnect the main line power supply.

3006.6 Plumbing systems. Plumbing systems shall not be located in elevator equipment rooms.

SECTION 3007 FIRE SERVICE ACCESS ELEVATOR

3007.1 General. Where required by Section 403.6.1, every floor of the building shall be served by fire service access elevators complying with Sections 3007.1 through 3007.10. Except as modified in this section, fire service access elevators shall be installed in accordance with this chapter and *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*.

3007.2 Phase I Emergency recall operation. Actuation of any building fire alarm-initiating device shall initiate Phase I emergency recall operation on all fire service access elevators in accordance with *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*. All other elevators shall remain in normal service unless Phase I emergency recall operation is manually initiated by a separate, required three-position, key-operated "Fire Recall" switch or automatically initiated by the associated elevator lobby, hoistway or elevator machine room smoke detectors. In addition, if the building also contains occupant evacuation elevators in accordance with Section 3008, an independent, three-position, key-operated "Fire Recall" switch conforming to the applicable requirements in *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders* shall be provided at the designated level for each fire service access elevator.

3007.3 Automatic sprinkler system. The building shall be equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, except as otherwise per-

mitted by Section 903.3.1.1.1 and as prohibited by Section 3007.3.1.

3007.3.1 Prohibited locations. Automatic sprinklers shall not be installed in elevator machine rooms, elevator machine spaces, and elevator hoistways of fire service access elevators.

3007.3.2 Sprinkler system monitoring. The sprinkler system shall have a sprinkler control valve supervisory switch and waterflow-initiating device provided for each floor that is monitored by the building's fire alarm system.

3007.4 Water protection. An approved method to prevent water from infiltrating into the hoistway enclosure from the operation of the automatic sprinkler system outside the enclosed fire service access elevator lobby shall be provided.

3007.5 Shunt trip. Means for elevator shutdown in accordance with Section 3006.5 shall not be installed on elevator systems used for fire service access elevators.

3007.6 Hoistway enclosures. The fire service access elevator hoistway shall be located in a shaft enclosure complying with Section 708.

3007.6.1 Structural integrity of hoistway enclosures. The fire service access elevator hoistway enclosure shall comply with Sections 403.2.3.1 through 403.2.3.4.

3007.6.2 Hoistway lighting. When fire-fighters' emergency operation is active, the entire height of the hoistway shall be illuminated at not less than 1 footcandle (11 lux) as measured from the top of the car of each fire service access elevator.

3007.7 Fire service access elevator lobby. The fire service access elevator shall open into a fire service access elevator lobby in accordance with Sections 3007.7.1 through 3007.7.5.

Exception: Where a fire service access elevator has two entrances onto a floor, the second entrance shall be permitted to open into an elevator lobby in accordance with Section 708.14.1.

3007.7.1 Access. The fire service access elevator lobby shall have direct access from the enclosed elevator lobby to a smokeproof enclosure complying with Section 909.20.

Exception: Access to a smokeproof enclosure shall be permitted to be through a protected path of travel that has a level of fire protection not less than the elevator lobby enclosure. The protected path shall be separated from the enclosed elevator lobby through an opening protected by a smoke and draft control assembly in accordance with Section 716.5.3.

3007.7.2 Lobby enclosure. The fire service access elevator lobby shall be enclosed with a smoke barrier having a fire-resistance rating of not less than 1 hour, except that lobby doorways shall comply with Section 3007.7.3.

Exception: Enclosed fire service access elevator lobbies are not required at the levels of exit discharge.

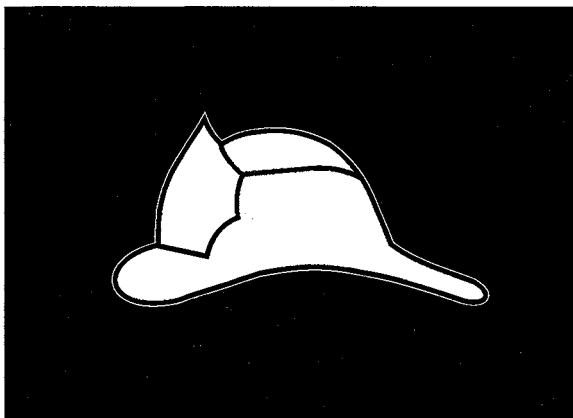
3007.7.3 Lobby doorways. Other than the door to the hoistway, each doorway to a fire service access elevator lobby shall be provided with a ¾-hour fire door assembly complying with Section 716.5. The fire door assembly

shall also comply with the smoke and draft control door assembly requirements of Section 716.5.3.1 with the UL 1784 test conducted without the artificial bottom seal.

3007.7.4 Lobby size. *Regardless of any number of fire service access elevators served by the same elevator lobby, the enclosed fire service access elevator lobby shall be not less than 150 square feet (14 m^2) in area with a minimum dimension of 8 feet (2440 mm).*

3007.7.5 Fire service access elevator symbol. A pictorial symbol of a standardized design designating which elevators are fire service access elevators shall be installed on each side of the hoistway door frame on the portion of the frame at right angles to the fire service access elevator lobby. The fire service access elevator symbol shall be designed as shown in Figure 3007.7.5 and shall comply with the following:

1. The fire service access elevator symbol shall be not less than 3 inches (76 mm) in height.
2. The vertical center line of the fire service access elevator symbol shall be centered on the hoistway door frame. Each symbol shall not be less than 78 inches (1981 mm), and not more than 84 (2134 mm) inches above the finished floor at the threshold.



**FIGURE 3007.7.5
FIRE SERVICE ACCESS ELEVATOR SYMBOL**

3007.8 Elevator system monitoring. The fire service access elevator shall be continuously monitored at the fire command center by a standard emergency service interface system meeting the requirements of NFPA 72.

3007.9 Electrical power. The following features serving each fire service access elevator shall be supplied by both normal power and Type 60/Class 2/Level 1 standby power:

1. Elevator equipment.
2. Elevator hoistway lighting.
3. Elevator machine room ventilation and cooling equipment.
4. Elevator controller cooling equipment.

3007.9.1 Protection of wiring or cables. Wires or cables that are located outside of the elevator hoistway and machine room and that provide normal or standby power,

control signals, communication with the car, lighting, heating, air conditioning, ventilation and fire-detecting systems to fire service access elevators shall be protected by construction having a fire-resistance rating of not less than 2 hours, or shall be circuit integrity cable having a fire-resistance rating of not less than 2 hours.

Exception: Wiring and cables to control signals are not required to be protected provided that wiring and cables do not serve Phase II emergency in-car operations.

3007.10 Standpipe hose connection. A Class I standpipe hose connection in accordance with Section 905 shall be provided in the interior exit stairway and ramp having direct access from the fire service access elevator lobby.

3007.10.1 Access. The exit enclosure containing the standpipe shall have access to the floor without passing through the fire service access elevator lobby.

SECTION 3008 OCCUPANT EVACUATION ELEVATORS

3008.1 General. Where elevators are to be used for occupant self-evacuation during fires, all passenger elevators for general public use shall comply with Sections 3008.1 through 3008.11. Where other elevators are used for occupant self-evacuation, they shall also comply with these sections.

3008.1.1 Additional exit stairway. Where an additional means of egress is required in accordance with Section 403.5.2, an additional exit stairway shall not be required to be installed in buildings provided with occupant evacuation elevators complying with Section 3008.1.

3008.1.2 Fire safety and evacuation plan. The building shall have an approved fire safety and evacuation plan in accordance with the applicable requirements of Section 404 of the *California Fire Code*. The fire safety and evacuation plan shall incorporate specific procedures for the occupants using evacuation elevators.

3008.2 Phase I Emergency recall operation. An independent, three-position, key-operated "Fire Recall" switch complying with *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders* shall be provided at the designated level for each occupant evacuation elevator.

3008.2.1 Operation. The occupant evacuation elevators shall be used for occupant self-evacuation only in the normal elevator operating mode prior to Phase I Emergency Recall Operation in accordance with the requirements in *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders* and the building's fire safety and evacuation plan.

3008.2.2 Activation. Occupant evacuation elevator systems shall be activated by any of the following:

1. The operation of an automatic sprinkler system complying with Section 3008.3;
2. Smoke detectors required by another provision of the code;
3. Approved manual controls.

3008.3 Automatic sprinkler system. The building shall be protected throughout by an approved, electrically supervised automatic sprinkler system in accordance with Section 903.3.1.1, except as otherwise permitted by Section 903.3.1.1 and as prohibited by Section 3008.3.1.

3008.3.1 Prohibited locations. Automatic sprinklers shall not be installed in elevator machine rooms and elevator machine spaces for occupant evacuation elevators *in accordance with this Section and 3006.4.1.*

3008.3.2 Sprinkler system monitoring. The sprinkler system shall have a sprinkler control valve supervisory switch and water flow-initiating device provided for each floor that is monitored by the building's fire alarm system.

3008.4 Water protection. An approved method to prevent water from infiltrating into the hoistway enclosure from the operation of the automatic sprinkler system outside the enclosed occupant evacuation elevator lobby shall be provided.

3008.5 Shunt trip. Means for elevator shutdown in accordance with Section 3006.5 shall not be installed on elevator systems used for occupant evacuation elevators.

3008.6 Hoistway enclosure protection. Occupant evacuation elevator hoistways shall be located in shaft enclosures complying with Section 713.

3008.6.1 Structural integrity of hoistway enclosures. Occupant evacuation elevator hoistway enclosures shall comply with Sections 403.2.3.1 through 403.2.3.4.

3008.7 Occupant evacuation elevator lobby. The occupant evacuation elevators shall open into an elevator lobby in accordance with Sections 3008.7.1 through 3008.7.7.

3008.7.1 Access. The occupant evacuation elevator lobby shall have direct access to an interior exit stairway or ramp.

3008.7.2 Lobby enclosure. The occupant evacuation elevator lobby shall be enclosed with a smoke barrier having a fire-resistance rating of not less than 1 hour, except that lobby doorways shall comply with Section 3008.7.3.

Exception: Enclosed occupant evacuation elevator lobbies are not required at the levels of exit discharge.

3008.7.3 Lobby doorways. Other than the door to the hoistway, each doorway to an occupant evacuation elevator lobby shall be provided with a $\frac{3}{4}$ -hour fire door assembly complying with Section 716.5. The fire door assembly shall also comply with the smoke and draft control assembly requirements of Section 716.5.3.1 with the UL 1784 test conducted without the artificial bottom seal.

3008.7.3.1 Vision panel. A vision panel shall be installed in each fire door assembly protecting the lobby doorway. The vision panel shall consist of fire-protection-rated glazing and shall be located to furnish clear vision of the occupant evacuation elevator lobby.

3008.7.3.2 Door closing. Each fire door assembly protecting the lobby doorway shall be automatic-closing

upon receipt of any fire alarm signal from the emergency voice/alarm communication system serving the building.

3008.7.4 Lobby size. Each occupant evacuation elevator lobby shall have minimum floor area as follows:

1. The occupant evacuation elevator lobby floor area shall accommodate, at 3 square feet (0.28 m^2) per person, not less than 25 percent of the occupant load of the floor area served by the lobby.
2. The occupant evacuation elevator lobby floor area also shall accommodate one wheelchair space of 30 inches by 48 inches (760 mm by 1220 mm) for each 50 persons, or portion thereof, of the occupant load of the floor area served by the lobby.

Exception: The size of lobbies serving multiple banks of elevators shall have the minimum floor area approved on an individual basis and shall be consistent with the building's fire safety and evacuation plan.

3008.7.5 Signage. An approved sign indicating elevators are suitable for occupant self-evacuation shall be posted on all floors adjacent to each elevator call station serving occupant evacuation elevators.

3008.7.6 Lobby status indicator. Each occupant evacuation elevator lobby shall be equipped with a status indicator arranged to display all of the following information:

1. An illuminated green light and the message, "Elevators available for occupant evacuation," when the elevators are operating in normal service and the fire alarm system is indicating an alarm in the building.
2. An illuminated red light and the message, "Elevators out of service, use exit stairs" when the elevators are in Phase I emergency recall operation *or Phase II firefighters' emergency operation* in accordance with the requirements in *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*.
3. No illuminated light or message when the elevators are operating in normal service.

3008.7.7 Two-way communication system. A two-way communication system shall be provided in each occupant evacuation elevator lobby for the purpose of initiating communication with the fire command center or an alternate location approved by the fire department.

3008.7.7.1 Design and installation. The two-way communication system shall include audible and visible signals and shall be designed and installed in accordance with the requirements in ICC A117.1.

3008.7.7.2 Instructions. Instructions for the use of the two-way communication system along with the location of the station shall be permanently located adjacent to each station. Signage shall comply with the ICC A117.1 requirements for visual characters.

3008.8 Elevator system monitoring. The occupant evacuation elevators shall be continuously monitored at the fire

command center or a central control point approved by the fire department and arranged to display all of the following information:

1. Floor location of each elevator car.
2. Direction of travel of each elevator car.
3. Status of each elevator car with respect to whether it is occupied.
4. Status of normal power to the elevator equipment, elevator controller cooling equipment, and elevator machine room ventilation and cooling equipment.
5. Status of standby or emergency power system that provides backup power to the elevator equipment, elevator controller cooling equipment, and elevator machine room ventilation and cooling equipment.
6. Activation of any fire alarm initiating device in any elevator lobby, elevator machine room or machine space, or elevator hoistway.

3008.8.1 Elevator recall. The fire command center or an alternate location approved by the fire department shall be provided with the means to manually initiate a Phase I Emergency Recall of the occupant evacuation elevators in accordance with *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders*.

3008.9 Electrical power. The following features serving each occupant evacuation elevator shall be supplied by both normal power and Type 60/Class 2/Level 1 standby power:

1. Elevator equipment.
2. Elevator machine room ventilation and cooling equipment.
3. Elevator controller cooling equipment.

3008.9.1 Protection of wiring or cables. Wires or cables that are located outside of the elevator hoistway and machine room and that provide normal or standby power, control signals, communication with the car, lighting, heating, air conditioning, ventilation and fire-detecting systems to fire service access elevators shall be protected by construction having a fire-resistance rating of not less than 2 hours, or shall be circuit integrity cable having a fire-resistance rating of not less than 2 hours.

Exception: Wiring and cables to control signals are not required to be protected provided that wiring and cables do not serve Phase II emergency in-car operations.

3008.10 Emergency voice/alarm communication system. The building shall be provided with an emergency voice/alarm communication system. The emergency voice/alarm communication system shall be accessible to the fire department. The system shall be provided in accordance with Section 907.2.12.2.

3008.10.1 Notification appliances. No fewer than one audible and one visible notification appliance shall be installed within each occupant evacuation elevator lobby.

3008.11 Hazardous material areas. No building areas shall contain hazardous materials exceeding the maximum allowable quantities per control area as addressed in Section 414.2.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

CHAPTER 31– SPECIAL CONSTRUCTION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | X | X | X | X | X | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | X | X | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | X | | | | X | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| 3101 | | | X | | | | | | | | | | | | | | | | | |
| 3102.1 | | | X | | | | | | | | | | | | | | | | | |
| 3102.3.1 | | | X | | | | | | | | | | | | | | | | | |
| 3103 | | | X | | | | | | | | | | | | | | | | | |
| 3104 | | | X | | | | | | | | | | | | | | | | | |
| 3104.2, Exception 2 | | | | | X | X | | | | | | | | | | | | | | |
| 3105 | | | X | | | | | | | | | | | | | | | | | |
| 3105.4 | | | X | | | | | | | | | | | | | | | | | |
| 3106 | | | X | | | | | | | | | | | | | | | | | |
| 3109 | | | | † | † | | | | | | | | | | | | | | | |
| 3109.4.4-3109.6 | X | | | | | | | | | | | | | | | | | | | |
| 3110 | | | X | | | | | | | | | | | | | | | | | |
| 3111 | | | X | | | | | | | | | | | | | | | | | |

The state agency does not adopt sections identified by the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 31

SPECIAL CONSTRUCTION

SECTION 3101 GENERAL

3101.1 Scope. The provisions of this chapter shall govern special building construction including membrane structures, temporary structures, pedestrian walkways and tunnels, automatic vehicular gates, awnings and canopies, marquees, signs, and towers and antennas.

SECTION 3102 MEMBRANE STRUCTURES

3102.1 General. The provisions of Sections 3102.1 through 3102.8 shall apply to air-supported, air-inflated, membrane-covered cable and membrane-covered frame structures, collectively known as membrane structures, erected for a period of 180 days or longer. Those erected for a shorter period of time shall comply with the *California Fire Code*. Membrane structures covering water storage facilities, water clarifiers, water treatment plants, sewage treatment plants, greenhouses and similar facilities not used for human occupancy are required to meet only the requirements of Sections 3102.3.1 and 3102.7. Membrane structures erected on a building, balcony, deck or other structure for any period of time shall comply with this section.

3102.2 Definitions. The following terms are defined in Chapter 2:

AIR-INFLATED STRUCTURE.

AIR-SUPPORTED STRUCTURE.

Double skin.

Single skin.

CABLE-RESTRAINED, AIR-SUPPORTED STRUCTURE.

MEMBRANE-COVERED CABLE STRUCTURE.

MEMBRANE-COVERED FRAME STRUCTURE.

NONCOMBUSTIBLE MEMBRANE STRUCTURE.

3102.3 Type of construction. Noncombustible membrane structures shall be classified as Type IIB construction. Non-combustible frame or cable-supported structures covered by an approved membrane in accordance with Section 3102.3.1 shall be classified as Type IIB construction. Heavy timber frame-supported structures covered by an approved membrane in accordance with Section 3102.3.1 shall be classified as Type IV construction. Other membrane structures shall be classified as Type V construction.

Exception: Plastic less than 30 feet (9144 mm) above any floor used in greenhouses, where occupancy by the general public is not authorized, and for aquaculture pond covers is not required to meet the fire propagation performance criteria of NFPA 701.

3102.3.1 Membrane and interior liner material. Membranes and interior liners shall be either noncombustible as set forth in Section 703.5 or *shall be flame resistant in accordance with appropriate standards set forth in CCR, Title 19, Division 1, Chapter 8. Tops and sidewalls shall be made either from fabric that has been flame resistant treated with an approved exterior chemical process by an approved application concern, or from inherently flame resistant fabric approved and listed by the State Fire Marshal (see CCR, Title 19, Division 1, Chapter 8).*

Exception: Plastic less than 20 mil (0.5 mm) in thickness used in greenhouses, where occupancy by the general public is not authorized, and for aquaculture pond covers is not required to meet the fire propagation performance criteria of NFPA 701.

3102.4 Allowable floor areas. The area of a membrane structure shall not exceed the limitations set forth in Table 503, except as provided in Section 506.

3102.5 Maximum height. Membrane structures shall not exceed one story nor shall such structures exceed the height limitations in feet set forth in Table 503.

Exception: Noncombustible membrane structures serving as roofs only.

3102.6 Mixed construction. Membrane structures shall be permitted to be utilized as specified in this section as a portion of buildings of other types of construction. Height and area limits shall be as specified for the type of construction and occupancy of the building.

3102.6.1 Noncombustible membrane. A noncombustible membrane shall be permitted for use as the roof or as a skylight of any building or atrium of a building of any type of construction provided it is not less than 20 feet (6096 mm) above any floor, balcony or gallery.

3102.6.1.1 Membrane. A membrane meeting the fire propagation performance criteria of NFPA 701 shall be permitted to be used as the roof or as a skylight on buildings of Types IIB, III, IV and V construction, provided it is not less than 20 feet (6096 mm) above any floor, balcony or gallery.

3102.7 Engineering design. The structure shall be designed and constructed to sustain dead loads; loads due to tension or inflation; live loads including wind, snow or flood and seismic loads and in accordance with Chapter 16.

3102.8 Inflation systems. Air-supported and air-inflated structures shall be provided with primary and auxiliary inflation systems to meet the minimum requirements of Sections 3102.8.1 through 3102.8.3.

3102.8.1 Equipment requirements. This inflation system shall consist of one or more blowers and shall include provisions for automatic control to maintain the required

inflation pressures. The system shall be so designed as to prevent overpressurization of the system.

3102.8.1.1 Auxiliary inflation system. In addition to the primary inflation system, in buildings larger than 1,500 square feet (140 m^2) in area, an auxiliary inflation system shall be provided with sufficient capacity to maintain the inflation of the structure in case of primary system failure. The auxiliary inflation system shall operate automatically when there is a loss of internal pressure and when the primary blower system becomes inoperative.

3102.8.1.2 Blower equipment. Blower equipment shall meet all of the following requirements:

1. Blowers shall be powered by continuous-rated motors at the maximum power required for any flow condition as required by the structural design.
2. Blowers shall be provided with inlet screens, belt guards and other protective devices as required by the building official to provide protection from injury.
3. Blowers shall be housed within a weather-protecting structure.
4. Blowers shall be equipped with backdraft check dampers to minimize air loss when inoperative.
5. Blower inlets shall be located to provide protection from air contamination. The location of inlets shall be approved.

3102.8.2 Standby power. Wherever an auxiliary inflation system is required, an approved standby power-generating system shall be provided. The system shall be equipped with a suitable means for automatically starting the generator set upon failure of the normal electrical service and for automatic transfer and operation of all of the required electrical functions at full power within 60 seconds of such service failure. Standby power shall be capable of operating independently for not less than 4 hours.

3102.8.3 Support provisions. A system capable of supporting the membrane in the event of deflation shall be provided for in air-supported and air-inflated structures having an occupant load of 50 or more or where covering a swimming pool regardless of occupant load. The support system shall be capable of maintaining membrane structures used as a roof for Type I construction not less than 20 feet (6096 mm) above floor or seating areas. The support system shall be capable of maintaining other membranes not less than 7 feet (2134 mm) above the floor, seating area or surface of the water.

SECTION 3103 TEMPORARY STRUCTURES

3103.1 General. The provisions of Sections 3103.1 through 3103.4 shall apply to structures erected for a period of less than 180 days. Tents and other membrane structures erected for a period of less than 180 days shall comply with the *California Fire Code*. Those erected for a longer period of time shall comply with applicable sections of this code.

3103.1.1 Permit required. Temporary structures that cover an area greater than 120 square feet (11.16 m^2), including connecting areas or spaces with a common means of egress or entrance which are used or intended to be used for the gathering together of 10 or more persons, shall not be erected, operated or maintained for any purpose without obtaining a permit from the building official.

3103.2 Construction documents. A permit application and construction documents shall be submitted for each installation of a temporary structure. The construction documents shall include a site plan indicating the location of the temporary structure and information delineating the means of egress and the occupant load.

3103.3 Location. Temporary structures shall be located in accordance with the requirements of Table 602 based on the fire-resistance rating of the exterior walls for the proposed type of construction.

3103.4 Means of egress. Temporary structures shall conform to the means of egress requirements of Chapter 10 and shall have an exit access travel distance of 100 feet (30 480 mm) or less.

SECTION 3104 PEDESTRIAN WALKWAYS AND TUNNELS

3104.1 General. This section shall apply to connections between buildings such as pedestrian walkways or tunnels, located at, above or below grade level, that are used as a means of travel by persons. The pedestrian walkway shall not contribute to the building area or the number of stories or height of connected buildings.

3104.2 Separate structures. Connected buildings shall be considered to be separate structures.

Exceptions:

1. Buildings on the same lot in accordance with Section 503.1.2 shall be considered a single structure.
2. *[DSA-AC and HCD 1-AC] For purposes of accessibility as required by Chapters 11A and 11B, structurally connected buildings, buildings connected by stairs, walkways, or roofs, and buildings with multiple wings shall be considered one structure.*

3104.3 Construction. The pedestrian walkway shall be of noncombustible construction.

Exceptions:

1. Combustible construction shall be permitted where connected buildings are of combustible construction.
2. Fire-retardant-treated wood, in accordance with Section 603.1, Item 1.3, shall be permitted for the roof construction of the pedestrian walkway where connected buildings are a minimum of Type I or II construction.

3104.4 Contents. Only materials and decorations approved by the building official shall be located in the pedestrian walkway.

3104.5 Fire barriers between pedestrian walkways and buildings. Walkways shall be separated from the interior of the building by not less than 2-hour fire barriers constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 711, or both. This protection shall extend vertically from a point 10 feet (3048 mm) above the walkway roof surface or the connected building roof line, whichever is lower, down to a point 10 feet (3048 mm) below the walkway and horizontally 10 feet (3048 mm) from each side of the pedestrian walkway. Openings within the 10-foot (3048 mm) horizontal extension of the protected walls beyond the walkway shall be equipped with devices providing a $\frac{3}{4}$ -hour fire protection rating in accordance with Section 715.

Exception: The walls separating the pedestrian walkway from a connected building and the openings within the 10-foot (3048 mm) horizontal extension of the protected walls beyond the walkway are not required to have a fire-resistance rating by this section where any of the following conditions exist:

1. The distance between the connected buildings is more than 10 feet (3048 mm). The pedestrian walkway and connected buildings, except for open parking garages, are equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. The wall is capable of resisting the passage of smoke or is constructed of a tempered, wired or laminated glass wall and doors subject to the following:
 - 1.1. The wall or glass separating the interior of the building from the pedestrian walkway shall be protected by an automatic sprinkler system in accordance with Section 903.3.1.1 and the sprinkler system shall completely wet the entire surface of interior sides of the wall or glass when actuated;
 - 1.2. The glass shall be in a gasketed frame and installed in such a manner that the framing system will deflect without breaking (loading) the glass before the sprinkler operates; and
 - 1.3. Obstructions shall not be installed between the sprinkler heads and the wall or glass.
2. The distance between the connected buildings is more than 10 feet (3048 mm) and both sidewalls of the pedestrian walkway are not less than 50 percent open with the open area uniformly distributed to prevent the accumulation of smoke and toxic gases.
3. Buildings are on the same lot in accordance with Section 503.1.2.
4. Where exterior walls of connected buildings are required by Section 705 to have a fire-resistance rating greater than 2 hours, the walkway shall be equipped throughout with an automatic sprinkler

system installed in accordance with Section 903.3.1.1.

The previous exception shall apply to pedestrian walkways having a maximum height above grade of three stories or 40 feet (12 192 mm), or five stories or 55 feet (16 764 mm) where sprinklered.

3104.6 Public way. Pedestrian walkways over a public way shall comply with Chapter 32.

3104.7 Egress. Access shall be provided at all times to a pedestrian walkway that serves as a required exit.

3104.8 Width. The unobstructed width of pedestrian walkways shall be not less than 36 inches (914 mm). The total width shall be not greater than 30 feet (9144 mm).

3104.9 Exit access travel. The length of exit access travel shall be 200 feet (60 960 mm) or less.

Exceptions:

1. Exit access travel distance on a pedestrian walkway equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 shall be 250 feet (76 200 mm) or less.
2. Exit access travel distance on a pedestrian walkway constructed with both sides not less than 50 percent open shall be 300 feet (91 440 mm) or less..
3. Exit access travel distance on a pedestrian walkway constructed with both sides not less than 50 percent open, and equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, shall be 400 feet (122 m) or less.

3104.10 Tunneled walkway. Separation between the tunneled walkway and the building to which it is connected shall be not less than 2-hour fire-resistant construction and openings therein shall be protected in accordance with Table 716.5.

SECTION 3105 AWNINGS AND CANOPIES

3105.1 General. Awnings or canopies shall comply with the requirements of Sections 3105.2 through 3105.4 and other applicable sections of this code.

3105.2 Definition. The following term is defined in Chapter 2:

RETRACTABLE AWNING.

3105.3 Design and construction. Awnings and canopies shall be designed and constructed to withstand wind or other lateral loads and live loads as required by Chapter 16 with due allowance for shape, open construction and similar features that relieve the pressures or loads. Structural members shall be protected to prevent deterioration. Awnings shall have frames of noncombustible material, fire-retardant-treated wood, wood of Type IV size, or 1-hour construction with combustible or noncombustible covers and shall be either fixed, retractable, folding or collapsible.

3105.4 Canopy materials. Canopies shall be constructed of a rigid framework with an approved covering that meets the

fire propagation performance criteria of NFPA 701 or has a flame spread index not greater than 25 when tested in accordance with ASTM E 84 or UL 723. *All fabrics and all interior decorative fabrics or materials shall be flame resistant in accordance with appropriate standards set forth in CCR, Title 19, Division 1, Chapter 8. Tops and sidewalls shall be made either from fabric that has been flame resistant treated with an approved exterior chemical process by an approved application concern, or from inherently flame resistant fabric approved and listed by the State Fire Marshal (see CCR, Title 19, Division 1, Chapter 8).*

SECTION 3106 MARQUEES

3106.1 General. Marquees shall comply with Section 3106.2 through 3106.5 and other applicable sections of this code.

3106.2 Thickness. The height or thickness of a marquee measured vertically from its lowest to its highest point shall be not greater than 3 feet (914 mm) where the marquee projects more than two-thirds of the distance from the lot line to the curb line, and shall be not greater than 9 feet (2743 mm) where the marquee is less than two-thirds of the distance from the lot line to the curb line.

3106.3 Roof construction. Where the roof or any part thereof is a skylight, the skylight shall comply with the requirements of Chapter 24. Every roof and skylight of a marquee shall be sloped to downspouts that shall conduct any drainage from the marquee in such a manner so as not to spill over the sidewalk.

3106.4 Location prohibited. Every marquee shall be so located as not to interfere with the operation of any exterior standpipe, and such that the marquee does not obstruct the clear passage of stairways or exit discharge from the building or the installation or maintenance of street lighting.

3106.5 Construction. A marquee shall be supported entirely from the building and constructed of noncombustible materials. Marquees shall be designed as required in Chapter 16. Structural members shall be protected to prevent deterioration.

SECTION 3107 SIGNS

3107.1 General. Signs shall be designed, constructed and maintained in accordance with this code.

SECTION 3108 TELECOMMUNICATION AND BROADCAST TOWERS

3108.1 General. Towers shall be designed and constructed in accordance with the provisions of TIA-222. Towers shall be designed for seismic loads; exceptions related to seismic design listed in Section 2.7.3 of TIA-222 shall not apply. In Section 2.6.6.2 of TIA 222, the horizontal extent of Topographic Category 2, escarpments, shall be 16 times the height of the escarpment.

Exception: Single free-standing poles used to support antennas not greater than 75 feet (22 860 mm), measured from the top of the pole to grade, shall not be required to be noncombustible.

3108.2 Location and access. Towers shall be located such that guy wires and other accessories shall not cross or encroach upon any street or other public space, or over above-ground electric utility lines, or encroach upon any privately owned property without the written consent of the owner of the encroached-upon property, space or above-ground electric utility lines. Towers shall be equipped with climbing and working facilities in compliance with TIA-222. Access to the tower sites shall be limited as required by applicable OSHA, FCC and EPA regulations.

SECTION 3109 SWIMMING POOL ENCLOSURES AND SAFETY DEVICES

3109.1 General. Swimming pools shall comply with the requirements of Sections 3109.2 through 3109.5 and other applicable sections of this code.

3109.2 Definition. The following terms are defined in Chapter 2:

ANSI/APSP PERFORMANCE STANDARD.

APPROVED SAFETY POOL COVER.

ENCLOSURE.

EXIT ALARMS.

PUBLIC SWIMMING POOL.

SUCTION OUTLET.

SWIMMING POOL or POOL.

SWIMMING POOLS.

3109.3 Public swimming pools. Public swimming pools shall be completely enclosed by a fence not less than 4 feet (1290 mm) in height or a screen enclosure. Openings in the fence shall not permit the passage of a 4-inch-diameter (102 mm) sphere. The fence or screen enclosure shall be equipped with self-closing and self-latching gates.

3109.4 Residential swimming pools. Residential swimming pools shall comply with Sections 3109.4.1 through 3109.4.3.

Exception: A swimming pool with a power safety cover or a spa with a safety cover complying with ASTM F 1346 need not comply with Section 3109.4.

3109.4.1 Barrier height and clearances. The top of the barrier shall be not less than 48 inches (1219 mm) above grade measured on the side of the barrier that faces away from the swimming pool. The vertical clearance between grade and the bottom of the barrier shall be not greater than 2 inches (51 mm) measured on the side of the barrier that faces away from the swimming pool. Where the top of the pool structure is above grade, the barrier is authorized to be at ground level or mounted on top of the pool structure, and the vertical clearance between the top of the pool structure and the bottom of the barrier shall be not greater than 4 inches (102 mm).

3109.4.1.1 Openings. Openings in the barrier shall not allow passage of a 4-inch-diameter (102 mm) sphere.

3109.4.1.2 Solid barrier surfaces. Solid barriers which do not have openings shall not contain indentations or protrusions except for normal construction tolerances and tooled masonry joints.

3109.4.1.3 Closely spaced horizontal members. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is less than 45 inches (1143 mm), the horizontal members shall be located on the swimming pool side of the fence. Spacing between vertical members shall be not greater than $1\frac{3}{4}$ inches (44 mm) in width. Where there are decorative cutouts within vertical members, spacing within the cutouts shall be not greater than $1\frac{3}{4}$ inches (44 mm) in width.

3109.4.1.4 Widely spaced horizontal members. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is 45 inches (1143 mm) or more, spacing between vertical members shall be not greater than 4 inches (102 mm). Where there are decorative cutouts within vertical members, spacing within the cutouts shall be not greater than $1\frac{3}{4}$ inches (44 mm) in width.

3109.4.1.5 Chain link dimensions. Mesh size for chain link fences shall be not greater than a $2\frac{1}{4}$ inch square (57 mm square) unless the fence is provided with slats fastened at the top or the bottom which reduce the openings to not more than $1\frac{3}{4}$ inches (44 mm).

3109.4.1.6 Diagonal members. Where the barrier is composed of diagonal members, the opening formed by the diagonal members shall be not greater than $1\frac{3}{4}$ inches (44 mm).

3109.4.1.7 Gates. Access doors or gates shall comply with the requirements of Sections 3109.4.1.1 through 3109.4.1.6 and shall be equipped to accommodate a locking device. Pedestrian access doors or gates shall open outward away from the pool and shall be self-closing and have a self-latching device. Doors or gates other than pedestrian access doors or gates shall have a self-latching device. Release mechanisms shall be in accordance with Sections 1008.1.9 and 1109.13. Where the release mechanism of the self-latching device is located less than 54 inches (1372 mm) from the bottom of the door or gate, the release mechanism shall be located on the pool side of the door or gate 3 inches (76 mm) or more, below the top of the door or gate, and the door or gate and barrier shall be without openings greater than $\frac{1}{2}$ inch (12.7 mm) within 18 inches (457 mm) of the release mechanism.

3109.4.1.8 Dwelling wall as a barrier. Where a wall of a dwelling serves as part of the barrier, one of the following shall apply:

1. Doors with direct access to the pool through that wall shall be equipped with an alarm that pro-

duces an audible warning when the door and/or its screen, if present, are opened. The alarm shall be listed and labeled in accordance with UL 2017. In dwellings not required to be Accessible units, Type A units or Type B units, the deactivation switch shall be located 54 inches (1372 mm) or more above the threshold of the door. In dwellings required to be Accessible units, Type A units or Type B units, the deactivation switch shall be located not higher than 54 inches (1372 mm) and not less than 48 inches (1219 mm) above the threshold of the door.

2. The pool shall be equipped with a power safety cover that complies with ASTM F 1346.
3. Other means of protection, such as self-closing doors with self-latching devices, which are approved, shall be accepted so long as the degree of protection afforded is not less than the protection afforded by Section 3109.4.1.8, Item 1 or 2.

3109.4.1.9 Pool structure as barrier. Where an aboveground pool structure is used as a barrier or where the barrier is mounted on top of the pool structure, and the means of access is a ladder or steps, then the ladder or steps either shall be capable of being secured, locked or removed to prevent access, or the ladder or steps shall be surrounded by a barrier which meets the requirements of Sections 3109.4.1.1 through 3109.4.1.8. Where the ladder or steps are secured, locked or removed, any opening created shall not allow the passage of a 4-inch-diameter (102 mm) sphere.

3109.4.2 Indoor swimming pools. Walls surrounding indoor swimming pools shall not be required to comply with Section 3109.4.1.8.

3109.4.3 Prohibited locations. Barriers shall be located so as to prohibit permanent structures, equipment or similar objects from being used to climb the barriers.

3109.4.4 Private swimming pools (statewide). *These regulations are subject to local government modification. The applicable local government requirements at the time of application for a building permit should be verified. These standards become applicable commencing January 1, 1998, to a private, single-family home for which a construction permit for a new swimming pool has been issued on or after January 1, 1998.*

3109.4.4.1 Definitions. As used in this division, the following terms have the following meanings:

ANSI/APSP PERFORMANCE STANDARD means a standard that is accredited by the American National Standards Institute (ANSI) and published by the Association of Pool and Spa Professionals (APSP).

APPROVED SAFETY POOL COVER means a manually or power-operated safety pool cover that meets all of the performance standards of the American Society for Testing and Materials (ASTM), in compliance with Standard F 1346-91.

ENCLOSURE means a fence, wall or other barrier that isolates a swimming pool from access to the home.

EXITALARMS means devices that make audible, continuous alarm sounds when any door or window that permits access from the residence to the pool area, that is without any intervening enclosure, is opened or is left ajar. Exit alarms may be battery operated or may be connected to the electrical wiring of the building.

PUBLIC SWIMMING POOL means a swimming pool operated for the use of the general public with or without charge, or for the use of the members and guests of a private club. Public swimming pool does not include a swimming pool located on the grounds of a private single-family home.

SUCTION OUTLET means a fitting or fixture typically located at the bottom or on the sides of a swimming pool that conducts water to a recirculating pump.

SWIMMING POOL or **POOL** means any structure intended for swimming or recreational bathing that contains water over 18 inches (457 mm) deep. Swimming pool includes in-ground and above-ground structures and includes, but is not limited to, hot tubs, spas, portable spas and nonportable wading pools.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115921
AB 3305, Statutes 1996, c.925

3109.4.4.2 Construction permit; safety features required. Commencing January 1, 2007, except as provided in Section 3109.4.4.5, whenever a building permit is issued for construction of a new swimming pool or spa, or any building permit is issued for remodeling of an existing pool or spa, at a private, single-family home, it shall be equipped with at least one of the following seven drowning prevention safety features:

1. The pool shall be isolated from access to a home by an enclosure that meets the requirements of Section 3109.4.4.3.
2. The pool shall incorporate removable mesh pool fencing that meets American Society for Testing and Materials (ASTM) Specifications F 2286 standards in conjunction with a gate that is self-closing and self-latching and can accommodate a key lockable device.
3. The pool shall be equipped with an approved safety pool cover that meets all requirements of the ASTM Specifications F 1346.
4. The residence shall be equipped with exit alarms on those doors providing direct access to the pool.
5. All doors providing direct access from the home to the swimming pool shall be equipped with a self-closing, self-latching device with a release mechanism placed no lower than 54 inches (1372 mm) above the floor.
6. Swimming pool alarms that, when placed in pools, will sound upon detection of accidental or unauthorized entrance into the water. These pool alarms shall meet and be independently certified

to the ASTM Standard F 2208 "Standards Specification for Pool Alarms" which includes surface motion, pressure, sonar, laser and infrared type alarms. For purposes of this article, "swimming pool alarms" shall not include swimming protection alarm devices designed for individual use, such as an alarm attached to a child that sounds when the child exceeds a certain distance or becomes submerged in water.

7. Other means of protection, if the degree of protection afforded is equal to or greater than that afforded by any of the devices set forth in items 1-4, and have been independently verified by an approved testing laboratory as meeting standards for those devices established by the ASTM or the American Society of Testing Mechanical Engineers (ASME).

Prior to the issuance of any final approval for the completion of permitted construction or remodeling work, the local building code official shall inspect the drowning safety prevention devices required by this act and if no violations are found, shall give final approval.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115922
AB 3305 (Statutes 1996, c.925); AB 2977 (Statutes 2006, c.478); AB 382 (Statutes 2007, c.596)

3109.4.4.3 Enclosure; required characteristics. An enclosure shall have all of the following characteristics:

1. Any access gates through the enclosure open away from the swimming pool and are self-closing with a self-latching device placed no lower than 60 inches (1524 mm) above the ground.
2. A minimum height of 60 inches (1524 mm).
3. A maximum vertical clearance from the ground to the bottom of the enclosure of 2 inches (51 mm).
4. Gaps or voids, if any, do not allow passage of a sphere equal to or greater than 4 inches (102 mm) in diameter.
5. An outside surface free of protrusions, cavities or other physical characteristics that would serve as handholds or footholds that could enable a child below the age of five years to climb over.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115923
AB 3305, Statutes 1996, c.925

3109.4.4.4 Agreements to build; notice of provisions.

Any person entering into an agreement to build a swimming pool or spa, or to engage in permitted work on a pool or spa covered by this article, shall give the consumer notice of the requirements of this article.

Pursuant to existing law, the Department of Health Services shall have available on the department's web site, commencing January 1, 2007, approved pool safety information available for consumers to down-

load. Pool contractors are encouraged to share this information with consumers regarding the potential dangers a pool or spa poses toddlers. Additionally, pool contractors may provide the consumer with swimming pool safety materials produced from organizations such as the United States Consumer Product Safety Commission, Drowning Prevention Foundation, California Coalition for Children's Safety & Health, Safe Kids Worldwide, Association of Pool and Spa Professionals, or the American Academy of Pediatrics.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115924 AB 3305 (Statutes 1996, c.925); AB 2977 (Statutes 2006, c.478); AB 382 (Statutes 2007, c.596)

3109.4.4.5 Exempt facilities. The requirements of this article shall not apply to any of the following:

1. Public swimming pools.
2. Hot tubs or spas with locking safety covers that comply with the American Society for Testing Materials Emergency Performance Specification (ASTM ES 13-89).
3. Any pool within the jurisdiction of any political subdivision that adopts an ordinance for swimming pool safety that includes requirements that are at least as stringent as this division.
4. An apartment complex or any residential setting other than a single-family home.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115925 AB 3305, (Statutes 1996, c.925); AB 2977 (Statutes 2006, c.478); AB 382 (Statutes 2007,c.596)

3109.4.4.6 Application to facilities regulated by Department of Social Services. This division does not apply to any facility regulated by the State Department of Social Services even if the facility is also used as a private residence of the operator. Pool safety in those facilities shall be regulated pursuant to regulations adopted therefor by the State Department of Social Services.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115926 AB 3305, Statutes 1996, c.925); AB 2977 (Statutes 2006, c.478); AB 382 (Statutes 2007, c.596)

3109.4.4.7 Modification and interpretation of division. Notwithstanding any other provision of law, this article shall not be subject to further modification or interpretation by any regulatory agency of the state, this authority being reserved exclusively to local jurisdictions, as provided for in Item 5 of Section 3109.4.4.2 and Item 3 of Section 3109.4.4.5.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115927 AB 3305 (Statutes 1996, c.925); AB 2977 (Statutes 2006, c.478); AB 382 (Statutes 2007, c.596)

3109.4.4.8 Construction requirements for building a pool or spa. Whenever a building permit is issued for the construction a new swimming pool or spa, the pool or spa shall meet all of the following requirements:

1. The suction outlets of the pool or spa for which the permit is issued shall be equipped to provide circulation throughout the pool or spa as prescribed in Paragraphs 2 and 3.
2. The swimming pool or spa shall either have at least two circulation suction outlets per pump that shall be hydraulically balanced and symmetrically plumbed through one or more "T" fittings, and that are separated by a distance of at least three feet in any dimension between the suction outlets, or be designed to use alternatives to suction outlets including, but not limited to, skimmers or perimeter overflow systems to conduct water to the recirculation pump.
3. The circulation system shall have the capacity to provide a complete turnover of pool water, as specified in Section 3124B of Chapter 31B of the California Building Standards Code (Title 24 of the California Code of Regulations).
4. Suction outlets shall be covered with antientrapment grates, as specified in the ANSI/APSP-16 performance standard or successor standard designated by the federal Consumer Product Safety Commission, that cannot be removed except with the use of tools. Slots of openings in the grates or similar protective devices shall be of a shape, area and arrangement that would prevent physical entrapment and would not pose any suction hazard to bathers.
5. Any backup safety system that an owner of a new swimming pool or spa may choose to install in addition to the requirements set forth in subdivisions (1) through (4) above shall meet the standards as published in the document, "Guidelines for Entrapment Hazards: Making Pools and Spas Safer," Publication Number 363, March 2005, United States Consumer Products Safety Commission.
6. Whenever a building permit is for the remodel or modification of any existing swimming pool, toddler pool, or spa, the permit shall require that the suction outlet or suction outlets of the existing swimming pool, toddler pool, or spa be upgraded so as to be equipped with antientrapment grates, as specified in the ANSI/APSP-16 performance standard or a successor standard designated by the federal Consumer Product Safety Commission.

Authority: Health and Safety Code Section 18942(b)

Reference: Health and Safety Code Section 115928 AB 3305 (Statutes 1996, c.925); AB 2977 (Statutes 2006, c.478); AB 478 (Statutes 2007, c.596)

3109.5 Entrapment avoidance. Suction outlets shall be designed and installed in accordance with ANSI/APSP-7.

3109.6 Informative documents.

1. The Legislature encourages a private entity, in consultation with the Epidemiology and Prevention for Injury Control Branch of the department, to produce an informative brochure or booklet, for consumer use, explaining the child drowning hazards of, possible safety measures for, and appropriate drowning hazard prevention measures for, home swimming pools and spas, and to donate the document to the department.
2. The Legislature encourages the private entity to use existing documents from the United States Consumer Product Safety Commission on pool safety.
3. If a private entity produces the document described in Subdivisions 1 and 2 and donates it to the department, the department shall review and approve the brochure or booklet.
4. Upon approval of the document by the department, the document shall become the property of the state and a part of the public domain. The department shall place the document on its Web site in a format that is readily available for downloading and for publication. The department shall review the document in a timely and prudent fashion and shall complete the review within 18 months of receipt of the document from a private entity.

SECTION 3110 AUTOMATIC VEHICULAR GATES

3110.1 General. Automatic vehicular gates shall comply with the requirements of Sections 3110.2 through 3110.4 and other applicable sections of this code.

3110.2 Definition. The following term is defined in Chapter 2: VEHICULAR GATE.

3110.3 Vehicular gates intended for automation. Vehicular gates intended for automation shall be designed, constructed and installed to comply with the requirements of ASTM F 2200.

3110.4 Vehicular gate openers. Vehicular gate openers, where provided, shall be listed in accordance with UL 325.

SECTION 3111 SOLAR PHOTOVOLTAIC PANELS/MODULES

3111.1 Solar photovoltaic power systems. Solar photovoltaic power systems shall be installed in accordance with Sections 3111.2 through 3111.3 and the California Electrical Code.

3111.2 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Sections 3111.2.1 through 3111.2.3.3.

Exceptions:

1. Detached, nonhabitable Group U structures including, but not limited to, parking shade structures, carports, solar trellises and similar structures.

2. Roof access, pathways, and spacing requirements need not be provided where the fire chief has determined rooftop operations will not be employed.

3111.2.1 Roof access points. Roof access points shall be located in areas that do not require the placement of ground ladders over openings such as windows or doors, and located at strong points of building construction in locations where the access point does not conflict with overhead obstructions such as tree limbs, wires or signs.

3111.2.2 Solar photovoltaic systems for Group R-3 buildings. Solar photovoltaic systems for Group R-3 buildings shall be provided in accordance with Sections 3111.2.2.1 through 3111.2.2.4.

Exception: These requirements shall not apply to structures designed and constructed in accordance with the California Residential Code.

3111.2.2.1 Size of solar photovoltaic array. Each photovoltaic array shall be limited to 150 feet (45 720 mm) by 150 feet (45 720 mm). Multiple arrays shall be separated by a 3-foot-wide (914 mm) clear access pathway.

3111.2.2.2 Hip roof layouts. Panels and modules installed on Group R-3 buildings with hip roof layouts shall be located in a manner that provides a 3-foot-wide (914 mm) clear access pathway from the eave to the ridge on each roof slope where panels and modules are located. The access pathway shall be located at a structurally strong location on the building capable of supporting the live load of fire fighters accessing the roof.

Exception: These requirements shall not apply to roofs with slopes of two units vertical in 12 units horizontal (2:12) or less.

3111.2.2.3 Single ridge roofs. Panels and modules installed on Group R-3 buildings with a single ridge shall be located in a manner that provides two, 3-foot-wide (914 mm) access pathways from the eave to the ridge on each roof slope where panels and modules are located.

Exception: This requirement shall not apply to roofs with slopes of two units vertical in 12 units horizontal (2:12) or less.

3111.2.2.4 Roofs with roof hips and valleys. Panels and modules installed on Group R-3 buildings with roof hips and valleys shall be located no closer than 18 inches (457 mm) to a hip or a valley where panels and modules are to be placed on both sides of a hip or valley. Where panels are to be located on only one side of a hip or valley that is of equal length, the panels shall be permitted to be placed directly adjacent to the hip or valley.

Exception: These requirements shall not apply to roofs with slopes of two units vertical in 12 units horizontal (2:12) or less.

3111.2.2.5 Allowance for smoke ventilation operation. Panels and modules installed on residential buildings shall be located no less than 3 feet (914 mm) from the

ridge in order to allow for fire department smoke ventilation operations.

Exception: Panels and modules shall be permitted to be located up to the roof ridge where an alternative ventilation method approved by the fire chief has been provided or where the fire chief has determined vertical ventilation techniques will not be employed.

3111.2.3 Other than Group R-3 buildings. Access to systems for buildings other than those containing Group R-3 occupancies shall be provided in accordance with Sections 3111.2.3.1 through 3111.2.3.3.

Exception: Where it is determined by the fire code official that the roof configuration is similar to that of a Group R-3 occupancy, the residential access and ventilation requirements in Sections 3111.2.2.1 through 3111.2.2.5 shall be permitted to be used.

3111.2.3.1 Access. There shall be a minimum 6-foot-wide (1829 mm) clear perimeter around the edges of the roof.

Exception: Where either axis of the building is 250 feet (76 200 mm) or less, the clear perimeter around the edges of the roof shall be a minimum 4-foot-wide (1290 mm).

3111.2.3.2 Pathways. The solar installation shall be designed to provide designated pathways. The pathways shall meet the following requirements:

1. The pathway shall be over areas capable of supporting the live load of fire fighters accessing the roof.
2. The centerline axis pathways shall be provided in both axes of the roof. Centerline axis pathways shall run where the roof structure is capable of supporting the live load of fire fighters accessing the roof.
3. Shall be a straight line not less than 4 feet (1290 mm) clear to roof standpipes or ventilation hatches.
4. Shall provide not less than 4 feet (1290 mm) clear around roof access hatch with at least one not less than 4 feet (1290 mm) clear pathway to parapet or roof edge.

3111.2.3.3 Smoke ventilation. The solar installation shall be designed to meet the following requirements:

1. Arrays shall be no greater than 150 feet (45 720 mm) by 150 feet (45 720 mm) in distance in either axis in order to create opportunities for fire department smoke ventilation operations.
2. Smoke ventilation options between array sections shall be one of the following:
 - 2.1. A 4-foot (1290 mm) or greater in width pathway and bordering roof skylights or gravity-

operated dropout smoke and heat vents on not less than one side.

- 2.2. A 4-foot (1290 mm) or greater in width pathway and bordering all sides of nongravity-operated dropout smoke and heat vents on not less than one side.
- 2.4. A 4-foot (1290 mm) or greater in width pathway and bordering 4-foot by 8-foot (1290 mm by 2438 mm) "venting cutouts" every 20 feet (6096 mm) on alternating sides of the pathway.

3111.3 Ground-mounted photovoltaic arrays. Ground-mounted photovoltaic arrays shall comply with this section and the California Electrical Code. Setback requirements shall not apply to ground-mounted, free-standing photovoltaic arrays. A clear, brush-free area of 10 feet (3048 mm) shall be required for ground-mounted photovoltaic arrays.

CHAPTER 31A

**SYSTEMS FOR WINDOW CLEANING OR
EXTERIOR BUILDING MAINTENANCE**

*See Title 8, California Code of Regulations, Division 1, Chapter 4, Subchapter 7,
General Industry Safety Orders, Group 1, Articles 5 and 6.*

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE CHAPTER 31B – PUBLIC SWIMMING POOLS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | CSA | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|-----|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | X | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | X | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |
| 3114B.1 w/Exception 2 only | | | | | | X | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

CHAPTER 31B [DPH] PUBLIC POOLS

Division I—GENERAL

SECTION 3101B SCOPE

The provisions of this chapter shall apply to the construction, installation, renovation, alteration, addition, relocation, replacement or use of any public pool and to its ancillary facilities, mechanical equipment and related piping. Public pools include those located in or designated as the following: commercial building, hotel, motel, resort, recreational vehicle or mobile home park, campground, apartment house, condominium, townhouse, homeowner association, club, community building or area, public or private school, health club or establishment, water park, swim school, medical facility, bed and breakfast, licensed day-care facility, recreation and park district and municipal pools.

Note: Existing law limits application of building standards. Please see Health and Safety Code Sections 18938.5 and 116050.

[DSA-AC] Refer to Chapter 11B for accessibility provisions applicable to public accommodations, commercial buildings and public housing.

SECTION 3102B DEFINITIONS

ANCILLARY FACILITY is any area used in conjunction with or for the operation of a pool such as public dressing rooms, lockers, shower or bathroom areas, drinking fountains, equipment room, pool deck area, pool enclosure or building space that is intended to be used by pool users.

BACKWASH is the process of reversing the flow of water through the filter to thoroughly clean the filter media and/or elements and remove the debris from the contents of the filter vessel.

CANTILEVERED DECKING is the part of the deck which extends over a top edge of a pool or spa.

CLEAN POOL WATER is pool water that is free of dirt, oils, scum, algae, floating materials or visible organic and inorganic materials that would pollute the water.

CLEAR POOL WATER is pool water that is free from cloudiness and is transparent.

COPING is a slip-resistant cap installed on the top edge of a pool or spa.

CORROSION RESISTANT is capable of maintaining original surface characteristics under the prolonged influence of the use environment.

DECK is an area surrounding a pool which is specifically constructed or installed for use by pool users.

DIATOMACEOUS EARTH is a filtering media consisting of microscopic fossilized skeletons of diatoms.

EASILY CLEANABLE is a characteristic of a surface or material that allows removal of dirt, stains or residue by normal cleaning methods.

EFFECTIVE PARTICLE SIZE is the theoretical size of a sieve in mm that will pass 10 percent by weight of sand.

ENFORCING AGENT is the health officer, director of environmental health, registered environmental health specialist or environmental health specialist trainee.

EQUIPMENT AREA is an area where the recirculation system and all related appurtenances are located.

HANDHOLD is a structure located at or above the water line around the perimeter of the pool wall that allows a pool user to hold onto the poolside for support.

INLET is a fitting or fixture through which recirculated water enters the pool.

LADDER is a series of vertically separate treads or rungs either connected by vertical rail members or independently fastened to an adjacent vertical pool wall.

LIVING UNIT is any building or portion thereof that contains living facilities including provisions for sleeping.

MAIN DRAIN is a submerged suction outlet typically located at the bottom of a pool that conducts water to a recirculating pump.

MEDICAL POOL is a special-purpose pool used by a State-recognized medical institution engaged in the healing arts under the direct supervision of licensed medical personnel for treatment of the infirm.

OUTLET is a fitting or fixture through which recirculated water is removed from the pool which may or may not be connected to the pump.

PERFORMANCE STANDARD is a standard that is accredited and published. Products compliant with a standard may be listed by any authorized nationally recognized testing laboratory.

PERIMETER OVERFLOW SYSTEM is a system which includes perimeter-type overflow gutters, surge basin or similar surface water collective system components and their interconnecting piping.

PERMISSIBLE EXPOSURE LIMIT is the maximum amount or concentration of a chemical that a worker may be exposed to under United States Occupational Safety and Health Administration regulations.

POOL OR PUBLIC POOL is an artificial basin, chamber or tank constructed or prefabricated with impermeable surfaces that is used, or intended to be used, for public swimming, diving or recreational activities but does not include individual therapeutic tubs or baths where the main purpose is the cleaning of the body. Any manmade lake or swimming lagoon with a sand beach or sand bottom is not a public pool.

POOL OPERATOR or OPERATOR is a person who is responsible for maintaining compliance with all requirements relating to pool operation, maintenance and safety of pool users.

POOL USER is a person using a pool and ancillary facilities for the purpose of water activities such as diving, swimming or wading.

RADIUS OF CURVATURE is the radius arc which denotes the curved surface from the point of departure from the springline of the pool to the pool bottom.

READILY ACCESSIBLE is capable of being reached easily for cleaning, repair, replacement or inspection without the necessity of removing a panel, door or similar obstruction and without requiring a person to climb over or remove obstacles or to use devices such as portable ladders.

READILY DISASSEMBLED means capable of being taken apart by hand or by using only simple tools such as a screwdriver, pliers or open-end wrench.

RECESSED STEPS are a series of vertically spaced cavities in the pool wall creating riser and tread areas for pool ingress and egress.

RECIRCULATION SYSTEM is the system of hydraulic components designed to remove, filter, disinfect and return water to the pool.

RIM FLOW GUTTER is a perimeter overflow system in which the overflow rim is at the same elevation with the deck.

SKIMMER EQUALIZER LINE is a submerged suction outlet located below the waterline and connected to the body of a skimmer that prevents air from being drawn into the pump if the water level drops below the skimmer weir or the skimmer is blocked by debris. A skimmer equalizer line is not a main drain.

SLIP RESISTANT is a rough finish that is not abrasive to the bare foot.

SPA POOL OR SPA is a pool that incorporates a water jet system, an aeration system or a combination of the two systems used in conjunction with heated water.

SPECIAL PURPOSE POOL is a pool constructed exclusively for a specific purpose, such as instruction, diving, competition or medical treatment.

SPLASH ZONE is the maximum distance the water from a spray ground can project horizontally.

SPRAY GROUND is a pool with no standing water in the splash zone and consists of a surge basin with a recirculation system from which water is directed through water features for contact with pool users.

SPRINGLINE is the point from which the pool wall breaks from vertical and begins its arc in the radius of curvature.

STAIRS are a series of two or more steps.

STEP is a riser and tread.

SUCTION OUTLET is any outlet that is connected to the pump through which water is removed from the pool.

SURGE BASIN is a reservoir or surge trench open to the atmosphere that receives water via gravity flow from the main

drain, spray ground or perimeter overflow system and from which the recirculation system operates.

TEMPERED WATER is water between 100°F and 110°F.

TURNOVER TIME is the maximum time allowed to circulate one complete volume of the pool water through the recirculation system.

UNIFORMITY COEFFICIENT is the ratio of the theoretical size of a sieve in mm that will pass 60 percent of the sand to the theoretical size of a sieve in mm that will pass 10 percent of the sand.

WADING POOL is a pool intended to be used for wading by small children and having a maximum water depth of 18 inches (457 mm) at the deepest point.

WATER FEATURE means an interactive device or structure through which water is directed to the pool user such as a water fountain, water spray, dancing water jet, waterfall, dumping bucket or shooting water cannon.

WATERLINE shall be defined as one of the following:

1. **Skimmer system.** The waterline shall be the midpoint of the operating range of the skimmers.
2. **Overflow system.** The waterline shall be the top edge of the overflow rim.

PLAN REVIEW, PERMITS, CONSTRUCTION AND FIELD INSPECTIONS

SECTION 3103B PLAN REVIEW

3103B.1 A person proposing to construct, renovate or alter a pool, ancillary facilities or equipment and appurtenances shall submit plans and specifications detailing compliance with this chapter to the enforcing agent for review and written approval prior to commencing construction and shall first be cleared by the enforcing agent before substitution if not an exact duplicate of the units being changed or replaced. A local building department shall not issue a permit for a public pool or ancillary facility until the plans have been approved by the enforcing agent.

3103B.2 Plans submitted for approval pursuant to this section shall be drawn to a scale of $\frac{1}{4}$ inch (6.4 mm) equals 1 foot (305 mm), except that plans for spa pools shall be drawn to a scale of 1 inch (25 mm) equals 1 foot (305 mm), unless otherwise approved by the enforcing agent.

3103B.3 The enforcing agent shall notify the person submitting the plans and specifications of approval or disapproval.

3103B.4 The enforcing agent shall retain one copy of the approved plans and specifications and any subsequent changes or modifications. The approved plans shall be valid for a period of two years from the date of approval or as extended by the enforcing agent.

SECTION 3104B CONSTRUCTION

Pools and all ancillary facilities, equipment and appurtenances shall be constructed, renovated or altered in compliance with plans approved pursuant to Section 3103B.

SECTION 3105B PLAN COMPLIANCE INSPECTIONS

3105B *The pool owner, operator or designated agent shall notify the enforcing agent prior to scheduling the following inspections:*

1. Exposed plumbing; and
2. Prior to applying pneumatically placed concrete; and
3. Prior to applying the final surface to the pool shell; and
4. At the completion of construction. No pool shall be opened to the public without the written approval of the enforcing agent.

POOL STRUCTURE

SECTION 3106B SPECIAL REQUIREMENTS FOR SPRAY GROUNDS

3106B Spray grounds. *All applicable provisions of this chapter shall apply to a spray ground unless specifically addressed in this section.*

3106B.1 *All parts of the spray ground shall be designed and constructed so that there are no safety hazards.*

3106B.2 Walking surface. *A minimum 4-foot wide walking surface shall extend around the perimeter of the splash zone of a spray ground.*

3106B.3 *The recirculation system shall be in operation at all times that the spray ground is open for use and shall have a minimum of four turnover cycles prior to opening for proper disinfection and filtration.*

3106B.4 *There shall be no standing water within the splash zone.*

3106B.5 *Nozzles that spray from the ground level shall be flush with the ground with openings no greater than $\frac{1}{2}$ inch. Spray ground water features that extend above the ground must be clearly visible.*

3106B.6 *The splash zone shall be sloped so that only water from the spray ground water feature flows back to the surge basin. Areas adjacent to the splash zone shall be sloped away from the spray ground to deck drains or other surface water disposal systems.*

3106B.7 *All foggers and misters that produce finely atomized mists shall be supplied directly from a potable water source and not from the surge basin.*

3106B.8 *When multiple pumps are used the control systems for the spray ground water feature pump and recirculation system pump shall be electrically interconnected so that when the recirculation pump is off the spray ground water feature pump also is off.*

3106B.9 *The spray ground shall have a surge basin or treatment tank constructed of materials which are inert, corrosion resistant, nontoxic and watertight including materials such as concrete, fiberglass, high density polyethylene, stainless steel or other materials as approved by the enforcing agent which can withstand all anticipated loadings under full and empty conditions as determined by an engineer or architect who has experience working on public pools.*

3106B.10 *The total volume of the surge basin shall be at least 4,000 gallons or a minimum of three times the gallons per minute flow rate of all the spray ground pumps and the recirculation pump combined, whichever is higher.*

3106B.11 *The turnover time shall be one-half hour or less.*

3106B.12 *The suction intake for the spray ground or water feature pump in the surge basin shall be located adjacent to the recirculation return line.*

3106B.13 *When separate pumps are used, the suction intake for the recirculation pump shall be located in the lowest portion of the surge basin and on the opposite side from the suction intake for the spray ground pump.*

3106B.14 *The surge basin shall be designed to have easy access for cleaning and inspection. The basin shall have at least one ladder access and shall have at least one 3-foot by 3-foot access opening. Lids shall be locked or require a tool to open.*

3106B.15 *The surge basin shall be equipped with an automatic make up water fill device through an air gap or be protected by an approved backflow prevention device in accordance with Chapter 6 of the California Plumbing Code.*

3106B.16 *Ultraviolet light disinfection shall be used to supplement disinfection methods required in this chapter unless another treatment process is provided that has been determined by a nationally recognized testing laboratory to be capable of providing at least the equivalent level of reduction of cryptosporidium as the ultraviolet light disinfection system specified in this section. The ultraviolet light disinfection unit shall comply with the applicable requirements established by the NSF/ANSI 50-2010 performance standard effective August 2010.*

3106B.17 *An accurately calibrated ultraviolet light intensity meter that has been properly filtered to restrict its sensitivity to the disinfection spectrum shall be installed in the wall of the disinfection chamber at the point of greatest water depth from the light source.*

3106B.18 *The ultraviolet light unit shall be located on the recirculation system and shall be installed to provide treated water directly to the spray features.*

3106B.19 The ultraviolet light disinfection system must be equipped with an automatic shutdown system that inactivates the water feature pump if the ultraviolet dosage rate drops below 40 mJ/cm².

3106B.20 Artificial lighting shall be provided at all spray ground pads which are used at night or which do not have adequate natural lighting so that all portions of the spray pad and deck may be seen easily. Lighting that may be exposed to the feature pool water shall be installed in accordance with the manufacturer's specifications and the California Electrical Code.

3106B.21 A means of diverting runoff from the splash zone shall be installed on the spray ground drainage piping before the surge basin to divert water to the storm drainage system when the spray ground is not in operation.

3106B.22 A removable and cleanable catch screen or basket shall be installed on the spray ground drainage system before it enters the reservoir to prevent larger debris from collecting in the surge basin.

SECTION 3107B ALTERNATIVE EQUIPMENT, MATERIALS AND METHODS OF CONSTRUCTION

3107B.1 The enforcing agent may approve an alternative equipment, material or method of construction provided it finds that the proposed design is satisfactory and complies with the provisions of this chapter, that the equipment, material, method or work offered is, for the purpose intended, at least equivalent to that prescribed in suitability, strength, effectiveness, fire resistance, durability, safety and sanitation or that the methods of installation proposed conform to other acceptable nationally recognized standards.

3107B.2 The enforcing agent shall require that sufficient evidence or proof be submitted to substantiate claims that may be made regarding the use of alternative equipment, material or method of construction.

3107B.3 Whenever there is insufficient evidence of compliance with the provisions of this chapter, the enforcing agent may require tests as proof of compliance to be made at no expense to the enforcing agent. Tests shall be made in accordance with approved standards, but in the absence of such standards the enforcing agent may specify the test procedure.

SECTION 3108B POOL CONSTRUCTION

3108B.1 **Pool shell.** The pool shall be built of reinforced concrete or material equivalent in strength, watertight and able to withstand anticipated stresses under both full and empty conditions taking into consideration factors such as climatic effects, geological conditions and integration of the pool with other structures.

3108B.2 **Finish.** The finished pool shell shall be lined with a smooth waterproof interior finish that will withstand repeated brushing, scrubbing and cleaning procedures. The interior pool finish shall completely line the pool to the tile lines, coping, or cantilevered deck.

3108B.3 **Finish color.** The finish color shall be white except for the following which shall be of contrasting color:

1. Lane and other required pool markings described in Section 3110B; and
2. The top surface edges of benches in spa pools; and
3. The edge of pool steps; and
4. Tiles installed at the waterline; and
5. Tiles installed at the 4 $\frac{1}{2}$ foot (1372 mm) depth line.

Exception: A spa pool may be finished in a light color other than white when approved by the enforcing agent.

3108B.4 **Projections and recessed areas.** The pool shell shall not have projections or recessed areas except for pool inlets and outlets as specified in Section 3137B.

Exception: This section shall not apply to handholds, recessed steps, ladders, stairs, handrails, skimmers or perimeter overflow systems.

SECTION 3109B POOL GEOMETRY

3109B.1 **General.** A pool shall conform to the appropriate criteria in Figures 31B-1 through 31B-7.

Exception: A special purpose pool may be exempted from construction standards that are not applicable to the proposed use.

3109B.2 **Dimensional tolerances.** A construction tolerance shall be permitted on all dimensions in Figures 31B-1 through 31B-3 not to exceed 2 inches (51 mm) except that the tolerance of the water level of a pool with a nonadjustable overflow system shall not exceed 1/8 inch (3.2 mm).

3109B.3 **Bottom slope break.** Any portion of a pool having a water depth of 4 $\frac{1}{2}$ feet (1372 mm) or less shall have a uniform slope that shall not exceed 1 foot (305 mm) of vertical in 10 feet (3050 mm) of horizontal. In pools with water depths greater than 4 $\frac{1}{2}$ feet (1372 mm) the slope shall meet the requirements in Figures 31B-1 through 31B-3. There shall be a uniform water depth along the entire base of the stairs.

SECTION 3110B PERMANENT MARKINGS

3110B.1 General. No markings, designs or lettering shall be permitted on the pool shell except for slip resistant lane markings, depth marking lines and safety markings.

3110B.2 Lane markings. Slipresistant lane lines at the bottom of the pool shall not exceed 12 inches (305 mm) in width.

3110B.3 Depth marking line. There shall be installed a straight line of slip resistant tile a minimum of 4 inches (102 mm) and not greater than 6 inches (152 mm) wide of a color contrasting with the background of the pool shell across the bottom of the pool where the water depth is $4\frac{1}{2}$ feet (1372 mm).

Exception: Pools having a maximum water depth of 5 feet (1524 mm) or less shall not be required to have a depth marking line.

3110B.4 Water depth markers.

3110B.4.1 Location. The water depth shall be clearly marked at the following locations:

1. Maximum depth; and
2. Minimum depth; and
3. Each end; and
4. Both sides at the shallowest and deepest part of the pool; and
5. At the break in the bottom slope between the shallow and deep portions of the pool (see also Section 3109B.3); and
6. Along the perimeter of the pool at distances not to exceed 25 feet (7620 mm).

Exception: A spa or wading pool shall have a minimum of two depth markers indicating the maximum depth.

Note: For an illustration diagram pertaining to this section see Figure 31B-8.

3110B.4.2 Position. Where required by Section 3110B.4.1, depth markers shall be located in the following positions:

1. On the coping or on the deck, the depth markers shall be placed as close as possible but no more than 3 feet (914 mm) from the pool water; and
2. For pools with skimmer systems the depth markers shall be high at the waterline which typically will result in the depth markers being submerged approximately 50 percent; or
3. For pools with perimeter overflow systems where coping cantilevers over the gutter depth markers may be positioned at the face of the cantilevered coping, the back wall above the gutter or immediately below the waterline which will result in the depth markers being completely submerged; or
4. For pools with rim flow gutters, depth markers shall be positioned immediately below the waterline which will result in the depth markers being completely submerged.

3110B.4.3 Tolerance. Depth markers shall be positioned to indicate the water depth accurate to the nearest 6 inches (152 mm) as measured at the waterline.

3110B.4.4 Size of markers. Depth markers shall:

1. Have numerals a minimum of 4 inches (102 mm) in height and of a color contrasting with the background and be marked in units of feet and inches. Abbreviations of FT and IN may be used in lieu of feet and inches; and
2. Be made of a durable material that is resistant to weathering; and
3. Be slip resistant when they are located on the pool deck.

3110B.5 No diving markers. For pool water depths 6 feet (1830 mm) or less no diving markers with the universal symbol of no diving, which is a red circle with a slash through it superimposed over the image of a diver, shall be installed on the deck directly adjacent to the depth markers required by Section 3110B.4.1. No diving markers shall comply with Section 3110B.4.4(2-3).

SECTION 3111B STEPS, RECESSED STEPS, LADDERS AND STAIRS

3111B.1 Construction. A means of entry and exit to and from the pool shall consist of steps, recessed steps, ladders, stairs, ramps or a combination of these. Stairs or ramps shall be provided in the shallowest portion of a pool if the vertical distance from the bottom of the pool to the deck is over 1 foot (305 mm). In pools with more than one shallow end, stairs or ramps shall be provided at a minimum at one shallow end. A second means of entry and exit shall be provided in the deep portion of a pool having a depth greater than $4\frac{1}{2}$ feet (1372 mm). Where the width of the pool exceeds 30 feet (9144 mm), such means of entry and exit shall be provided at each side, not more than 100 feet (30,480 mm) apart.

Note: For illustrated diagrams pertaining to this section see Figures 31B-6 and 31B-7.

3111B.2 Ladders. Ladders shall be corrosion resistant and shall be equipped with slip resistant tread surfaces. Ladders shall be rigidly installed and shall provide a clearance of not less than 3 inches (76 mm) or more than 5 inches (127 mm) between any part of the ladder and the pool wall.

3111B.3 Stairs. Each step of a stair shall have a tread in accordance with Figure 31B-7. Risers shall conform to Figure 31B-7. At least one hand rail shall be provided extending from the deck to not less than a point above the top of the lowest step installed in accordance with Figure 31B-7.

3111B.4 Ladder and recessed step dimensions. Ladder treads and recessed steps shall have a minimum tread of 5 inches (127 mm) and a width of 14 inches (356 mm) and shall be designed to be readily cleaned. Step risers shall be uniform and shall not exceed 12 inches (305 mm) in height. The first riser shall be measured from the deck.

3111B.5 Handrails for ladders and recessed steps. Handrails shall be provided at the top of both sides of each ladder and recessed steps and shall extend over the coping or edge of the deck.

3111B.6 Handrails for spas. Two hand rails shall be provided extending from the deck to not less than a point above the top of the lowest step in accordance with Figure 31B-7. The steps shall be located where the deck is at least 4 feet (1219 mm) wide.

3111B.7 Dimensional tolerances. Finished step tread and riser construction tolerances shall be $\pm \frac{1}{2}$ inch (12.5 mm).

[DSA-AC] Additional requirements may apply. Refer to Chapter 11B for accessibility provisions applicable to public accommodations, commercial buildings and public housing.

SECTION 3112B HANDHOLDS

3112B.1 General. Every pool shall be provided with handholds (perimeter overflow system, bull-nosed coping or cantilevered decking) around the entire perimeter installed not greater than 9 inches (229 mm) above the waterline.

Exception: Handholds are not required for wading pools.

3112B.2 For special purpose pools used for instruction or competitive swimming, a handhold at water level similar to the rim of a perimeter overflow system is required.

3112B.3 Where perimeter overflow systems are not provided, a bull-nosed coping or cantilevered decking of reinforced concrete, or material equivalent in strength and durability, with rounded slip resistant edges shall be provided. The overhang for either bull-nosed coping or cantilevered decking shall not exceed 2 inches (51 mm) or be less than 1 inch (25 mm) and shall not exceed $2\frac{1}{2}$ inches (64 mm) in thickness.

Exception: The enforcing agent may accept other handholds for spa pools.

SECTION 3113B DIVING BOARDS AND PLATFORMS

3113B.1 General. Diving boards and platforms shall be anchored to the pool deck, constructed of corrosion resistant material, designed and constructed to be easily cleanable and finished with a durable slip resistant material.

3113B.2 Rails and steps. Diving boards or platforms greater than 18 inches (456 mm) in height above the deck shall be provided with a ladder or stairs for access. Hand rails shall be provided at all ladders and stairs leading to diving boards or platforms more than 1 meter above the water. Diving boards and platforms that are over 1 meter above the water shall have guard rails on both sides of the diving board or platform that extend to a point on the platform directly above the water's edge. Guard rails shall be 36 inches (914 mm) above the diving board or platform.

3113B.3 Dimensions. Dimensions and clearances for the use of diving boards or platforms shall conform to those shown in Figures 31B-1 and 31B-2. Platforms and diving boards shall conform to the USA Diving Rules and Codes, Part 1, Subpart A and Appendix B, effective January 1, 2010.

SECTION 3114B POOL DECKS

3114B.1 General. A minimum continuous and unobstructed 4-foot wide (1219 mm) slip resistant, cleanable, nonabrasive deck area of concrete or like material shall be provided flush with the top of the pool coping extending completely around the pool, and the deck area shall further extend 4 feet (1219 mm) on both sides and rear of any diving board, fixed disabled access assistance device or slide and their appurtenances. The deck width shall be measured from the poolside edge of the coping lip.

Exception: A deck at least 4 feet (1219 mm) in width shall extend around a continuous 50 percent or more of the perimeter of a spa pool.

3114B.2 Deck between pools and/or spas. Where multiple pools and/or spas are built adjacent to each other, the deck width separating them shall be a minimum of 6 feet (1830 mm).

3114B.3 Deck slope. The pool's deck surface shall have a slope of no less than 1 percent ($\frac{1}{8}$ inch per foot) but no more than 2 percent ($\frac{1}{4}$ inch per foot) away from the pool to a deck drainage system and shall be constructed and finished to prevent standing water.

3114B.4 Deck covering. Deck coverings or other materials that are not equivalent to concrete in strength, durability and slip resistance and are not able to withstand repeated brushing, scrubbing or cleaning procedures shall not be installed or used within 4 feet (1219 mm) of the pool.

3114B.5 Unpaved areas. Landscape plants, flower beds or similar unpaved areas shall not be located within 4 feet (1219 mm) of a spa pool.

SECTION 3115B POOL LIGHTING

3115B.1 General. Pools shall have underwater and deck lighting such that lifeguards or other persons may observe, without interference from direct and reflected glare from the lighting sources, every part of the underwater area and pool surface, all diving boards or other pool appurtenances. If underwater or deck surface lighting is not operational, the operator of the pool shall secure the pool area and not permit any use of the pool after dark and shall post the same sign as required in Section 3120B.9.

Note: See Part 3, Article 3-680, Title 24, California Code of Regulations for electrical installation requirements.

3115B.2 Nighttime use. Pools used at night shall be equipped with underwater lighting fixtures that will provide complete illumination to all underwater areas of the pool with no blind

spots. Illumination shall enable a lifeguard or other persons to determine whether:

1. A pool user is lying on the bottom of the pool; and
2. The pool water conforms to the definition of "clear pool water."

Exception: Pools provided with a system of overhead lighting fixtures where it can be demonstrated to the enforcing agent that the system is equivalent to the underwater lighting fixture system.

3115B.3 Deck area lighting. When the pool is to be used at night, pool deck areas and emergency egress areas shall be provided with lighting so that persons walking on the deck can identify hazards. Lighting fixtures shall be aimed towards the deck area and away from the pool surface insofar as practical.

ANCILLARY FACILITIES

SECTION 3116B

DRESSING, SHOWER AND TOILET FACILITIES

3116B.1 Shower and dressing facilities shall be provided for users of a pool.

Exceptions:

1. Shower and dressing facilities may not be required when pool users have access to such facilities in adjacent living quarters.
2. Public toilet facilities may be omitted when pool users have access to toilet facilities either in living quarters located not more than 300 feet (91,440 mm) in travel distance from the pool or in an adjacent building such as a recreational facility, clubhouse or cabana.

3116B.2 Number of sanitary facilities. For the purpose of this subsection, one pool user shall be considered for every 15 square feet (1.39 m²) of pool water surface area and/or spray ground splash zone area.

3116B.2.1 Showers. One shower shall be provided for every 50 pool users.

3116B.2.2 Toilets. Separate toilet facilities shall be provided for each sex. One toilet shall be provided for every 60 women or less and one toilet plus one urinal for every 75 men or less.

3116B.2.3 Lavatories. One lavatory shall be provided for every 80 pool users.

3116B.3 Construction.

3116B.3.1 Floors. Floors shall have a hard, nonabsorbent surface, such as portland cement concrete, ceramic tile or other approved material, which extends upwards onto the wall at least 5 inches (127 mm) with a coved base. Floors which may be walked on by a wet pool user shall be slip resistant. Floors shall be sloped not less than $\frac{1}{4}$ inch (6.4mm) per foot to floor drains or other approved surface water disposal areas. Carpeting and other similar artificial

floor covering shall not be permitted on shower and toilet room floors.

3116B.3.2 Interior surfaces. The materials used in the walls, except for structural elements, shall be of a type which is not adversely affected by moisture.

3116B.3.3 Privacy. All doors and windows shall be arranged to prevent viewing of the interior from any portion of the building used by the opposite sex and from view from the outdoors. View screens shall be permitted for this purpose.

3116B.4 Water supply.

3116.B.4.1 Showers and lavatories shall be provided with hot and cold water faucets.

3116B.4.2 Tempered water shall be permitted in lieu of individual hot and cold water faucets.

3116B.4.3 A means to limit the hot water to 110°F (43°C) maximum shall be provided to prevent scalding. This temperature limit control shall not be adjustable by the pool user.

SECTION 3117B DRINKING FOUNTAINS

One guarded jet drinking fountain shall be provided for the first 250 pool users and an additional fountain shall be provided for each additional 200 pool users or fraction thereof. The number of pool users shall be determined according to Section 3116B.2.

Exception: Drinking fountains shall not be required when drinking water is available at adjacent living quarters, or in an adjacent building such as a bathhouse, cabana, clubhouse or recreational facility.

SECTION 3118B HOSE BIBBS

Potable water outlets with hose attachments shall be protected by a nonremovable hose bibb backflow preventer, a nonremovable hose bibb vacuum breaker or by an atmospheric vacuum breaker installed not less than 6 inches (152 mm) above the highest point of usage located on the discharge side of the last valve as required by the California Plumbing Code. In climates where freezing temperatures occur, a listed self-draining frost-proof hose bibb with an integral backflow preventer or vacuum breaker shall be used. Hose bibbs shall be provided so that all portions of the pool deck area may be reached with a 75 foot length of hose attached to the hose bibb. A hose bibb shall be provided in the equipment area. Hose bibbs shall be located so that they do not constitute a hazard.

SECTION 3119B POOL ENCLOSURE

3119B.1 Enclosure. The pool shall be enclosed by one or a combination of the following: a fence, portion of a building, wall, or other approved durable enclosure. Doors, windows,

gates of living units or associated private premises shall not be permitted as part of the pool enclosure. The enclosure, doors and gates shall meet all of the following specifications:

1. The enclosure shall have a minimum effective perpendicular height of 5 feet (1524 mm) as measured from the outside as depicted in Figure 31B-4; and
2. Openings, holes or gaps in the enclosure, doors and/or gates shall not allow the passage of a 4-inch (102 mm) diameter sphere. The enclosure shall be constructed over a hard and permanent material equivalent to concrete; and
3. The enclosure shall be designed and constructed so that it cannot be readily climbed by small children. Horizontal and diagonal member designs which might serve as a ladder for small children are prohibited. Horizontal members shall be spaced at least 48 inches (1219 mm) apart. No planters or other structures that can be climbed shall be permitted within 5 feet (1524 mm) of the outside of the pool enclosure or within a 5 foot (1524 mm) arc as depicted in Figure 31B-5. The area 5 feet (1524 mm) outside of the pool enclosure shall be a common area open to the public; and
4. Chain link may be used, provided that the openings are not greater than $\frac{1}{4}$ inches (44 mm) measured horizontally.

3119B.2 Gates. Gates and doors opening into the pool enclosure also shall meet the following specifications:

1. Gates and doors shall be equipped with self-closing and self-latching devices. The self-latching device shall keep the gate or door securely closed. Gates and doors shall open outwardly away from the pool except where otherwise prohibited by law. Hand activated door or gate opening hardware shall be located at a height no lower than 42 inches (1067 mm) but no higher than 44 inches (1179 mm) above the deck or walkway; and
2. Gates and doors shall be capable of being locked during times when the pool is closed. Exit doors which comply with Chapter 10, Title 24, California Code of Regulations shall be considered as meeting these requirements; and
3. The pool enclosure shall have at least one means of egress without a key for emergency purposes. Unless all gates or doors are so equipped, those gates and/or doors which will allow egress without a key shall have a sign in letters at least 4 inches (102 mm) high stating EMERGENCY EXIT; and
4. The enclosure shall be constructed so that all persons will be required to pass through common pool enclosure gates or doors in order to gain access to the pool area. All gates and doors exiting the pool area shall open into a public area or a walkway accessible by all patrons of the pool.

3119B.3 Retroactivity. Sections 3119B.1 and 3119B.2 shall apply only to public pool enclosures constructed on or after July 1, 1994. Notwithstanding the foregoing effective date, no fence enclosure shall be less than 4 feet (1219 mm) in height.

3119B.4 Enclosure of pools constructed prior to July 1, 1994. The enforcing agent may allow the installation of an enclosure

which reduces the pool deck to less than 4 feet (1219 mm) in width when the physical characteristics of a site preclude providing a 4-foot (1219 mm) wide deck around the perimeter of an existing pool.

SECTION 3120B REQUIRED SIGNS

3120B.1 General. All signs shall have clearly legible letters or numbers not less than 4 inches (102 mm) high, unless otherwise required in this section, affixed to a wall, pole, gate or similar permanent structure in a location visible to all pool users.

3120B.2 Pool user capacity sign. A sign shall indicate the maximum number of pool users permitted for each pool.

3120B.2.1 Spa pool. The pool user capacity of a spa pool shall be based on one pool user for every 10 square feet (0.929 m²) of pool water surface area.

3120B.2.2 Other pools. The pool user capacity for all other pools shall be based on one pool user for every 20 square feet (1.858 m²) of pool water surface area.

Exception: Pool user capacity requirements do not apply to wading pools or spray grounds.

3120B.3 No diving sign. Signs shall be posted in conspicuous places and shall state, "NO DIVING" at pools with a maximum water depth of 6 feet or less.

3120B.4 No lifeguard sign. Where no lifeguard service is provided, a sign shall be posted stating, "NO LIFEGUARD ON DUTY." The sign also shall state in letters at least 1 inch (25 mm) high, "Children under the age of 14 shall not use pool without a parent or adult guardian in attendance."

Exception: "No lifeguard sign" requirement does not apply to spray grounds that have no standing water.

3120B.5 Artificial respiration and cardiopulmonary resuscitation sign. An illustrated diagram with text at least $\frac{1}{4}$ inch (6 mm) high of artificial respiration and cardiopulmonary resuscitation procedures shall be posted.

3120B.6 Emergency sign. The emergency telephone number 911 with numbers not less than 4 inches (102 mm), the number of the nearest emergency services and the name and street address of the pool facility with numbers and text not less than 1 inch (25 mm) shall be posted.

3120B.7 Warning sign for a spa pool. A warning sign for spa pools shall be posted stating, "CAUTION" and shall include the following language in letters at least 1 inch (25 mm) high:

1. Elderly persons, pregnant women, infants and those with health conditions requiring medical care should consult with a physician before entering the spa.
2. Unsupervised use by children under the age of 14 is prohibited.
3. Hot water immersion while under the influence of alcohol, narcotics, drugs or medicines may lead to serious consequences and is not recommended.

4. Do not use alone.
5. Long exposure may result in hyperthermia, nausea, dizziness or fainting.

3120B.8 Emergency shut off. In letters at least one inch (25 mm) high a sign shall be posted at the spa emergency shut off switch stating, "EMERGENCY SHUT OFF SWITCH."

3120B.9 No use after dark. Where pools were constructed for which lighting was not required, a sign shall be posted at each pool entrance on the outside of the gate(s) stating, "NO USE OF POOL ALLOWED AFTER DARK."

3120B.10 Keep closed. A sign shall be posted on the exterior side of gates and doors leading into the pool enclosure area stating, "KEEP GATE CLOSED." or "KEEP DOOR CLOSED."

[DSA-AC] Additional requirements may apply. Refer to Chapter 11B for accessibility provisions applicable to public accommodations, commercial buildings and public housing.

3120B.11 Diarrhea. A sign in letters at least 1 inch (25 mm) high and in a language or diagram that is clearly stated shall be posted at the entrance area of a public pool which states that persons having currently active diarrhea or who have had active diarrhea within the previous 14 days shall not be allowed to enter the pool water.

3120B.12 Wave pools. A sign in letters at least 1 inch (25 mm) high shall be posted that describes the requirements for wave pools as described in Section 115952, Health and Safety Code.

3120B.13 Spray ground sign. A sign shall be posted at each spray ground and be visible from any part of the spray ground that states, "CAUTION: WATER IS RECIRCULATED. DO NOT DRINK."

3120B.14 Exit. Where automatic gaseous chlorine chemical feeders are used, a sign shall be posted at the pool area entrance which shows in a diagrammatic form an emergency evacuation procedure. Designated emergency exits shall be marked "EXIT."

3120B.15 Gaseous oxidizer. Where automatic gaseous chlorine chemical feeders are used, a warning sign with the appropriate hazard identification symbol shall be posted on the exterior side of the door entering the chemical feeder room or area. The sign shall state, "DANGER: GASEOUS OXIDIZER - (specific chemical name)" or as otherwise required by the California Fire Code.

3120B.16 Turn on before entering. Where automatic gaseous chemical feeders are used, a sign shall be posted at the switch to the light and ventilation system for the gaseous chemical feeder room stating, "TURN ON BEFORE ENTERING," or as otherwise required by the California Fire Code or the California Electrical Code.

3120B.17 Direction of flow.

- 3120B.17.1.** The direction of flow for the recirculation equipment shall be labeled clearly with directional symbols such as arrows on all piping in the equipment area.

3120B.17.2. Where the recirculation equipment for more than one pool is located on site, the equipment shall be marked as to which pool the system serves.

3120B.17.3. Valves and plumbing lines shall be labeled clearly with the source or destination descriptions.

SECTION 3121B INDOOR POOL VENTILATION

Indoor pools, dressing rooms and toilet rooms shall be ventilated according to the requirements in Chapter 4 of the California Mechanical Code.

SECTION 3122B POOL EQUIPMENT ENCLOSURE

For pools constructed on or after January 1, 2013, pool equipment shall be enclosed as follows:

1. All equipment installed for recirculation, filtration and disinfection of pool water shall be installed so that access is limited to persons authorized by the pool owner or operator; and
2. Pool equipment shall be mounted on a continuous slab of concrete or other equivalent easily cleanable and nonabsorbent material; and
3. Floors shall be sloped a minimum of $1/4$ inch (6.4 mm) per foot to a drain.

SECTION 3123B GENERAL REQUIREMENTS

3123B.1 System description. Each pool shall be provided with a separate recirculation system designed for the continuous recirculation, filtration and disinfection of the pool water. The system shall consist of pumps, filters, chemical feeders, skimmers or perimeter overflow systems, valves, pipes, connections, fittings and appurtenances.

Exception: Pools using fresh water equivalent in flow to the requirements of Section 3124B.

Note: Fresh makeup pool water shall conform to the water quality standards of Section 65531, Chapter 20, Title 22, California Code of Regulations.

3123B.2 Equipment. All pumps, filters, chemical feeders, skimmers and supplemental equipment shall comply with the applicable requirements established by the NSF/ANSI 50-2012 performance standard effective September 2012.

3123B.3 Installation. All equipment related to pool operations shall be installed and maintained according to this chapter and in accordance with the equipment manufacturer's written instructions.

3123B.4 Equipment access. All filters, valves, pumps, strainers and equipment shall be readily accessible for repair and replacement.

SECTION 3124B TURNOVER TIME

The recirculation system shall have the capacity to provide a complete turnover of pool water in:

1. One-half hour or less for a spa pool; and
2. One-half hour or less for a spray ground; and
3. One hour or less for a wading pool; and
4. Two hours or less for a medical pool; and
5. Six hours or less for all other types of public pools.

SECTION 3125B RECIRCULATION PIPING SYSTEM AND COMPONENTS

3125B.1 Line sizes. Pipes shall be sized so flow velocity of piping systems including all pipes and fittings other than inlet devices or venturi throats shall not exceed 6 feet per second (1.829 m/s) in any suction or copper piping and 8 feet per second (2.438 m/s) in any portion of the return system.

3125B.1.1 Materials. All piping, tubing and fittings shall comply with the applicable standards for potable water system materials set forth in Chapter 6 of the California Plumbing Code.

3125B.2 Gauges. A pressure and vacuum gauge shall be provided for each pump system. Each gauge shall have a scale range approximately $1\frac{1}{4}$ times the maximum anticipated working pressure or vacuum and shall be accurate within 2 percent of scale. The pressure gauge located on the filter shall be marked with the clean start up pressure reading.

3125B.3 Flow meter. A flow meter shall be provided on each recirculation system accurate to within 10 percent of flow and installed according to the manufacturer's written instructions with increments in the range of normal flow.

3125B.4 Basket strainer. A basket strainer shall be provided on the suction side of the recirculation pump. A basket strainer will not be required on pumps connected to vacuum filters where the filter elements are not removed for cleaning.

3125B.5 Backwash piping. Piping, including necessary valves conforming to Section 3125B.1, shall be provided for each filter vessel or element which requires periodic backwashing.

3125B.6 Valves. Valves shall not be located in any deck area surrounding a pool. Valves shall be installed on all recirculation, backwashing and drain system lines which require shutoff isolation, adjustment or control of the rate of flow. Each valve shall be installed in the equipment area and labeled as to its purpose.

SECTION 3126B RECIRCULATION PUMP CAPACITY

3126B.1 Pool recirculation pumps shall have the following total dynamic head capacities:

1. **Pressure diatomaceous earth filters.** At least 60 feet (18,288 mm); and
2. **Vacuum diatomaceous earth filters.** Twenty inches (508 mm) vacuum on the suction side and 40 feet (12,192 mm) total dynamic head; and
3. **Rapid sand filters.** At least 45 feet (13,716 mm); and
4. **High rate sand filters.** At least 60 feet (18,288 mm); and
5. **Cartridge filters.** At least 60 feet (18,288 mm).

3126B.2. Pumps with other total dynamic head capacities shall be permitted provided the turnover times are maintained as required in Section 3124B.

SECTION 3127B WATER SUPPLY INLETS

3127B.1 General. Each pool shall be supplied with potable water by means of a permanently installed pipeline from a public water supply system holding a permit from the California Department of Public Health or from a source approved by the enforcing agent.

3127B.2 Backflow prevention. There shall be no direct connection between any potable water supply system and the pool or its piping system unless protected by a backflow prevention device in accordance with Chapter 6 of the California Plumbing Code.

3127B.3 Makeup water. Automatic makeup water flow controls with a manual override control shall be provided to maintain the proper pool water level.

SECTION 3128B FILTERS (ALL TYPES)

3128B.1 General requirements. All filters, regardless of type, shall be designed and constructed according to the applicable requirements established by the NSF/ANSI 50-2012 performance standard effective September 2012.

3128B.2 Installation. Each filter vessel shall be installed, piped and provided with valves so that it can be isolated from the recirculation system for repairs and backwashing.

SECTION 3129B RAPID SAND PRESSURE FILTERS

In addition to the requirements for all filters as indicated in Section 3128B, the following apply to rapid sand pressure filters.

3129B.1 Flow rates. The filtration rate shall not exceed 3 gallons per minute per square foot (122.24 L/m per m²) of filter

area. The backwash rate shall not be less than 15 gallons per minute per square foot ($611.2 \text{ L/m per m}^2$) of filter area.

3129B.2 Filter media. The filter shall contain not less than a 20-inch (508 mm) depth of media and not less than a 10-inch (254 mm) depth of filter gravel above the underdrain system.

3129B.2.1 The filter media shall have an effective particle size between 0.40 and 0.55 millimeters and a uniformity coefficient not exceeding 1.75.

3129B.2.2 The filter gravel shall be sized and placed to provide uniform flow distribution from the underdrain system and to support the bed of filter sand without loss of sand to the pool or without development of jet streams or channeling in the filtration media.

SECTION 3130B DIATOMACEOUS EARTH FILTERS

In addition to the requirements for all filters as indicated in Section 3128B, the following applies to diatomaceous earth filters.

3130B.1 Flow rates. The filtration rate for both pressure and vacuum diatomaceous earth filters shall not exceed 2 gallons per minute per square foot ($81.49 \text{ L/m per m}^2$) of filter area.

SECTION 3131B HIGH-RATE SAND FILTERS

In addition to the requirements for all filters as indicated in Section 3128B, the following apply to high rate sand filters.

3131B.1 Flow rates. Maximum and minimum flow rates for backwash and filtration shall be maintained according to the applicable requirements established by the NSF/ANSI 50-2010 performance standard effective August 2010.

3131B.2 The filter media shall have an effective particle size between 0.40 and 0.55 mm and a uniformity coefficient not exceeding 1.75.

3131B.3 The backwash rate for a high rate sand filter shall be a minimum of 15 gallons per minute per square foot of filter area.

SECTION 3132B CARTRIDGE FILTERS

In addition to the requirements for all filters as indicated in Section 3128B, the following apply to cartridge filters.

3132B.1 The filtration rate shall not exceed 0.375 gallons per minute per square foot of filter area.

3132B.2 An approved wash down area equipped with potable water shall be provided in the pool equipment area with permanently installed drainage piping discharging to the public sewer or wastewater system approved by the enforcing wastewater agency. The filter vessel shall be capable of being drained and shall be equipped with an indirect drain for the purpose of draining the entire contents of the filter vessel. Drainage and backwash piping shall be considered indirect

waste and installed in accordance with the requirements of Chapter 8 of the California Plumbing Code.

3132B.3 An additional set of filter elements shall be available for installation while the existing filter elements are cleaned.

SECTION 3133B CHEMICAL FEEDERS

All chemical feeders including disinfectant feeders and the auxiliary feeders used for solutions, slurries or solids, along with components such as pumps, strainers, tubing connections, tanks and injection fittings shall comply with the provisions of this section.

3133B.1 General design requirements. The chemical feeder equipment shall:

1. Be maintained and repaired according to manufacturers' specifications; and
2. Be constructed with an adjustable output rate device to permit repeated adjustments without loss of output rate accuracy and adjusted by an automatic chemical monitoring and control system that regulates, at a minimum, pH and disinfectant; and
3. Meet the applicable requirements established by the NSF/ANSI 50-2012 performance standard effective September 2012.

3133B.2 Piping. Piping used for the chemical feeder and its auxiliary equipment shall be resistant to corrosion or chemical deterioration.

3133B.3 Installation. Chemical feeders and associated components shall be constructed and installed to prevent uncontrolled discharge or siphoning of chemicals and fumes directly into the pool, its recirculation system, the pool area or ancillary facilities.

SECTION 3134B DISINFECTANT FEEDERS

Disinfectant feeders shall comply with applicable requirements established by the NSF/ANSI 50-2010 performance standard effective August 2010 for disinfectant feeders. In addition to the requirements for chemical feeders as indicated in Section 3133B, the following apply to disinfectant feeders.

3134B.1 Minimum capacity. All feeders shall be capable of supplying not less than the equivalent of 3 pounds (1 kg) of 100 percent available chlorine per day per 10,000 gallons (37,850 L) of pool water capacity.

3134B.2 Rate of flow adjustment. A visible means of determining the rate of flow through the device shall be provided for each disinfectant feeder.

3134B.3 Compressed chlorine gas disinfectant equipment. Chlorine gas shall not be dispensed directly into the water of a pool except as an aqueous solution through the return line of the recirculation system.

3134B.3.1 Compressed gas containers. Each container or cylinder shall be secured to prevent accidental movement. A valve protection cap shall be provided to cover the discharge valve at all times when the cylinder is not connected to the dispensing system.

3134B.3.2 Container scale. Compressed gas chlorine containers in use shall be on a scale in the gas chlorinator room.

3134B.3.3 Chlorine feeding device. The chlorine feeding device shall be capable of delivering chlorine in an aqueous solution at the maximum design rate. The device shall not allow the backflow of pool water into the chlorine container. The device shall not allow the release of chlorine gas to the atmosphere under normal operating conditions. The device shall be designed and installed to conduct chlorine gas leaks to the outdoors during a release of chlorine gas or an interruption of the water supply.

3134B.3.4 Piping. Piping carrying chlorine gas under pressure shall not be located outside the gas chlorination equipment room.

SECTION 3135B GAS CHLORINATION EQUIPMENT ROOM

Compressed chlorine gas storage containers and auxiliary components shall be installed indoors in a separate room of not less than 1-hour fire resistant construction and shall comply with the California Fire Code and all of the following.

3135B.1 Location. The gas chlorination equipment room shall not be located in any habitable building, above the first floor or below ground level.

3135B.2. Exit. Required exit doors shall swing in the direction of exit of travel and shall not open directly toward the pool or pool deck.

3135B.3 Ventilation. Mechanical exhaust ventilation systems shall be in compliance with the California Mechanical Code.

3135B.4 Alarm. An audible and visible chlorine detection alarm system shall be located in the room containing the gas chlorine equipment. The sensor shall be located within 6 inches (152 mm) of the floor level. The system shall continually monitor the room and shall activate when chlorine concentrations in the room exceed a Permissible Exposure Limit of 0.5 ppm. Activation of the alarm shall shut off the chlorine at the source and turn on the lights and ventilation system. The alarm system shall consist of the following:

1. An audible alarm capable of producing a sound level of at least 90 decibels; and
2. A visible alarm consisting of a strobe light which is mounted directly over the entrance to the chlorine equipment room. The light shall be visible during daylight hours.

3135B.5 Illumination. Artificial illumination of at least 50 footcandles as measured 30 inches (750 mm) from the floor shall be provided in the room.

3135B.6 Switches. Switches for the control of mechanical ventilation and lighting fixtures shall be located adjacent to the entry door outside the room.

3135B.7 Equipment interlocks. The gas chlorine feeding device shall be interlocked with the pool recirculating pump so that the gas chlorine feeding device shall not operate when the recirculating pump is off or during the filter backwash.

3135B.8 Storage. The gas chlorine room shall not be used for the storage of items not related to the use of the gas chlorine equipment.

SECTION 3136B POOL SKIMMING SYSTEMS

The pool shall be equipped with one or more skimming methods to provide continuous skimming of the pool water and shall be capable of continually withdrawing not less than 100 percent of the flow rate.

3136B.1 Surface skimmers. Each surface skimmer shall comply with the following provisions:

1. The skimmer shall be recessed into the pool wall; and
2. The skimmer shall be individually adjustable for the rate of flow with either an external or internal device; and
3. If used, a skimmer equalizer suction outlet shall be connected to at least two suction grate assemblies that meet the ANSI/APSP-16 2011 performance standard and are located at least 3 feet (915 mm) apart in any dimension between the suction outlets; and
4. The skimmer weir shall automatically adjust to variations in the pool water level over a range of not less than 4 inches (102 mm); and
5. Each skimmer shall be provided with a removable and cleanable screen or basket to trap objects. The screen or basket shall be accessible through an opening in the deck above the skimmer; and
6. There shall be a minimum of one skimmer for every 500 square feet or less of pool water surface area or an adequate number to meet 100 percent of pump flow at the manufacturer's maximum flow rating, whichever is greater; and
7. Each skimmer shall be located in relation to pool inlets to aid recirculation and surface skimming; and
8. All surface skimmers shall comply with applicable requirements established by the NSF/ANSI 50-2012 performance standard effective September 2012.

3136B.2 Perimeter overflow systems. A perimeter overflow system shall be required in pools whose water surface area equals or exceeds 5,000 square feet (464.52 m^2). Perimeter overflow systems shall be designed by an engineer or architect who has experience working on public pools and shall comply with the following provisions:

1. **Location.** The overflow system shall be integrated with the pool structure and extend completely around the pool parallel to the pool deck except where an entry or exit may require interruption; and

2. **Channel detail.** The overflow channel shall be not less than 3 inches (76 mm) deep, the section shall not diverge with depth of the channel, and the width of the bottom shall be not less than 3 inches (76 mm). The opening beneath the coping into the overflow system shall be a minimum of 4 inches (102 mm) beneath the coping in any direction measured radially from the inner edge of the overflow channel lip; and
3. **Channel lip.** The overflow channel lip shall be not more than 12 inches (305 mm) below the level of the coping or deck. The lip edge shall be rounded and shall be not thicker than $2\frac{1}{2}$ inches (64 mm) or thinner than 1 inch (25 mm) for the top 2 inches (51 mm); and
4. **Channel covering.** Covered overflow channels shall be permitted provided the openings do not exceed $\frac{1}{2}$ inch in the smaller dimension; and
5. **Channel outlets.** Channel outlet spacing and channel bottom slope shall be hydraulically designed by an engineer or architect who has experience working on public pools; and
6. **Channel outlet covers.** Overflow channel outlet covers shall be accessible for cleaning and maintenance. Openings of the channel outlet covers shall not pass a $\frac{1}{2}$ inch (13 mm) sphere in the smaller dimension; and
7. **Channel drain piping.** Channel drain piping shall provide drainage of the overflow system, carry overflow water to a surge basin and return to skimming within 10 minutes after being flooded by a sudden displacement of the pool water by pool users; and
8. **Surge storage capacity.** A perimeter overflow system shall be provided with a minimum surge storage capacity of not less than 1 gallon per square foot (40.75 L/m²) of pool water surface area. Surge storage shall be permitted in the surge basin, perimeter overflow channel and in the channel drain piping returning to the surge basin.

SECTION 3137B POOL FITTINGS

3137B.1 Outlets. Each pool shall be provided with a main drain submerged suction outlet typically located at the bottom of a pool that conducts water to a recirculating pump. Suction outlets shall comply with all of the following provisions:

1. Each pump on a pool system shall be connected to at least two suction outlets. The suction outlets shall be hydraulically balanced and symmetrically plumbed through one or more "T" fittings and shall be separated by a distance of at least 3 feet (915 mm) in any dimension between the suction outlets; and
2. All suction outlets shall be equipped with suction fittings that meet the ANSI/APSP-16 2011 performance standard; and
3. The velocity of the suction piping installed between the suction outlets shall not exceed 3 feet per second (.91 mps) under normal operation, or 6 feet per second (1.82 mps) if one outlet is blocked; and

4. **Hydrostatic relief devices.** In areas with a high ground-water table, or as required by local plumbing codes, a hydrostatic relief device shall be installed. When used in conjunction with a safety vacuum release system, the hydrostatic relief device must meet the manufacturer's installation requirements for the safety vacuum release system.

Exception: Alternative outlet locations that have been designed by a licensed engineer who has experience working on public pools may be used if approved by the enforcing agent.

3137B.2 Inlet fittings. Each pool shall be provided with not less than two recirculation system inlets for the first 10,000 gallon (37,850 L) capacity and one additional inlet for each additional 10,000 gallon (37,850 L) or less capacity.

3137B.2.1 Construction. Inlet fittings shall not protrude greater than $1\frac{1}{4}$ inches (32 mm) into the pool and shall be shaped, rounded and smooth.

3137B.2.2 Location. Inlet fittings shall be located no less than 18 inches (457 mm) below the waterline, except for a spa pool or wading pool. Inlet fittings shall be separated by at least 10 feet (3048 mm) and shall be located so as to ensure uniform circulation.

3137B.2.3 Adjustment. Provisions shall be made for adjusting the volume of flow through each inlet. Wall inlets shall be capable of adjusting the direction of flow and to produce sufficient velocity to impart a substantial circulatory movement to the pool water.

3137B.2.4 Floor inlets. Pools that are greater than 40 feet (12,192 mm) in width or 3,000 square feet (278.7 m²) in surface area shall have floor-mounted return inlets. The number of floor inlets shall be in compliance with Section 3137B.2. All floor inlet fittings shall be located to provide uniform circulation and shall be installed so as to be flush with the surface of the pool bottom.

SECTION 3138B SPA POOL SPECIAL REQUIREMENTS

3138B.1 Aeration system. A spa pool aeration and/or jet system shall be completely separate from the recirculation system and shall not be interconnected with any other pool.

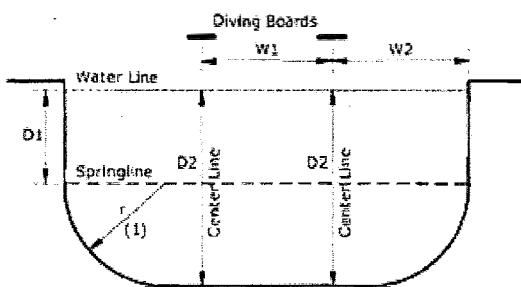
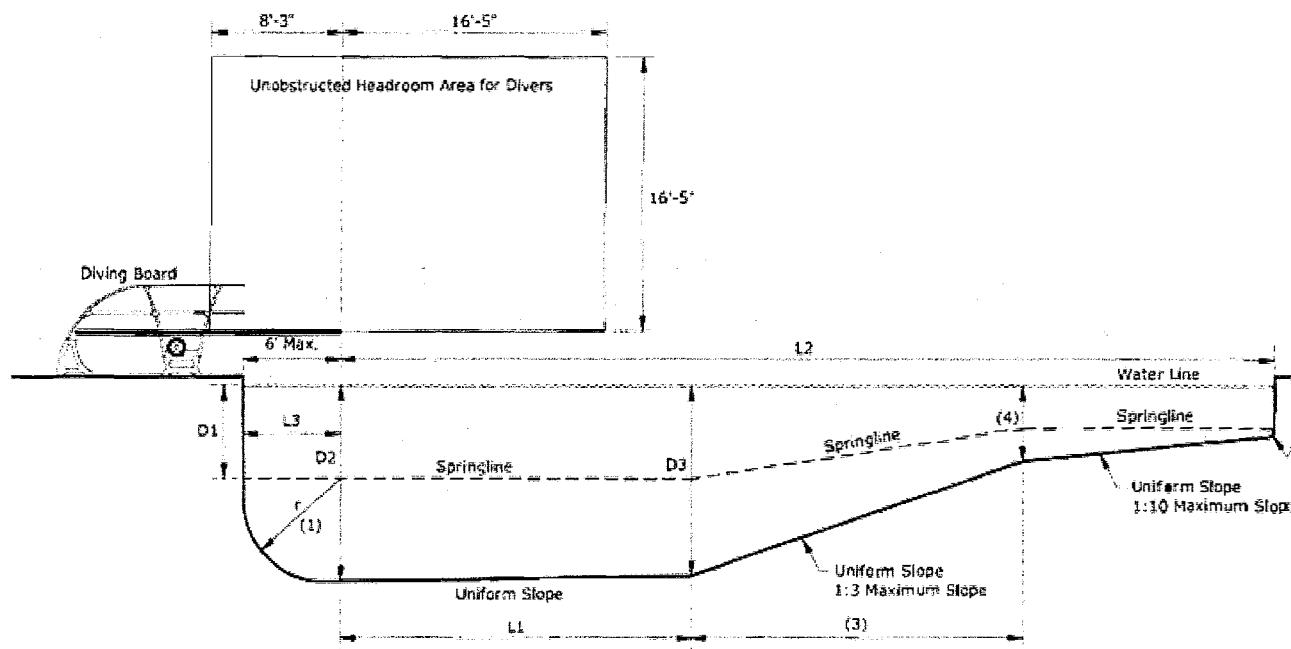
3138B.2 Maximum operating temperature. The allowable water temperature of a spa pool shall not exceed 104° F (40° C).

3138B.3 Surface area. The water surface area of a spa pool shall not exceed 250 square feet (23.23 m²).

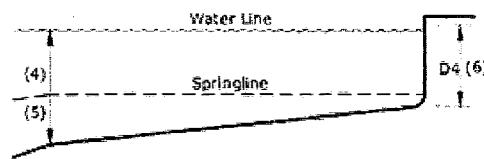
3138B.4 Maximum depth. The water depth in a spa pool shall not exceed 4 feet (1220 mm).

3138B.5 Emergency shut off switch. A clearly labeled emergency shut off switch for the control of both the recirculation system and the aeration and/or jet system shall be installed adjacent to the spa pool.

LONGITUDINAL SECTION



Transverse Section Deep End



Transverse Section Shallow End

**FIGURE 31B-1
DEPTHES AND CLEARANCES FOR POOLS WITH DIVING BOARDS GREATER THAN 30 INCHES (762 mm) ABOVE THE WATER LINE**

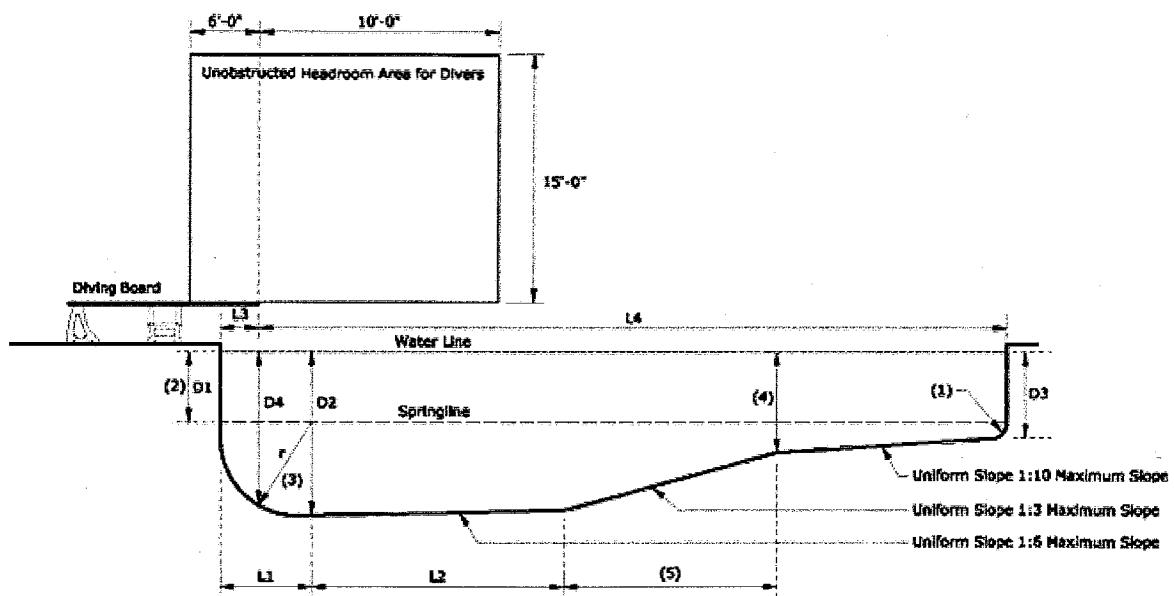
TABLE 31B-1

| BOARDS AND PLATFORMS | DEPTH OF WATER | | | | | LENGTH OF SECTION | | | | |
|----------------------|----------------|-------|--------|--------|-------|-------------------|--------|--------|--------|--------|
| | DIM | D1 | D2 | D3 | D4 | L1 | L2 | L3 | W1 | W2 |
| 1 meter board | Min. | 5' 6" | 11' 6" | 11' 2" | 0' 0" | 16' 5" | 29'-7" | 5' 11" | 7' 11" | 8' 3" |
| 3 meter board | Min. | 6' 6" | 12' 6" | 12' 2" | 0' 0" | 19' 9" | 33' 8" | 5' 11" | 8' 7" | 11' 6" |

Notes for Figure 31B-1 and Table 31B-1:

1. Maximum radius shall equal D2 minus D1 dimensions.
2. Radius at the shallow end shall not be more than 12 inches.
3. The length of a section is based on the maximum slope and other maximum and minimum dimensions.
4. Where there is a break in slope, the break shall be located at a water depth equal to 4' 6".
5. The springline depth at (4) shall not be more than 4' 0".
6. The maximum water depth shall be 3' 6".
7. Each pool shall be provided with a main drain submerged suction outlet typically located at the bottom of the pool that conducts water to a recirculating pump.

LONGITUDINAL SECTION



TRANSVERSE SECTION AT D2

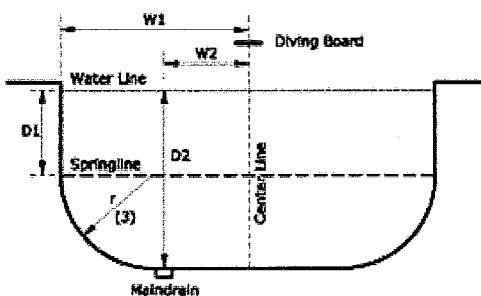


FIGURE 31B-2
DEPTHES AND CLEARANCES FOR POOLS WITH DIVING BOARDS 30 INCHES (762 MM) OR LESS ABOVE THE WATER LINE

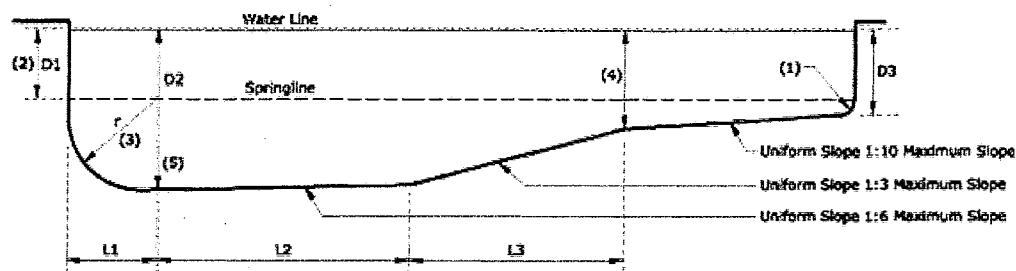
TABLE 31B-2

| DIMENSION | DEPTH OF WATER | | | | LENGTH OF SECTION | | | | | |
|-----------|----------------|-------|-------|-------|-------------------|-------|-------|--------|-------|-------|
| | D1 | D2 | D3 | D4 | L1 | L2 | L3 | L4 | W1 | W2 |
| Minimum | 2' 6" | 8' 6" | 0' 0" | 7'-0" | 6' 0" | 6' 0" | 2' 6" | 30' 0" | 9' 0" | 3' 0" |
| Maximum | — | — | 3' 6" | — | 10' 0" | — | 4' 0" | — | — | — |

Notes for Figure 31B 2 and Table 31B 2:

1. Radius at the shallow end shall be a maximum of 1' 0".
2. Springline D1 shall extend to the break in slope between the shallow area and the deep area.
3. Maximum radius shall equal D2 minus D1 dimensions.
4. Where there is a break in slope, the break shall be located at a water depth equal to 4' 6".
5. Length of section is based on maximum slope and other maximum or minimum dimensions.
6. Each pool shall be provided with a main drain submerged suction outlet typically located at the bottom of the pool that conducts water to a recirculating pump.

LONGITUDINAL SECTION



TRANSVERSE SECTION AT D2

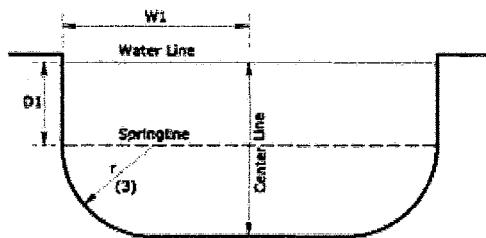


FIGURE 31B-3
DEPTHS AND CLEARANCES FOR POOLS WITHOUT DIVING BOARDS

TABLE 31B-3A
POOLS WITH MAXIMUM WATER DEPTH $\leq 6\text{ }0$

| DIMENSION | DEPTH OF WATER | | | LENGTH OF SECTION | | | |
|-----------|----------------|-------|-------|-------------------|-------|-------|-------|
| | D1 | D2 | D3 | L1 | L2 | L3 | W1 |
| Minimum | 2' 6" | — | 0' 0" | 3' 6" | 3' 0" | 3' 0" | 6' 0" |
| Maximum | — | 6' 0" | 3' 6" | — | — | — | — |

TABLE 31B-3B
POOLS WITH MAXIMUM WATER DEPTH $> 6\text{ }0$

| DIMENSION | DEPTH OF WATER | | | LENGTH OF SECTION | | |
|-----------|----------------|---------|-------|-------------------|-------|-------|
| | D1 | D2 | D3 | L1 | L2 | W1 |
| Minimum | 2' 6" | > 6' 0" | 0' 0" | 3' 6" | 3' 0" | 7' 6" |
| Maximum | — | — | 3' 6" | — | — | — |

Notes for Figure 31B-3 and Tables 31B-3a and 31B-3b.

1. Radius at the shallow end shall be a maximum of 1' 0".
2. Springline D1 shall extend to the break in slope between the shallow area and deep area.
3. Maximum radius shall equal D2 minus D1 dimensions.
4. Where there is a break in slope, the break shall be located at a water depth equal to 4' 6".
5. Each pool shall be provided with a main drain submerged suction outlet typically located at the bottom of the pool that conducts water to a recirculating pump.

SECTION 3139B SOLAR HEATING INSTALLATIONS

3139B.1 Solar heating systems shall comply with the following:

1. Solar heating system suction outlets shall comply with Section 3137B; and
2. Solar heating system suction outlets shall be located no closer than 5 feet (1525 mm) to any pool inlet fitting; and
3. The installation of a solar heating system on a new or existing pool shall not interfere with the required turnover rate as specified in Section 3124B nor exceed the pipe flow velocities as specified in Section 3125B.1.

SECTION 3140B CLEANING SYSTEMS

A vacuum cleaning system shall be available which is capable of removing sediment from all parts of the pool floor. A cleaning system using potable water shall be protected by a backflow prevention device in accordance with Chapter 6 of the California Plumbing Code. No cleaning system shall operate in the pool when the pool is open or available for use by pool users. Built-in vacuum suction lines shall not be installed in the pool.

SECTION 3141B WASTEWATER DISPOSAL

3141B.1 General requirements. Material cleaned from filters and backwash water from any recirculation system shall be disposed in a manner that is acceptable to the local wastewater agency and will not create a nuisance. Backwash water shall not be returned to a pool. Pipes carrying wastewater from pools including pool drainage and backwash from filters shall be installed as an indirect waste in accordance with the requirements of Chapter 8 of the California Plumbing Code. Where a pump is used to discharge waste pool water to the drainage system, the pump discharge shall be installed as an indirect waste.

3141B.2 Diatomaceous earth filters. The backwash from a diatomaceous earth filter shall discharge into a separation tank that has been installed to collect the waste diatomaceous earth mixture. The wastewater from the separation tank shall discharge into a sanitary sewer or other disposal system acceptable to the local wastewater agency.

3141B.3 Piping. Sumps and drain piping shall have sufficient capacity to receive recirculation system backwash without overflow of the sump receiver. The sump shall not permit sewage to enter the surge basin or the pool in the event of a sewage backup

3141B.4 Visual indicator. Where direct observation of the backwash discharge is not visible to the operator during backwash operations, a sight glass shall be installed on the wastewater discharge line.

3141B.5 Prohibited connection. There shall be no direct connection between the pool, its recirculation system or overflow drain to any sanitary sewer, storm drain or drainage system.

SECTION 3142B Reserved

SECTION 3143B Reserved

SECTION 3144B Reserved

SECTION 3145B Reserved

SECTION 3146B Reserved

SECTION 3147B Reserved

SECTION 3148B Reserved

SECTION 3149B Reserved

SECTION 3150B Reserved

SECTION 3151B Reserved

SECTION 3152B Reserved

SECTION 3153B Reserved

SECTION 3154B Reserved

SECTION 3155B Reserved

SECTION 3156B Reserved

SECTION 3157B
Reserved

SECTION 3158B
Reserved

SECTION 3159B
Reserved

Division II – PUBLIC SWIMMING POOLS

Note: These building standards are in statute but have not been adopted through the regulatory process. Enforcement of these standards set forth in this section does not depend upon adoption of regulations; therefore, enforcement agencies shall enforce the standards pursuant to the timeline set forth in this section prior to adoption of related regulations.

SECTION 3160B
GROUND FAULT CIRCUIT INTERRUPTERS

1. “Public swimming pool,” as used in this section, means any swimming pool operated for the use of the general public with or without charge, or for the use of the members and guests of a private club, including any swimming pool located on the grounds of a hotel, motel, inn, an apartment complex or any residential setting other than a single-family home. For purposes of this section, “public swimming pool” shall not include a swimming pool located on the grounds of a private single-family home, or a swimming pool owned or operated by the state or any local governmental entity as set forth in Section 116049 of the Health and Safety Code.
2. All dry-niche light fixtures, and all underwater wet-niche light fixtures operating at more than 15 volts in public swimming pools, as defined in this section, shall be protected by a ground fault circuit interrupter in the branch circuit, and all light fixtures in public swimming pools shall have encapsulated terminals.
3. Any public swimming pool that does not meet the requirements specified in Item 2 by January 1, 1998, shall be retrofitted to comply with these requirements by July 1, 1998.
4. The ground-fault circuit interrupter required pursuant to this section shall comply with Underwriter’s Laboratory standards.
5. The owner or operator of a public swimming pool shall have its public swimming pool inspected by a qualified inspector on or before September 1, 1998, to determine compliance with this section.
6. All electrical work required for compliance with this section shall be performed by an electrician licensed pursuant

ant to Chapter 9 (commencing with Section 7000) of Division 3 of the Business and Professions Code.

Authority: Health and Safety Code Section 116064 (e)
Reference: Health and Safety Code Section 116049 SB 1360, (Statutes 1995, c. 415).

SECTION 3161B
WADING POOLS

1. “Public wading pool” means a pool that meets all of the following criteria:
 - 1.1. It has a maximum water depth not exceeding 18 inches (457 mm).
 - 1.2. It is a pool other than a pool that is located on the premises of a one-unit or two-unit residence, intended solely or the use of the residents or guests.
2. “Public wading pool” includes, but is not limited to, a pool owned or operated by private persons or agencies, or by state or local governmental agencies.
3. “Public wading pool” includes, but is not limited to, a pool located in an apartment house, hotel or similar setting that is intended for the use of residents or guests.
4. “Alteration” means any of the following:
 - 4.1. To change, modify or rearrange the structural parts or the design.
 - 4.2. To enlarge.
 - 4.3. To move the location of.
 - 4.4. To install a new water circulation system.
 - 4.5. To make any repairs costing fifty dollars (\$50) or more to an existing circulation system.
5. A public wading pool shall have at least two circulation drains per pump that are hydraulically balanced and symmetrically plumbed through one or more T fittings, and are separated by a distance of at least 3 feet (914 mm) in any dimension between drains.
6. All public wading pool main drain suction outlets that are under 12 inches (305 mm) across shall be covered with antivortex grates or similar protective devices. All main drain suction outlets shall be covered with grates or antivortex plates that cannot be removed except with the use of tools. Slots or openings in the grates or similar protective devices shall be of a shape, area and arrangement that would prevent physical entrapment and would not pose any suction hazard to bathers.
7. The maximum velocity in the pump suction hydraulic system shall not exceed 6 feet per second (1.8 m/s) when 100 percent of the pump’s flow comes from the main drain system and any main drain suction fitting in the system is completely blocked.
8. On or after January 1, 1998, all newly constructed public wading pools shall be constructed in compliance with this section.

9. Commencing January 1, 1998, whenever a construction permit is issued for alteration of an existing public wading pool, it shall be retrofitted so as to be in compliance with this section.
10. By January 1, 2000, every public wading pool, regardless of the date of original construction, shall be retrofitted to comply with this section.

Authority: Health and Safety Code Section 116064 (e)
Reference: Health and Safety Code Section 116064 AB 2114, (Statues 1995, c. 415).

SECTION 3162B ANTI-ENTRAPMENT DEVICES AND SYSTEMS

1. The Legislature finds and declares that the public health interest requires that there be uniform statewide health and safety standards for public swimming pools to prevent physical entrapment and serious injury to children and adults. It is the intent of the Legislature to occupy the whole field of health and safety standards for public swimming pools and the requirements established in this article and the regulations adopted pursuant to this article shall be exclusive of all local health and safety standards relating to public swimming pools.
2. As used in this section, the following words have the following meanings:
 - (a) "ANSI/APSP performance standard" means a standard that is accredited by the American National Standards Institute (ANSI) and published by the Association of Pool and Spa Professionals (APSP).
 - (b) "ASME/ANSI performance standard" means a standard that is accredited by the American National Standards Institute and published by the American Society of Mechanical Engineers.
 - (c) "ASTM performance standard" means a standard that is developed and published by ASTM International..
 - (d) "Public swimming pool" means an outdoor or indoor structure, whether in-ground or above-ground, intended for swimming or recreational bathing, including a swimming pool, hot tub, spa, or nonportable wading pool, that is any of the following:
 - (i) Open to the public generally, whether for a fee or free of charge.
 - (ii) Open exclusively to members of an organization and their guests, residents of a multiunit apartment building, apartment complex, residential real estate development, or other multifamily residential area, or patrons of a hotel or other public accommodations facility.
 - (iii) Located on the premises of an athletic club, or public or private school.
 - (e) "Qualified individual" means a contractor who holds a current valid license issued by the State of

California or a professional engineer licensed in the State of California who has experience working on public swimming pools.

- (f) "Safety vacuum release system" means a vacuum release system that ceases operation of the pump, reverses the circulation flow, or otherwise provides a vacuum release at a suction outlet when a blockage is detected.
- (g) "Skimmer equalizer line" means a suction outlet located below the waterline, typically on the side of the pool, and connected to the body of a skimmer that prevents air from being drawn into the pump if the water level drops below the skimmer weir. However, a skimmer equalizer line is not a suction outlet for purposes of Subdivisions (4) and (6).
- (h) "Suction outlet" means a fitting or fixture of a swimming pool that conducts water to a recirculating pump.
- (i) "Unblockable suction outlet" means a suction outlet, including the sump, that has a perforated (open) area that cannot be shadowed by the area of the 18-inch by 23-inch body blocking element of the ANSI/APSP-16 performance standard, and that the rated flow through any portion of the remaining open area cannot create a suction force in excess of the removal force values in Table 1 of that standard.
3. Subject to Subdivision (6), every public swimming pool shall be equipped with anti-entrapment devices or systems that comply with ANSI/APSP-16 performance standard or successor standard designated by the Federal Consumer Product Safety Commission.
 - a. A public swimming pool that has a suction outlet in any location other than on the bottom of the pool shall be designed so that the recirculation system shall have the capacity to provide a complete turnover of pool water within the following time:
 - (i) One-half hour or less for a spa pool.
 - (ii) One-half hour or less for a spray ground.
 - (iii) One hour or less for a wading pool.
 - (iv) Two hours or less for a medical pool.
 - (v) Six hours or less for all other types of public pools.
4. Subject to Subdivisions (5) and (6), every public swimming pool with a single suction outlet that is not an unblockable suction outlet shall be equipped with at least one or more of the following devices or systems that are designed to prevent physical entrapment by pool drains:
 - (a) A safety vacuum release system that has been tested by a nationally recognized testing laboratory and found to conform to ASME/ANSI Performance Standard A112.19.17, as in effect on December 31, 2009, or ASTM Performance Standard F2387, as in effect on December 31, 2009.

- (b) A suction-limiting vent system with a tamper-resistant atmospheric opening, provided that it conforms to any applicable ASME/ANSI or ASTM performance standard.
- (c) A gravity drainage system that utilizes a collector tank, provided that it conforms to any applicable ASME/ANSI or ASTM performance standard.
- (d) An automatic pump shut-off system tested by a department-approved independent third party and found to conform to any applicable ASME/ANSI or ASTM performance standard.
- (e) Any other system that is deemed, in accordance with federal law, to be equally effective as, or more effective than, the systems described in paragraph (a) at preventing or eliminating the risk of injury or death associated with the circulation system of the pool and suction outlets.
5. Every public swimming pool constructed on or after January 1, 2010, shall have at least two suction outlets per pump that are hydraulically balanced and symmetrically plumbed through one or more "T" fittings, and that are separated by a distance of at least three feet in any dimension between the suction outlets. A public swimming pool constructed on or after January 1, 2010, that meets the requirements of this subdivision, shall be exempt from the requirements of Subdivision (4).
6. A public swimming pool constructed prior to January 1, 2010, shall be retrofitted to comply with Subdivisions (3) and (4) by no later than July 1, 2010, except that no further retrofitting is required for a public swimming pool that completed a retrofit between December 19, 2007, and January 1, 2010, that complied with the Virginia Graeme Baker Pool and Spa Safety Act (15 U.S.C. Sec. 8001 et seq.) as in effect on the date of issue of the construction permit, or for a nonportable wading pool that completed a retrofit prior to January 1, 2010, that complied with state law on the date of issue of the construction permit. A public swimming pool owner who meets the exception described in this subdivision shall do one of the following prior to September 30, 2010:
- File the form issued by the department pursuant to subdivision (g), as otherwise provided in subdivision (h).
 - File a signed statement attesting that the required work has been completed.
 - Provide a document containing the name and license number of the qualified individual who completed the required work.
 - Provide either a copy of the final building permit, if required by the local agency, or a copy of one of the following documents if no permit was required:
 - A document that describes the modification in a manner that provides sufficient information to document the work that was done to comply with federal law.
 - A copy of the final paid invoice. The amount paid for the services may be omitted or redacted from the final invoice prior to submission.
7. Prior to March 31, 2010, the department shall issue a form for use by an owner of a public swimming pool to indicate compliance with this section. The department shall consult with county health officers and directors of departments of environmental health in developing the form and shall post the form on the department's Internet Web site. The form shall be completed by the owner of a public swimming pool prior to filing the form with the appropriate city, county, or city and county department of environmental health. The form shall include, but not be limited to, the following information:
- A statement of whether the pool operates with a single suction outlet or multiple suction outlets that comply with Subdivision (5).
 - Identification of the type of anti-entrapment devices or systems that have been installed pursuant to Subdivision (4) and the date or dates of installation.
 - Identification of the type of devices or systems designed to prevent physical entrapment that have been installed pursuant to Subdivision (4) in a public swimming pool with a single suction outlet that is not an unblockable suction outlet and the date or dates of installation or the reason why the requirement is not applicable.
 - A signature and license number of a qualified individual who certifies that the factual information provided on the form in response to paragraphs (a) to (c), inclusive, is true to the best of his or her knowledge.
8. A qualified individual who improperly certifies information pursuant to Paragraph (d) of Subdivision (7) shall be subject to potential disciplinary action at the discretion of the licensing authority.
9. Except as provided in Subdivision (6), each public swimming pool owner shall file a completed copy of the form issued by the department pursuant to this section with the city, county, or city and county department of environmental health in the city, county, or city and county in which the swimming pool is located. The form shall be filed within 30 days following the completion of the swimming pool construction or installation required pursuant to this section or, if the construction or installation is completed prior to the date that the department issues the form pursuant to this section, within 30 days of the date that the department issues the form. The public swimming pool owner or operator shall not make a false statement, representation, certification, record, report, or otherwise falsify information that he or she is required to file or maintain pursuant to this section.
10. In enforcing this section, health officers and directors of city, county, or city and county departments of environmental health shall consider documentation filed on or with the form issued pursuant to this section by the owner of a public swimming pool as evidence of compliance with this section. A city, county, or city and county department

of environmental health may verify the accuracy of the information filed on or with the form.

11. To the extent that the requirements for public wading pools imposed by Section 116064 conflict with this section, the requirements of this section shall prevail.
12. The department shall have no authority to take any enforcement action against any person for violation of this section and has no responsibility to administer or enforce the provisions of this section.

Authority: Health and Safety Code Section 116064 (e)

Reference: Health and Safety Code Section 116064.2 AB 2114, (Statutes 2012, c. 679).

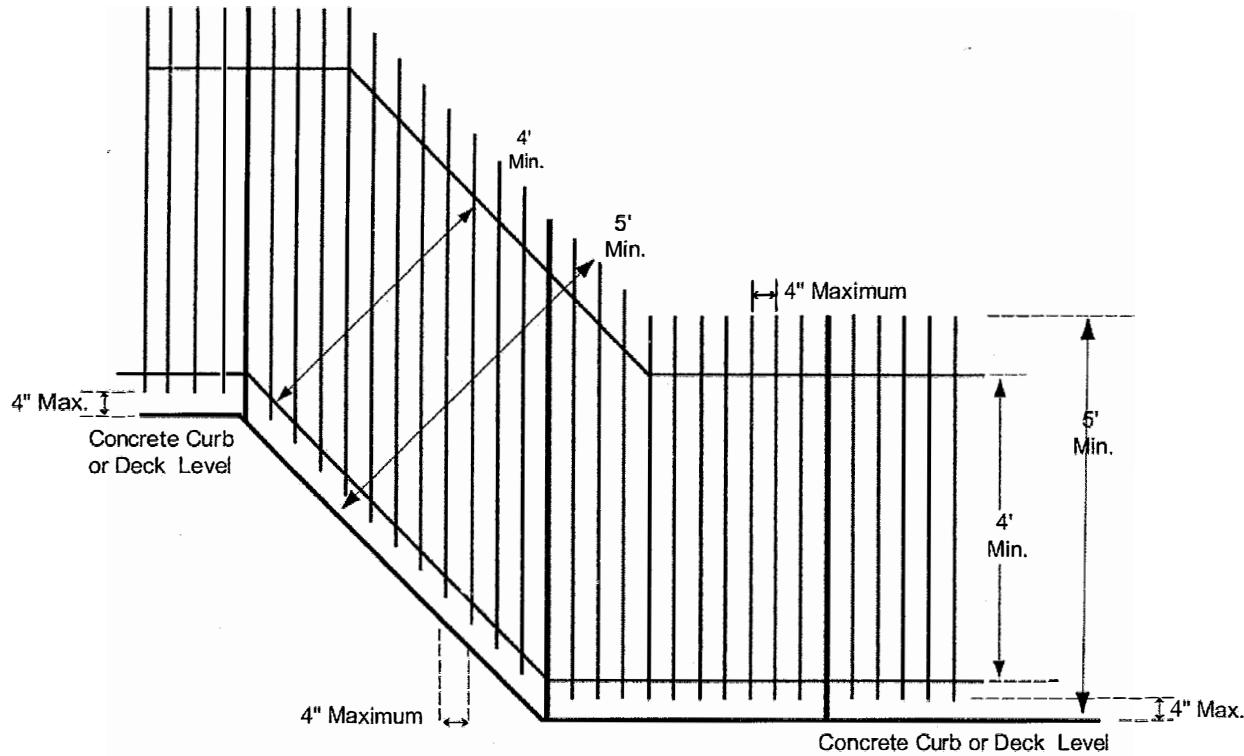


FIGURE 31B-4
PERPENDICULAR FENCING DIMENSIONS ON SLOPING GROUND

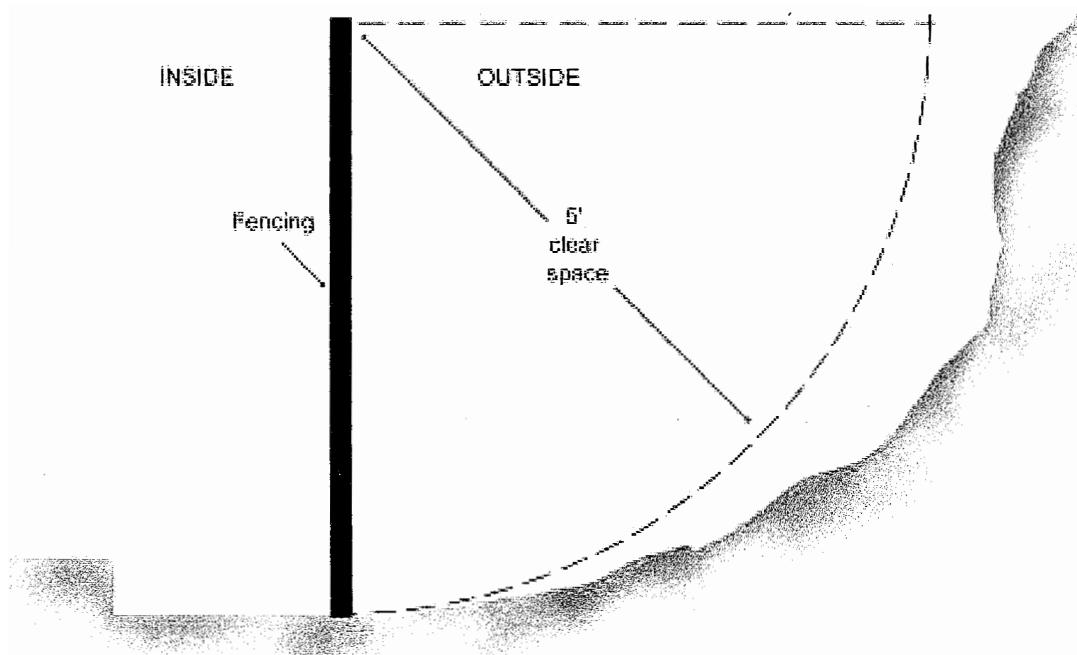


FIGURE 31B-5
EFFECTIVE FENCING HEIGHT

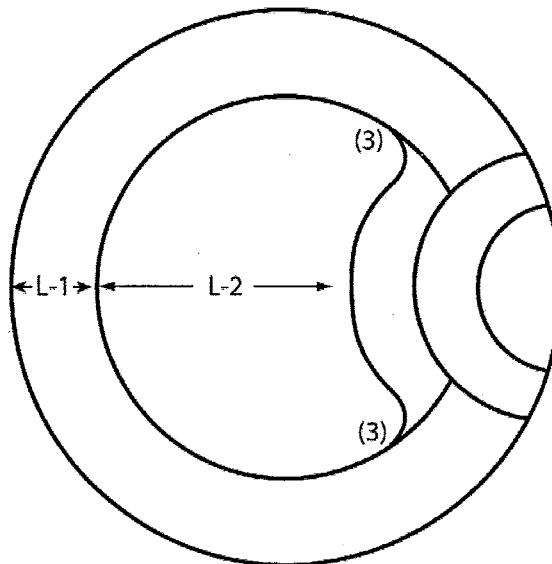
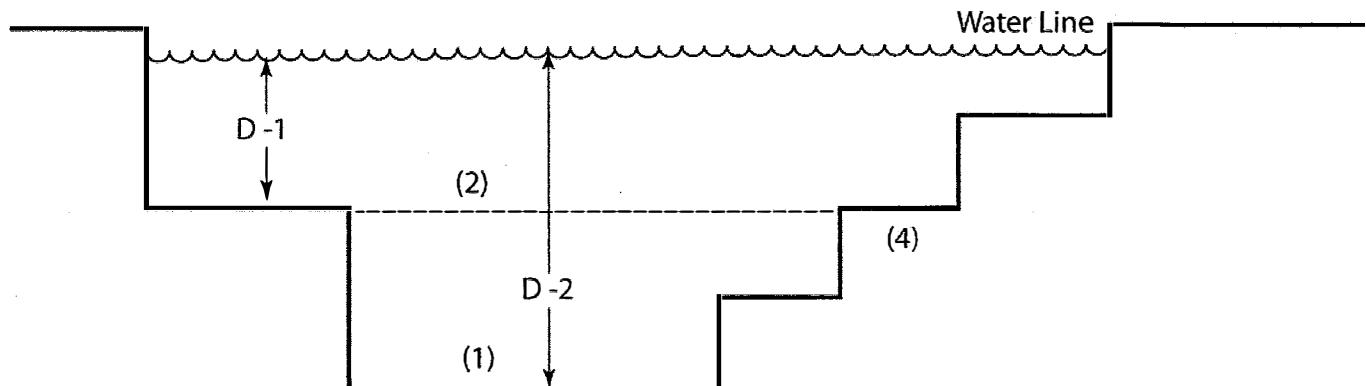
TOP VIEW**TRANSVERSE SECTION**

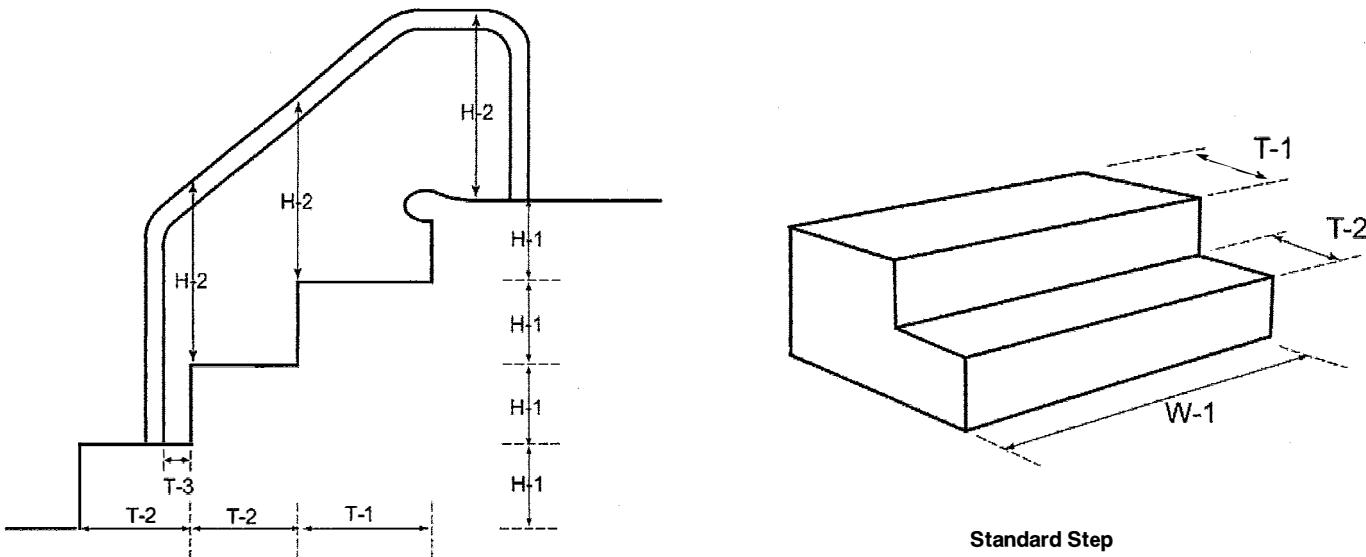
FIGURE 31B-6
DEPTHS AND DIMENSIONS FOR SPA POOLS

TABLE 31B-6

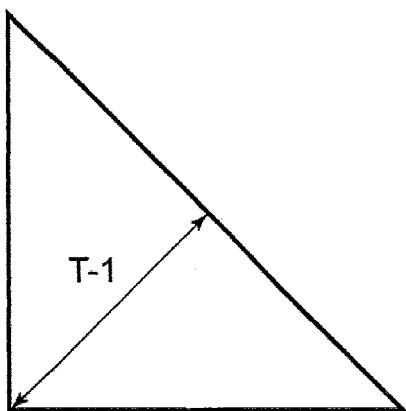
| Dimension | DEPTH OF WATER | | LENGTH OF SECTIONS | |
|-----------|----------------|-----|--------------------|-----|
| | D1 | D2 | L1 | L2 |
| Minimum | — | 24" | 12" | 24" |
| Maximum | 24" | 48" | 24" | — |

Notes for Figure 31B-6 and Table 31B-6:

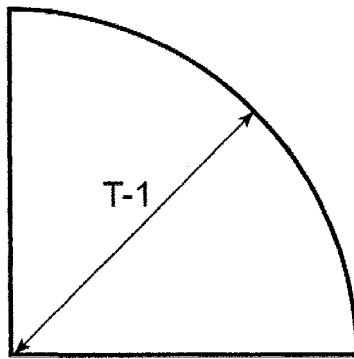
1. Bottom slope shall not exceed 1:10 and must be uniform.
2. Bench ramping shall not exceed 1:10 uniform slope, measured at the inner circumference of the bench.
3. Six inch minimum radius at "pinch points."
4. See Section 311B for step and handrail dimensions.



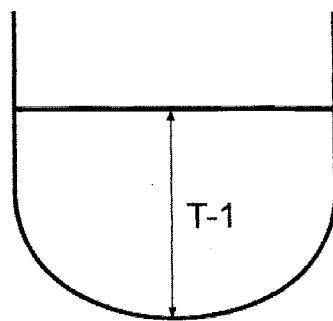
Standard Step



Triangular Step



Convex Step



Concave Step

FIGURE 31B-7
STAIR AND HANDRAIL DIMENSIONS

TABLE 31B-7

| DIMENSIONS | T-1_STANDARD | T-1 TRIANGULAR, CONCAVE, CONVEX | T-2 | T-3 | W-1 | H-1 | H-2 |
|------------|--------------|---------------------------------------|-----|-----|-----|-----|-----|
| Minimum | 14" | 21" | 12" | 3" | 24" | 6" | 28" |
| Maximum | 18" | 24" | 16" | — | — | 12" | 36" |

Note for Table 31B 7:

1. Six inch minimum radius at "pinch points".

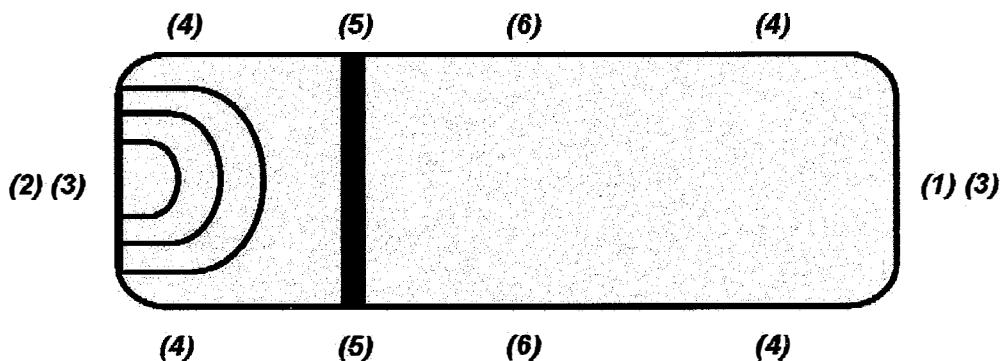


FIGURE 31B-8
DEPTH MARKER LOCATIONS

Notes:

1. Maximum depth.
2. Minimum depth.
3. Each end of pool.
4. Both sides at the shallowest and deepest parts of pool.
5. At the break in the bottom slope between the shallow and deep end.
6. Along the perimeter of the pool at distances not to exceed 25 feet.

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE CHAPTER 31C – RADIATION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | X | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |

CHAPTER 31C [DPH]

RADIATION

SECTION 3101C SCOPE

For the purpose of this chapter, the following terms shall have the meaning indicated:

PRIMARY PROTECTIVE BARRIER is a barrier to attenuate the useful beam.

SECONDARY PROTECTIVE BARRIER is a barrier to attenuate stray radiation.

STRAY RADIATION is radiation not serving any useful purpose, which includes leakage and scattered radiation.

USEFUL BEAM is the radiation which passes through the window, aperture, cone or other collimating device of the tube housing.

SECTION 3102C RADIATION SHIELDING BARRIERS

All radiation shielding barriers in rooms and enclosures housing machines shall meet the requirements of Section 12-31C-101, Chapter 12-31C, Part 12, California Referenced Standards Code. The Department of Health Services is the only agency that may grant a variance or exception to these standards.

SECTION 3103C MEDICAL RADIOGRAPHIC AND PHOTOFLUOROGRAPHIC INSTALLATIONS

3103C.1 Operator station. The operator's station at the control shall be behind a protective barrier either in a separate room, in a protected booth or behind a shield which will intercept the useful beam and any radiation which has been scattered only once.

3103C.2 Patient observation and communication. Provision shall be made for the operator to observe and communicate with the patient without leaving the shielded position at the control panel. When an observation window is used, it must provide radiation attenuation equal to that required in the surrounding barrier.

SECTION 3104C MEDICAL THERAPEUTIC X-RAY INSTALLATIONS

3104C.1 General. All wall, floor and ceiling areas that can be struck by the useful beam, plus a border of 1 foot (305 mm), shall be provided with primary protective barriers.

3104C.2 Equipment operating above 50 kVp. Equipment operating above 50 kVp shall conform with the following:

1. The control station shielding shall either be an integral part of the building or anchored to the building.

2. The control station shall be provided with a window having radiation attenuation equal to that required by the adjacent barrier, or a mirror system, or a closed-circuit television viewing screen. The patient area must be visible to the operator without having to leave the protected area during exposure.

3104C.3 Equipment operating above 150 kVp. Equipment operating above 150 kVp shall conform to the following:

1. The treatment room shall be provided with interlocks so that when any door of the treatment room is opened, either the machine will shut off automatically or the radiation level within the room will be reduced to an average of not more than 2 milliroentgens per hour and a maximum of 10 milliroentgens per hour at a distance of one meter in any direction from the target. After such shutoff or reduction in output, it shall be possible to restore the machine to full operation only from the control panel.
2. The control station shall be within a protective booth or in an adjacent room.

3104C.4 A minimum of one door shall be provided with an auxiliary means for being opened in case of power failure or mechanical breakdown, where large power-driven doors offer the only access to the room.

3104C.5 A flashing red warning signal light energized only when the useful beam is on shall be located adjacent to the entrance(s) to a therapy room with equipment capable of operating above 500 kVp.

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE CHAPTER 31D – FOOD ESTABLISHMENTS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | X | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |



CHAPTER 31D [DPH] FOOD ESTABLISHMENTS

SECTION 3101D SCOPE

The provisions of this chapter shall apply to the construction of commissaries serving mobile food preparation units.

SECTION 3102D DEFINITIONS

For the purpose of this chapter, the following term shall have the meaning indicated:

COMMISSARIES SERVING MOBILE FOOD PREPARATION UNITS are food establishments in which food, containers, equipment or supplies are stored or handled for use in vehicles, mobile food preparation units, food carts or vending machines.

SECTION 3103D BUILDINGS AND STRUCTURES

3103D.1 Light. Ten foot candles (107.6 lux) of uniformly distributed light as measured 30 inches (762 mm) above the floor shall be provided in all rooms and areas in commissaries serving mobile food preparation units.

CHAPTER 31E
RESERVED

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE CHAPTER 31F – MARINE OIL TERMINALS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | | | | | X | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |

CHAPTER 31F [SLC]

MARINE OIL TERMINALS

Division I

SECTION 3101F [SLC] INTRODUCTION

3101F.1 General. The Lempert-Keene-Seastrand oil spill prevention and response act of 1990 (act), as amended, authorized the California State Lands Commission (SLC) to regulate marine oil terminals (MOTs) in order to protect public health, safety and the environment. The authority for this regulation is contained in Sections 8755 and 8756 of the California Public Resources Code. This act defines "oil" as any kind of petroleum, liquid hydrocarbons, or petroleum products or any fraction or residues thereof, including but not limited to, crude oil, bunker fuel, gasoline, diesel fuel, aviation fuel, oil sludge, oil refuse, oil mixed with waste, and liquid distillates from unprocessed natural gas. The provisions of this chapter regulate marine oil terminals as defined under this act.

3101F.2 Purpose. The purpose of this code is to establish minimum engineering, inspection and maintenance criteria for MOTs in order to prevent oil spills and to protect public health, safety and the environment. This code does not, in general, address operational requirements. Relevant provisions from existing codes, industry standards, recommended practices, regulations and guidelines have been incorporated directly or through reference, as part of this code.

Where there are differing requirements between this code and/or references cited herein, the choice of application shall be subject to approval of the Marine Facilities Division (Division) of the SLC.

3101F.3 Applicability. The provisions of this chapter are applicable to the evaluation of existing MOTs and design of new MOTs in California. Each provision is classified as New (N), Existing (E), or Both (N/E) and shall be applied accordingly. If no classification is indicated, the classification shall be considered to be (N/E).

Existing (E) requirements apply to MOTs that are in operation on the date this code is adopted. For these MOTs, equivalent or in-kind replacement of existing equipment, short pipeline sections, or minor modification of existing components shall also be subject to the existing (E) requirements.

New (N) requirements apply to:

1. A MOT or berthing system (Subsection 3102F.1.3) that commences or recommences operation with a new or modified operations manual after adoption of this code.
2. Addition of new structural components or systems at an existing MOT that are structurally independent of existing components or systems.
3. Addition of new (nonreplacement) equipment, piping, pipelines, components or systems to an existing MOT.
4. Major repairs or substantially modified in-place systems.
5. Any associated major installations or modifications.

3101F.4 Overview. This Code ensures that a MOT can be safely operated within its inherent structural and equipment-related constraints.

Section 3102F defines minimum requirements for audit, inspection and evaluation of the structural, electrical and

mechanical systems on a prescribed periodic basis, or following a significant, potentially damage-causing event.

Section 3103F, 3104F and 3107F provide criteria for structural loading, deformation and performance-based evaluation considering earthquake, wind, wave, current, seiche and tsunami effects.

Section 3105F provides requirements for the safe mooring and berthing of tank vessels and barges.

Section 3106F describes requirements for geotechnical hazards and foundation analyses, including consideration of slope stability and soil failure.

Section 3108F provides requirements for fire prevention, detection and suppression including appropriate water and foam volumes.

Sections 3109F through 3111F provide requirements for piping/pipelines, mechanical and electrical equipment and electrical systems.

English units are prescribed herein; however, many of the units in the references are in System International (SI).

3101F.5 Risk reduction strategies. Risk reduction strategies, such as pipeline segmentation devices, system flexibility and spill containment devices may be used to reduce the size of a potential oil spill. Such strategies may reduce the MOT risk classification as determined from Table 31F-4-1.

3101F.6 Review requirements.

3101F.6.1 Quality assurance. All audits, inspections, engineering analyses or design shall be reviewed by a professional having similar or higher qualifications as the person who performed the work, to ensure quality assurance. This review may be performed in-house.

Peer review is required for nonlinear dynamic structural analyses and alternative lateral force procedures not prescribed herein. The peer review may be from an independent internal or external source. The peer reviewer shall be a California registered civil or structural engineer.

3101F.6.2 Division review. The following will be subject to review for compliance with this code by the Division or its authorized representative(s):

1. Any audit, inspection, analysis or evaluation of MOTs.
2. Any significant change, modification or re-design of a structural, mooring, fire, piping/pipelines, mechanical or electrical system at an MOT, prior to use or reuse.
3. Engineering analysis and design for any new MOT prior to construction. Also see Section 3102F.3.3.1.
4. Construction inspection team and the construction inspection report(s).

3101F.7 Alternatives. In special circumstances where certain requirements of these standards cannot be met, alternatives that provide an equal or better protection of the public health, safety and the environment shall be subject to Division Chief approval with concurrence of the Division's lead engineer in responsible charge.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 2

SECTION 3102F AUDIT AND INSPECTION

3102F.1 General.

3102F.1.1 Purpose. Section 3102F defines minimum requirements for audit, inspection, and evaluation of the structural, mechanical and electrical components and systems.

3102F.1.2 Audit and inspections types. The audit and inspections described in this Chapter (31F) and 2 CCR 2320 (a) and (b) [2.1] are:

1. Annual inspection
2. Audit
3. Post-event inspection

Each has a distinct purpose and is conducted either at a defined interval (see Table 31F-2-1 and Section 3102F.3.3.2), as a result of a significant, potentially damage-causing event or a significant change in operations. In the time between audits and inspections, operators are expected to conduct periodic walk-down examinations of the MOT to detect potentially unsafe conditions.

3102F.1.3 Berthing systems. For the purpose of assigning structural ratings and documenting the condition of mechanical and electrical systems, an MOT shall be divided into independent "berthing systems." A berthing system consists of the wharf and supporting structure, mechanical and electrical components that serve the berth and pipeline systems as defined in Title 2 CCR §2560 and 2561(n).

For example, a MOT consisting of wharves with three berths adjacent to the shoreline could contain three independent "berthing systems" if the piping does not route through adjacent berths. Therefore, a significant defect that would restrict the operation of one berth would have no impact on the other two berths. Conversely, if a T-head Pier, with multiple berths sharing a trestle that supports all piping to the shoreline, had a significant deficiency on the common trestle, the operation of all berths could be adversely impacted. This configuration is classified as a single berthing system.

The physical boundaries of a berthing system may exclude unused sections of a structure. Excluded sections must be physically isolated from the berthing system. Expansion joints may provide this isolation.

3102F.1.4 Records. All MOTs shall have records reflecting current, as-built conditions for all berthing systems. Records shall include, but not be limited to modifications and/or replacement of structural components, electrical or mechanical equipment or relevant operational changes, new construction including design drawings, calculations, engineering analyses, soil borings, equipment manuals, specifications, shop drawings, technical and maintenance manuals and documents.

Chronological records and reports of annual inspections, audits and post-event inspections and documentation of equipment or structural changes shall be maintained.

Records shall be indexed and be readily accessible to the Division (see 2 CCR Section 2320 (c) (2)) [2.1].

3102F.1.5 Baseline inspection. If "as-built" or subsequent modification drawings are not available, incomplete or inaccurate, a baseline inspection is required to gather data in sufficient detail for adequate evaluation.

The level of detail required shall be such that structural member sizes, connection and reinforcing details are documented, if required in the structural analysis. In addition, the strength and/or ductility characteristics of construction materials shall be determined, as appropriate. Nondestructive testing, partially destructive testing and/or laboratory testing methods may be used.

All fire, piping, mechanical and electrical systems shall be documented as to location, capacity, operating limits and physical conditions.

3102F.2 Annual inspection. The annual inspection required by 2 CCR 2320 (a)(1) [2.1], may include an engineering examination of the topside and underside areas of the dock, including the splash zone. The Division shall perform the inspection, with cooperation from the owner/operator. Observations will be recorded and a report of violations and deficiencies shall be provided to the operator.

Subject to operating procedures, a boat shall be provided to facilitate the inspection of the dock undersides and piles down to the splash zone. If a boat is not available or the under dock inspection cannot be performed by the Division during the annual inspection, the MOT operator shall carry out or cause to be carried out, such an inspection. The operator will then provide the Division with a report detailing the examination results including photographs, videos and sketches as necessary to accurately depict the state of the underside of the dock.

3102F.3 Audits.

3102F.3.1 Objective. The objective of the audit is to review structural, mechanical and electrical systems on a prescribed periodic basis to verify that each berthing system is fit for its specific defined purpose. The audit includes above water and underwater inspections, engineering evaluation, documentation and recommended follow-up actions.

3102F.3.2 Overview. The audit shall include above water and underwater inspections, and structural, electrical and mechanical systems evaluations, with supporting documentation, drawings and follow-up actions. Structural systems shall include seismic, operational, mooring, berthing and geotechnical considerations. Mechanical systems shall include fire, piping/pipelines and mechanical equipment considerations. The audit is performed by a multi-disciplinary team of engineers, qualified inspectors and may include Division representatives.

The above water inspection involves an examination of all structural, mechanical and electrical components above the waterline. Structural defects and their severity shall be documented, but the exact size and location of each deficiency is typically not required.

The underwater inspection involves an examination of all structural, mechanical and electrical components below the waterline. A rational and representative underwater sampling of piles may be acceptable with Division approval, for cases of limited visibility, heavy marine growth, restricted inspection times because of environmental factors (currents, water temperatures, etc.) or a very large number of piles.

Global operational structural assessment rating(s) (OSAR), global seismic structural assessment rating(s) (SSAR) and global inspection condition assessment rating(s) (ICAR) shall be assigned to each structure and overall berthing system, where appropriate (Table 31F-2-4).

Remedial action priorities (RAP) shall be assigned for component deficiencies (Table 31F-2-5). Recommendations for remediation and/or upgrading shall be prescribed as necessary.

An audit is not considered complete until the audit report is received by the Division.

3102F.3.3 Schedule.

3102F.3.3.1 Initial audit. For a new MOT or new berthing system(s), the initial audit of the "as-built" systems(s) shall be performed prior to commencement of operations.

3102F.3.3.2 Subsequent audits. A subsequent audit report of each terminal shall be completed at a maximum interval of 4 years, and includes documentation of inspections. This interval may be reduced, based on the recommendation of the audit team leader, and with the approval of the Division, depending on the extent and rate of deterioration or other factors.

The maximum interval for above water inspections shall be 4 years. The maximum interval for underwater inspections is dependent upon the condition of the facility, the construction material type and/or the environment at the mudline, as shown in Table 31F-2-1.

If there are no changes in the defined purpose (see Section 3102F.3.6.1) of the berthing system(s), then analyses from previous audits may be referenced. However, if there is a significant change in a berthing system(s), or when deterioration or damage must be considered, a new analysis may be required.

The Division may require an audit, inspection or supplemental evaluations to justify changes in the use of the berthing system(s).

3102F.3.4 Audit team.

3102F.3.4.1 Project manager. The audit shall be conducted by a multidisciplinary team under the direction of a project manager representing the MOT. The project manager shall have specific knowledge of the MOT and may serve other roles on the audit team.

3102F.3.4.2 Audit team leader. The audit team leader shall lead the on-site audit team and shall be responsible for directing field activities, including the inspection of all structural, mechanical and electrical systems. The team

leader shall be a California registered civil or structural engineer and may serve other roles on the audit team.

3102F.3.4.3 Structural inspection team. The structural inspection shall be conducted under the direction of a registered civil or structural engineer.

All members of the structural inspection team shall be graduates of a 4-year civil/structural engineering, or closely related (ocean/coastal) engineering curriculum, and shall have been certified as an Engineer-in-Training; or shall be technicians who have completed a course of study in structural inspections. The minimum acceptable course in structural inspections shall include 80 hours of instruction specifically related to structural inspection, followed by successful completion of a comprehensive examination. An example of an acceptable course is the U.S. Department of Transportation's "Safety Inspection of In-Service Bridges." Certification as a Level IV Bridge Inspector by the National Institute of Certification in Engineering Technologies (NICET) shall also be acceptable [2.2].

For underwater inspections, the registered civil or structural engineer directing the underwater structural inspection shall also be a commercially trained diver or equivalent and shall actively participate in the inspection, by personally conducting a minimum of 25 percent of the underwater examination [2.2].

Each underwater team member shall also be a commercially trained diver, or equivalent. Divers performing manual tasks such as cleaning or supporting the diving operation, but not conducting or reporting on inspections, may have lesser technical qualifications [2.2].

3102F.3.4.4 Structural analyst. A California registered civil or structural engineer shall be in responsible charge of the structural evaluations.

3102F.3.4.5 Electrical inspection team. A registered electrical engineer shall direct the on-site team performing the inspection and evaluation of electrical components and systems.

3102F.3.4.6 Mechanical inspection team. A registered engineer shall direct the on-site team performing the inspection and evaluation of piping/pipeline, mechanical and fire components and systems, except the Fire Protection Assessment in accordance with Section 3108E.2.2.

3102F.3.4.7 Divisional representation. The Division representative(s) may participate in any audit or inspection as observer(s) and may provide guidance.

3102F.3.4.8 Geotechnical analyst. A California registered civil engineer with a California authorization as a geotechnical engineer shall perform the geotechnical evaluation required for the audit and all other geotechnical evaluations.

3102F.3.5 Scope of inspections.

3102F.3.5.1 Above water structural inspection. The above water inspection shall include all accessible components above +3 ft MLLW. Accessible components shall

be defined as those components above and below deck that are reachable without the need for excavation or extensive removal of materials that may impair visual inspection. The above water inspection shall include, but not be limited to, the following:

1. Piles
2. Pile caps
3. Beams
4. Deck soffit
5. Bracing
6. Retaining walls and bulkheads
7. Connections
8. Seawalls
9. Slope protection
10. Deck topsides and curbing
11. Expansion joints
12. Fender system components
13. Dolphins and deadmen
14. Mooring points and hardware
15. Navigation aids
16. Platforms, ladders, stairs, handrails and gangways
17. Backfill (sinkholes/differential settlement)

3102F3.5.2 Underwater structural inspection. The underwater inspection shall include all accessible components from +3 ft MLLW to the mudline, including the slope and slope protection, in areas immediately surrounding the MOT. The water depth at the berth(s) shall be evaluated,

verifying the maximum or loaded draft specified in the MOT's Operations Manual (2 CCR 2385 (d)) [2.1].

The underwater structural inspection shall include the Level I, II and III inspection efforts, as shown in Tables 31F-2-2 and 31F-2-3. The underwater inspection levels of effort are described below, per [2.2]:

Level I—Includes a close visual examination, or a tactile examination using large sweeping motions of the hands where visibility is limited. Although the Level I effort is often referred to as a “swim-by” inspection, it must be detailed enough to detect obvious major damage or deterioration due to overstress or other severe deterioration. It should confirm the continuity of the full length of all members and detect undermining or exposure of normally buried elements. A Level I effort may also include limited probing of the substructure and adjacent channel bottom.

Level II—A detailed inspection which requires marine growth removal from a representative sampling of components within the structure. For piles, a 12-inch high band should be cleaned at designated locations, generally near the low waterline, at the mud-line, and midway between the low waterline and the mudline. On a rectangular pile, the marine growth removal should include at least three sides; on an octagon pile, at least six sides; on a round pile, at least three-fourths of the perimeter. On large diameter piles, 3 ft or greater, marine growth removal should be effected on 1 ft by 1 ft areas at four locations approximately equally spaced around the perimeter, at each elevation. On large solid faced elements such as retaining structures, marine growth removal should be effected on 1 ft by 1 ft areas at the three specified elevations. The inspection should also focus on typical areas of weakness, such as attachment points and welds. The Level II effort is

**TABLE 31F-2-1
MAXIMUM INTERVAL BETWEEN UNDERWATER INSPECTIONS (YEARS)¹**

| INSPECTION CONDITION ASSESSMENT RATING (ICAR) ⁶ | CONSTRUCTION MATERIAL | | | | CHANNEL BOTTOM OR MUDLINE—SCOUR ⁴ | |
|--|--|-------------------------------------|--|-------------------------------------|--|-------------------------------------|
| | Unwrapped Timber or Unprotected Steel (no coating or cathodic protection) ⁴ | | Concrete, Wrapped Timber, Protected Steel or Composite Materials (FRP, plastic, etc.) ⁴ | | | |
| | Benign ² Environment | Aggressive ³ Environment | Benign ² Environment | Aggressive ³ Environment | Benign ² Environment | Aggressive ³ Environment |
| 6 (Good) | 6 | 4 | 6 | 5 | 6 | 5 |
| 5 (Satisfactory) | 6 | 4 | 6 | 5 | 6 | 5 |
| 4 (Fair) | 5 | 3 | 5 | 4 | 6 | 5 |
| 3 (Poor) | 4 | 3 | 5 | 4 | 6 | 5 |
| 2 (Serious) | 2 | 1 | 2 | 2 | 2 | 2 |
| 1 (Critical) | N/A ⁵ | N/A ⁵ | N/A ⁵ | N/A ⁵ | N/A ⁵ | N/A ⁵ |

1. The maximum interval between Underwater Inspections shall be changed as appropriate, with the approval of the Division, based on the extent of deterioration observed on a structure, the rate of further anticipated deterioration or other factors.
2. Benign environments include fresh water and maximum current velocities less than 1.5 knots for the majority of the days in a calendar year.
3. Aggressive environments include brackish or salt water, polluted water, or waters with current velocities greater than 1.5 knots for the majority of the days in the calendar year.
4. For most structures, two maximum intervals will be shown in this table, one for the assessment of construction material (timber, concrete, steel, etc.) and one for scour (last 2 columns). The shorter interval of the two should dictate the maximum interval used.
5. MOTs rated “Critical” will not be operational; and Emergency Action shall be required in accordance with Table 31F 2 6.
6. ICARs shall be assigned in accordance with Table 31F 2 4.

**TABLE 31F-2-2
UNDERWATER INSPECTION LEVELS OF EFFORT [2.2]**

| LEVEL | PURPOSE | DETECTABLE DEFECTS | | | |
|-------|--|--|---|---|--|
| | | Steel | Concrete | Timber | Composite |
| I | General visual/tactile inspection to confirm as built condition and detect severe damage | Extensive corrosion, holes Severe mechanical damage | Major spalling and cracking Severe reinforcement corrosion Broken piles | Major loss of section Broken piles and bracings Severe abrasion or marine borer attack | Permanent deformation Broken piles Major cracking or mechanical damage |
| II | To detect surface defects normally obscured by marine growth | Moderate mechanical damage Corrosion pitting and loss of section | Surface cracking and spalling Rust staining Exposed reinforcing steel and/or prestressing strands | External pile damage due to marine borers Splintered piles Loss of bolts and fasteners Rot or insect infestation | Cracking Delamination Material degradation |
| III | To detect hidden or interior damage, evaluate loss of cross sectional area, or evaluate material homogeneity | Thickness of material Electrical potentials for cathodic protection | Location of reinforcing steel Beginning of corrosion of reinforcing steel Internal voids Change in material strength | Internal damage due to marine borers (internal voids) Decrease in material strength | N/A |

**TABLE 31F-2-3
SCOPE OF UNDERWATER INSPECTIONS [2.2]**

| LEVEL | | SAMPLE SIZE AND METHODOLOGY* | | | | | | | Slope Protection, Channel Bottom or Mudline-Scour |
|-------|-------------------------|---|---|---|--|---|---|---|---|
| | | Steel | | Concrete | | Timber | | Composite | |
| | | Piles | Bulkheads/ Retaining Walls | Piles | Bulkheads/ Retaining Walls | Piles | Bulkheads/ Retaining Walls | Piles | |
| I | Sample Size: Method: | 100% Visual/Tactile | 100% Visual/Tactile | 100% Visual/Tactile | 100% Visual/Tactile | 100% Visual/Tactile | 100% Visual/Tactile | 100% Visual/Tactile | 100% Visual/Tactile |
| II | Sample Size: Method: | 10% Visual: Removal of marine growth in 3 bands | Every 100 LF Visual: Removal of marine growth in 1 SF areas | 10% Visual: Removal of marine growth in 3 bands | Every 100 LF Visual: Removal of marine growth in 1 SF areas | 10% Visual: Removal of marine growth on 3 bands Measurement: Remaining diameter | Every 50 LF Visual: Removal of marine growth in 1 SF areas | 10% Visual: Removal of marine growth in 3 bands | 0% |
| III | Sample Size: Method: | 5% Remaining thickness measurement; electrical potential measurement; corrosion profiling as necessary | Every 200 LF Remaining thickness measurement; electrical potential measurement; corrosion profiling as necessary | 0% N/A | 0% N/A | 5% Internal marine borer infestation evaluation | Every 100 LF Internal marine borer infestation evaluation | 0% | 0% |

1. The minimum inspection sampling size for small structures shall include at least two components.

LF = Linear Feet; SF = Square Feet; N/A = Not Applicable

intended to detect and identify damaged and deteriorated areas that may be hidden by surface biofouling. The thoroughness of marine growth removal should be governed by what is necessary to discern the condition of the underlying structural material. Removal of all biofouling staining is generally not required.

Level III—A detailed inspection typically involving nondestructive or partially-destructive testing, conducted to detect hidden or interior damage, or to evaluate material homogeneity. Level III testing is generally limited to key structural areas, areas which are suspect or areas which may be representative of the underwater structure.

3102F.3.5.3 Special inspection considerations.

3102F.3.5.3.1 Coated components. For coated steel components, Level I and Level II efforts should focus on the evaluation of the integrity and effectiveness of the coating. The piles should be inspected without damaging the coating. Level III efforts should include ultrasonic thickness measurements without removal of the coating, where feasible.

3102F.3.5.3.2 Encased components. For steel, concrete or timber components that have been encased, the Level I and II efforts should focus on the evaluation of the integrity of the encasement. If evidence of signif-

cant damage to the encasement is present, or if evidence of significant deterioration of the underlying component is present, then the damage evaluation should consider whether the encasement was provided for protection and/or structural capacity. Encasements should not typically be removed for an audit.

For encasements on which the formwork has been left in place, the inspection should focus on the integrity of the encasement, not the formwork. Level I and Level II efforts in such cases should concentrate on the top and bottom of the encasement. For concrete components, if deterioration, loss of bonding, or other significant problems with the encasement are suspected, it may be necessary to conduct a special inspection, including coring of the encasement and laboratory evaluation of the materials.

3102F.3.5.3.3 Wrapped components. For steel, concrete or timber components that have been wrapped, the Level I and II efforts should focus on the evaluation of the integrity of the wrap. Since the effectiveness of a wrap may be compromised by removal, and since the removal and re-installation of wraps is time-consuming, it should not be routinely done. However, if evidence of significant damage exists, or if the effectiveness of the wraps is in question, then samples should be removed to facilitate the inspection and evaluation. The samples may be limited to particular zones or portions of members if damage is suspected, based on the physical evidence of potential problems. A minimum sample size of three members should be used. A five-percent sample size, up to 30 total members, may be adequate as an upper limit.

For wrapped timber components, Level III efforts should consist of removal of the wraps from a representative sample of components in order to evaluate the condition of the timber beneath the wrap. The sample may be limited to particular zones or portions of the members if damage is suspected (e.g., at the mudline/bottom of wrap or in the tidal zone). The sample size should be determined based on the physical evidence of potential problems and the aggressiveness of the environment. A minimum sample size of three members should be used. A five-percent sample size, up to 30 total members, may be adequate as an upper limit.

3102F.3.5.4 Mechanical and electrical inspections. The mechanical and electrical inspections shall include but not be limited to the following:

1. Loading arms
2. Cranes and lifting equipment, including cables
3. Piping/manifolds and supports
4. Oil transfer hoses
5. Fire detection and suppression systems
6. Vapor control system
7. Sumps/sump tanks
8. Vent systems

9. Pumps and pump systems
10. Lighting
11. Communications equipment
12. Gangways
13. Electrical switches and junction boxes
14. Emergency power equipment
15. Air compressors
16. Meters
17. Cathodic protection systems
18. Winches
19. ESD and other control systems
20. Ladders

All alarms, limit switches, load cells, current meters, anemometers, leak detection equipment, etc., shall be operated and/or tested to the extent feasible, to ensure proper function.

3102F.3.6 Evaluation and assessment.

3102F.3.6.1 Terminal operating limits. The physical boundaries of the facility shall be defined by the berthing system operating limits, along with the vessel size limits and environmental conditions.

The audit shall include a "Statement of Terminal Operating Limits," which must provide a concise statement of the purpose of each berthing system in terms of operating limits. This description must at least include, the minimum and maximum vessel sizes, including Length Overall (LOA), beam, and maximum draft with associated displacement (see Fig. 31F-2-1).

In establishing limits for both the minimum and maximum vessel sizes, due consideration shall be given to water depths, dolphin spacing, fender system limitations, manifold height and hose/loading arm reach, with allowances for tidal fluctuations, surge and drift.

Maximum wind, current or wave conditions, or combinations thereof, shall be clearly defined as limiting conditions for vessels at each berth, both with and without active product transfer.

3102F.3.6.2 Mooring and berthing. Mooring and berthing analyses shall be performed in accordance with Section 3105F. The analyses shall be consistent with the terminal operating limits and the structural configuration of the wharf and/or dolphins and associated hardware.

Based on inspection results, analyses and engineering judgment, mooring and berthing OSARs shall be assigned on a global basis, independently for each structure and overall berthing system. The OSARs defined in Table 31F-2-4 shall be used for this purpose. The mooring and berthing OSARs document the berthing system(s) fitness-for-purpose.

3102F.3.6.3 Structure. A structural evaluation, including a seismic analysis, shall be performed in accordance with Sections 3103F through 3107F. Such evaluation

shall consider local or global reduction in capacity, as determined from the inspection.

Based on inspection results, structural analyses and engineering judgment, OSARs (for operational loading) and SSARs shall be assigned on a global basis, independently for each structure, structural system(s) and berthing system(s), as appropriate. The OSARs and SSARs defined in Table 31F-2-4 shall be used for this purpose and document the structural and/or berthing system(s) fitness-for-purpose.

Based on inspection results and engineering judgment, ICARs shall be assigned on a global basis, independently for each above and underwater structure, structural system and berthing system, as appropriate. The ICARs defined in Table 31F-2-4 shall be used for this purpose.

Structural component deficiencies assigned RAPs as per Table 31F-2-5 shall be considered in the OSARs, SSARs and ICARs. The assigned ratings shall remain in effect until all the significant corrective action has been completed to the satisfaction of the Division, or until completion of the next audit.

3102F.3.6.4 Mechanical and electrical systems. An evaluation of all mechanical and electrical systems and components shall be performed in accordance with Sections 3108F through 3111F of these standards. If a pipeline stress analysis is required (see Section 3109F.3), forces and imposed seismic displacements resulting from the structural analysis shall be considered. Mechanical and electrical component deficiencies shall be assigned ratings from Table 31F-2-5.

3102F.3.7 Follow-up actions. Follow-up actions as described in Table 31F-2-6 shall be prescribed. Multiple follow-up actions may be assigned; however, guidance shall be provided as to the order in which the follow-up actions should be carried out.

If an assessment rating of "1", "2" or "3" (Table 31F-2-4) or a RAP of "P1" or "P2" (Table 31F-2-5) or "Emergency Action" using Table 31F-2-6, is assigned to a structure, berthing system or critical component, the Division shall be notified immediately. The Executive Summary Table ES-2 (see Example Table 31F-2-8) shall include implementation schedules for all follow-up and remedial actions. Follow-up and remedial actions and implementation schedules are subject to Division approval. Executive Summary Tables shall be maintained and updated by the MOT, and shall be submitted in the audit and/or upon Division request. For action plan implementation, see Section 3102F.3.9.

3102F.3.8 Documentation and reporting. The audit reports shall be signed and stamped by the audit team leader. The inspection and other reports and drawings shall be signed and stamped by the engineers in responsible charge.

Each audit and inspection, whether partial or complete, shall be adequately documented. Partial inspections cover only specific systems or equipment examined. The resulting

reports shall summarize and reference relevant previous ratings and deficiencies. Inspection reports shall be included in subsequent audits.

The contents of the audit and inspection reports for each berthing system shall, at a minimum, include the following as appropriate:

Executive summary—a concise narrative of the audit or inspection results and analyses conclusions. It shall include summary information for each berthing system, including an overview of the assigned follow-up actions. The Executive Summary Tables shall also be included (see Example Tables 31F-2-7A through 31F-2-7C and 31F-2-8).

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Introduction—a brief description of the purpose and scope of the audit or inspection, as well as a description of the inspection/evaluation methodology used.

Existing conditions—a description, along with a summary, of the observed conditions. Subsections shall be used to describe the above water structure, underwater structure, fire, piping/pipeline, mechanical and electrical systems, to the extent each are included in the scope of the audit. Photos, plan views and sketches shall be utilized as appropriate to describe the structure and the observed conditions. Details of the inspection results such as test data, measurements data, etc., shall be documented in an appendix.

Evaluation and assessment—assessment ratings shall be assigned to all structures and/or berthing systems. Also, see Section 3102F.3.6. All supporting calculations, as-built drawings and documentation shall be included in appendices as appropriate to substantiate the ratings. However, the results and recommendations of the engineering analyses shall be included in this section. Component deficiencies shall be described and a corresponding RAP assigned.

Follow-up actions—Specific follow-up actions (Table 31F-2-6) shall be documented (Table 31F-2-8), and remedial schedules included, for each audited system. Audit team leaders shall specify which follow-up actions require a California registered engineer to certify that the completion is acceptable.

Appendices—When appropriate, the following appendices shall be included:

1. Background data on the terminal - description of the service environment (wind/waves/currents), extent and type of marine growth, unusual environmental conditions, etc.
2. Inspection/testing data
3. Mooring and berthing analyses
4. Structural and seismic analyses and calculations
5. Geotechnical report
6. MOT Fire Protection Assessment
7. Pipeline stress and displacement analyses

- 8. Mechanical and electrical system documentation
- 9. Corrosion assessment
- 10. Photographs, sketches and supporting data shall be included to document typical conditions and referenced deficiencies, and to justify the assessment ratings and the remedial action priorities RAPs assigned.

3102F.3.9 Action plan implementation report. After implementation of remedial measures, a report shall be submitted to the Division and shall include:

1. A description of each action taken

**TABLE 31F-2-4
ASSESSMENT RATINGS**

| RATING | DESCRIPTION OF STRUCTURE(S) AND/OR SYSTEMS⁴ | |
|---------------------|---|--|
| | OSAR¹ and SSAR² | ICAR³ |
| 6 Good | <p><i>The capacity of the structure or system meets the requirements of this standard.</i> <i>The structure or system should be considered fit-for purpose. No repairs or upgrades are required.</i></p> | <p><i>No problems or only minor problems noted. Structural elements may show very minor deterioration, but no overstressing observed.</i> <i>No repairs or upgrades are required.</i></p> |
| 5 Satisfactory | <p><i>The capacity of the structure or system meets the requirements of this standard.</i> <i>The structure or system should be considered fit-for purpose. No repairs or upgrades are required.</i></p> | <p><i>Limited minor to moderate defects or deterioration observed, but no overstressing observed.</i> <i>No repairs or upgrades are required.</i></p> |
| 4 Fair | <p><i>The capacity of the structure or system is no more than 15 percent below the requirements of this standard, as determined from an engineering evaluation.</i> <i>The structure or system should be considered as marginal. Repair and/or upgrade measures may be required to remain operational. Facility may remain operational, provided a plan and schedule for remedial action is presented to and accepted by the Division.</i></p> | <p><i>All primary structural elements are sound, but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present, but do not significantly reduce the load bearing capacity of the structure.</i> <i>Repair and/or upgrade measures may be required to remain operational. Facility may remain operational, provided a plan and schedule for remedial action is presented to and accepted by the Division.</i></p> |
| 3 Poor | <p><i>The capacity of the structure or system is no more than 25 percent below the requirements of this standard, as determined from an engineering evaluation.</i> <i>The structure or system is not fit-for purpose. Repair and/or upgrade measures may be required to remain operational. The facility may be allowed to remain operational on a restricted or contingency basis until the deficiencies are corrected, provided a plan and schedule for such work is presented to and accepted by the Division.</i></p> | <p><i>Advanced deterioration or overstressing observed on widespread portions of the structure, but does not significantly reduce the load bearing capacity of the structure.</i> <i>Repair and/or upgrade measures may be required to remain operational. The facility may be allowed to remain operational on a restricted or contingency basis until the deficiencies are corrected, provided a plan and schedule for such work is presented to and accepted by the Division.</i></p> |
| 2 Serious | <p><i>The capacity of the structure or system is more than 25 percent below the requirements of this standard, as determined from an engineering evaluation.</i> <i>The structure or system is not fit-for purpose. Repairs and/or upgrade measures may be required to remain operational. The facility may be allowed to remain operational on a restricted basis until the deficiencies are corrected, provided a plan and schedule for such work is presented to and accepted by the Division.</i></p> | <p><i>Advanced deterioration, overstressing or breakage may have significantly affected the load bearing capacity of primary structural components. Local failures are possible and loading restrictions may be necessary.</i> <i>Repairs and/or upgrade measures may be required to remain operational. The facility may be allowed to remain operational on a restricted basis until the deficiencies are corrected, provided a plan and schedule for such work is presented to and accepted by the Division.</i></p> |
| 1 Critical | <p><i>The capacity of the structure or system is critically deficient relative to the requirements of this standard.</i> <i>The structure or system is not fit for purpose. The facility shall cease operations until deficiencies are corrected and accepted by the Division.</i></p> | <p><i>Very advanced deterioration, overstressing or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur and load restrictions should be implemented as necessary.</i> <i>The facility shall cease operations until deficiencies are corrected and accepted by the Division.</i></p> |

1. OSAR = Operational Structural Assessment Ratings

2. SSAR = Seismic Structural Assessment Ratings

3. ICAR = Inspection Condition Assessment Ratings [2.2]; Ratings shall be assigned comparing the observed condition to the original condition.

4. Structural, mooring or berthing systems

3102F4.1 Notification and action plan. Notification as per 2 CCR 2325(e) [2.1] shall be provided to the local area Division field office. The notification shall include, as a minimum:

1. Brief description of the event
2. Brief description of the nature, extent and significance of any damage observed as a result of the event
3. Operational status and any required restrictions
4. Statement as to whether a Post-Event inspection will be carried out

The Division may carry out or cause to be carried out, a post-event inspection. In the interim, the Division may direct a change in the operations manual, per 2 CCR 2385 (f)(3) [2.1].

If a post-event inspection is required, an action plan shall be submitted to the Division within five (5) days after the event. This deadline may be extended in special circumstances. The action plan shall include the scope of the inspection (above water, underwater, electrical, mechanical systems, physical limits, applicable berthing systems, etc.) and submission date of the final report. The action plan is subject to Division approval.

3102F4.2 Inspection team. The qualifications of the inspection team shall be the same as those prescribed in Section 3102F.3.4. Division representatives may participate in any post-event inspection, as observers, and may provide guidance.

3102F4.3 Scope. The post-event inspection shall focus on the possible damage caused by the event. General observations of long-term or preexisting deterioration such as significant corrosion-related damage or other deterioration should be made as appropriate, but should not be the focus of the inspection. The inspection shall always include an above-water assessment of structural, mechanical and electrical components.

The inspection team leader shall determine the need for, and methodology of, an underwater structural assessment, in consultation with the Division. Above water observations, such as shifting or differential settlement, misalignments, significant cracking or spalling, bulging, etc., shall be used to determine whether or not an underwater assessment is required. Similarly, the inspection team leader shall determine, in consultation with the Division, the need for,

**TABLE 31F-2-5
COMPONENT DEFICIENCY REMEDIAL ACTION PRIORITIES (RAP)**

| REMEDIAL PRIORITIES | DESCRIPTION AND REMEDIAL ACTIONS |
|---------------------|---|
| P1 | Specified whenever a condition that poses an immediate threat to public health, safety or the environment is observed. <u>Emergency Actions</u> may consist of barricading or closing all or portions of the berthing system, evacuating product lines and ceasing transfer operations. <u>The berthing system is not fit for purpose.</u> Immediate remedial actions are required prior to the continuance of normal operations. |
| P2 | Specified whenever defects or deficiencies pose a potential threat to public health, safety and the environment. Actions may consist of limiting or restricting operations until remedial measures have been completed. <u>The berthing system is not fit-for purpose.</u> This priority requires investigation, evaluation and urgent action. |
| P3 | Specified whenever systems require upgrading in order to comply with the requirement of these standards or current applicable codes. These deficiencies <u>do not require emergency or urgent actions.</u> <u>The MOT</u> may have limitations placed on its operational status. |
| P4 | Specified whenever damage or defects requiring repair are observed. <u>The berthing system is fit-for purpose.</u> <u>Repair can be performed during normal maintenance cycles, but not to exceed one year.</u> |
| R | Recommended action is a good engineering/maintenance practice, but not required by these standards. <u>The berthing system is fit for purpose.</u> |

**TABLE 31F-2-6
FOLLOW-UP ACTIONS [2.2]**

| FOLLOW-UP ACTION | DESCRIPTION |
|------------------------------------|--|
| Emergency Action | Specified whenever a condition which poses an immediate threat to public health, safety or the environment is observed. Emergency Actions may consist of barricading or closing all or portions of the berthing system, limiting vessel size, placing load restrictions, evacuating product lines, ceasing transfer operations, etc. |
| Engineering Evaluation | Specified whenever damage or deficiencies are observed which require further investigation or evaluation to determine appropriate follow up actions. |
| Repair Design Inspection | Specified whenever damage or defects requiring repair are observed. The repair design inspection is performed to the level of detail necessary to prepare appropriate repair plans, specifications and estimates. |
| Upgrade Design and Implementation | Specified whenever the system requires upgrading in order to comply with the requirements of these standards and current applicable codes. |
| Special Inspection | Typically specified to determine the cause or significance of nontypical deterioration, usually prior to designing repairs. Special testing, laboratory analysis, monitoring or investigation using nonstandard equipment or techniques are typically required. |
| Develop and Implement Repair Plans | Specified when the Repair Design Inspection and required Special Inspections have been completed. Indicates that the structure is ready to have repair plans prepared and implemented. |
| No Action | Specified when no further action is necessary until the next scheduled audit or inspection. |

and methodology of any supplemental inspections (e.g., special inspections (see Section 3102F.3.5.3).

The following information may be important in determining the need for, and methodology of, the post-event inspection:

1. Earthquakes or vessel or debris impact typically cause damage both above and below the waterline. Following a major earthquake, the inspection should focus on components likely to attract highest lateral loads (batter or shorter piles in the rear of the structure, etc.). In case of vessel or debris impact, the inspection effort should focus on components in the path of the impact mass.
2. Major floods or tsunamis may cause undermining of the structure, and/or scouring at the mudline.
3. Fire damage varies significantly with the type of construction materials but all types may be adversely affected. Special inspections (sampling and laboratory testing) shall be conducted, as determined by the inspection team leader, in order to determine the nature and extent of damage.
4. High wind or wave events often cause damage both above and below the waterline. An underwater inspection may be required if damage is visible above the waterline. Structural damage may be potentially increased if a vessel was at the berth during the event. The effects of high wind may be most prevalent on equipment and connections of such equipment to the structure.

The methodology of conducting an underwater post- event inspection should be established with due consideration of the structure type and type of damage anticipated. Whereas slope failures or scour may be readily apparent in waters of adequate visibility, overstressing cracks on piles covered with marine growth will not be readily apparent. Where such hidden damage is suspected, marine growth removal should be performed on a representative sampling of components in accordance with the Level II effort requirements described in Section 3102F.3.5.2. The cause of the event will determine the appropriate sample size and locations.

3102F.4.4 Post-event ratings. A post-event rating [2.2] shall be assigned to each berthing system upon completion of the inspection (see Table 31F-2-9). All observations of the above and under water structure, mechanical and electrical components and systems shall be considered in assigning a post-event rating.

Ratings should consider only damage that was likely caused by the event. Pre-existing deterioration such as corrosion damage should not be considered unless the structural integrity is immediately threatened or safety systems or protection of the environment may be compromised.

Assignment of ratings should reflect an overall characterization of the berthing system being rated. The rating shall consider both the severity of the deterioration and the extent to which it is widespread throughout the facility. The fact that the facility was designed for loads that are lower than the current standards for design should have no influence upon the ratings.

3102F.4.5 Follow-up actions. Follow-up actions shall be assigned upon completion of the post-event inspection of

each berthing system. Table 31F-2-5 specifies remedial action priorities for deficiencies. Table 31F-2-6 specifies various follow-up actions. Multiple follow-up actions may be assigned; however, guidance should be provided as to the order in which the follow-up actions should be carried-out. Follow-up actions shall be subject to Division approval.

3102F.4.6 Documentation and reporting. Documentation of the specific attributes of each defect shall not be required during a post-event inspection. However, a narrative description of significant damage shall be used. The description shall be consistent with and shall justify the post-event rating assigned.

A report shall be prepared and submitted to the Division upon completion of the post-event inspection and shall, at a minimum, include:

1. Brief description of the facility including the physical limits of the structure, type of construction material(s), and the mechanical and electrical systems present
2. Brief description of the event triggering the inspection
3. Scope of the inspection (above water, underwater, electrical or mechanical)
4. Date of the inspection
5. Names and affiliations of inspection team
6. Description of the nature, extent and significance of any observed damage resulting from the event
7. Photographs should be provided to substantiate the descriptions and justify the condition rating
8. Assignment of a post-event rating
9. Statement regarding whether the facility is fit to resume operations and, if so, under what conditions
10. Assignment of follow-up action(s)
11. Inspection data, drawings, calculations and other relevant engineering materials
12. Signature and stamp of team leader(s)

3102F.4.7 Action Plan Report. Upon completion of all actions delineated in the action plan, a final report shall be submitted to the Division to document the work completed. Supporting documentation such as calculations or other relevant data shall be provided in appendices.

3102F.5 References.

- [2.1] California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5, Marine Terminals Inspection and Monitoring, Sections 2315, 2320, 2325 and 2385 (short form example: 2 CCR 2315 (Title 2 of California Code of Regulations, Section 2315)).
- [2.2] Childs, K.M., editor, 2001, "Underwater Investigations - Standard Practice Manual," American Society of Civil Engineers, Reston, VA.

Authority: Sections 8755 and 8757, Public Resources Code

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

TABLE 31F-2-7A

| EXAMPLE | EXECUTIVE SUMMARY TABLE (ES-1A) GLOBAL OPERATIONAL STRUCTURAL ASSESSMENT RATINGS (OSAR) | | | | | | | | REV. # MM/YYYY | |
|-------------|--|--|---------------------------|-------------------------------|--------------------------|---------------------------|-------------------------------|---|--|--|
| | Berthing system | Berth(s) ¹ | Structure(s) ¹ | Type of analysis ² | OSAR rating ⁴ | Last audit date (MM/YYYY) | Next audit due date (MM/YYYY) | Last analysis date (MM/YYYY) ⁵ | Repair/replacement due date (MM/YYYY) ⁶ | |
| North Wharf | Berth 1 | Wharfhead | O | 5 | 08/2008 | 08/2011 | 02/2008 | N/A | Y | None |
| North Wharf | Berth 1 | Mooring Dolphin | M | 2 | 08/2008 | 08/2011 | 05/2008 | 12/2008 | N | Hook capacity inadequate |
| North Wharf | Berth 1 | Breasting Dolphin | B | 3 | 08/2008 | 08/2011 | 06/2008 | 02/2010 | Y | Berthing velocity restrictions required. Velocity monitoring system operational. Fender system to be upgraded. See Terminal Operating Limits. |
| North Wharf | Berth 1 | Overall | O | 4 | 08/2008 | 08/2011 | 02/2008 | N/A | Y | None |
| North Wharf | Berth 1 | Dolphins, Trestles, Catwalks, Bulkhead walls, etc. | | | 08/2008 | 08/2011 | | | | |
| South Wharf | Berth 2 | | | | 08/2008 | 08/2011 | | | | |

TABLE 31F-2-7B

| EXAMPLE | EXECUTIVE SUMMARY TABLE (ES-1B) GLOBAL SEISMIC STRUCTURAL ASSESSMENT RATINGS (SSAR) | | | | | | | | REV. # MM/YYYY |
|-------------|--|--|---------------------------|--------------------------|---------------------------|-------------------------------|---|--|--|
| | Berthing system | Berth(s) ¹ | Structure(s) ¹ | SSAR rating ⁴ | Last audit date (MM/YYYY) | Next audit due date (MM/YYYY) | Last analysis date (MM/YYYY) ⁵ | Repair/replacement due date (MM/YYYY) ⁶ | Fit-for-purpose (Y/N) |
| North Wharf | Berth 1 | Wharfhead | 2 | 08/2008 | 08/2011 | 05/2008 | 02/2010 | N | Level 1 – OK; SAP2000 Pushover Analysis Level 2 – NG; SAP2000 Pushover Analysis displacements too large and liquefaction |
| North Wharf | Berth 1 | Trestle | 5 | 08/2008 | 08/2011 | 05/2008 | N/A | Y | Level 1 – OK; SAP2000 Linear Analysis Level 2 – OK; SAP2000 Linear Analysis |
| North Wharf | Berth 1 | 30" Crude line | 5 | 08/2008 | 08/2011 | 05/2008 | N/A | Y | Level 1 – N/A Level 2 – OK; CAESAR Analysis |
| North Wharf | Overall | Overall | | | | | | | |
| North Wharf | Berth 1 | Dolphins, Pipeline Trestle, Bulkhead walls, etc. | | | | | | | |
| South Wharf | Berth 2 | | | | | | | | |

TABLE 31F-2-7C

| EXAMPLE | EXECUTIVE SUMMARY TABLE (ES-1C) GLOBAL INSPECTION CONDITION ASSESSMENT RATINGS (ICAR)⁸ | | | | | | | REV. # MM/YYYY |
|------------------------|--|---|---------------------------------------|-----------------------------------|--|-----------------------------------|--|--|
| | Berth(s)¹ | Structure(s)¹ | Type of inspection³ | ICAR rating^{4, 9} | Last inspection date (MM/YYYY)¹⁰ | Inspection interval (YRS.) | Next inspection due date (MM/YYYY)¹⁰ | |
| <i>Berthing system</i> | | | | | | | | |
| <i>North Wharf</i> | Berth 1 | Wharfhead | AW | 5 | 02/2008 | 3 | 02/2011 | General satisfactory condition. See RAPs in Table ES-2 for details. |
| <i>North Wharf</i> | Berth 1 | Wharfhead | UW | 4 | 02/2008 | 5 | 02/2013 | Pile damage; 10 serve, 15 minor See RAPs in Table ES 2 for details. |
| <i>North Wharf</i> | Berth 1 | Breasting Dolphin BD 1 | AW | 6 | 02/2008 | 3 | 02/2011 | See RAPs in Table ES 2 |
| <i>North Wharf</i> | Berth 1 | Breasting Dolphin BD 1 | UW | 5 | 02/2008 | 5 | 02/2013 | See RAPs in Table ES 2 |
| <i>North Wharf</i> | Berth 1 | Dolphins, Trestle, Catwalks, Bulkhead walls, etc. | | | | | | |
| <i>South Wharf</i> | Berth 2 | | | | | | | |

These notes apply to Tables 31F-2-7A through 7C:

1. The term "Overall" shall be input in this field when the assessment ratings are summarized for a berth.
2. "Types of Analyses": "O" = Operational Loading Analysis, "M" = Mooring Analysis, "B" = Berthing Analysis
3. "Types of Inspections": "AW" = Above Water Inspection, "UW" = Underwater Inspection
4. All assessment ratings shall be assigned in accordance with Table 31F-2-4.
5. The "Analysis Dates" are defined by the month and year in which the final design package is submitted to the Division.
6. The "Repair/Replacement Dates" are defined by the month and year in which the repair/replacement is to be completed and operational.
7. The "Description or Comments" shall reference all MOT operating limits. For OSARs, this includes berthing velocity restrictions, load limits, etc. For SSARs, this includes a brief list of the findings for each Seismic Performance Level.
8. Inspection findings may trigger a structural reassessment (see Tables 31F-2-7A and 31F-2-7B).
9. Ratings shall be assigned comparing the observed condition to the original condition.
10. The "Inspection Dates" are defined by the month and year in which the last day of formal field inspection is conducted.

TABLE 31F-2-9
POST-EVENT RATINGS AND REMEDIAL ACTIONS [22]

| RATING | SUMMARY OF DAMAGE | REMEDIAL ACTIONS |
|--------|---|---|
| A | <i>No significant event induced damage observed.</i> | <i>No further action required. The berthing system may continue operations.</i> |
| B | <i>Minor to moderate event induced damage observed but all primary structural elements and electrical/mechanical systems are sound.</i> | <i>Repairs or mitigation may be required to remain operational. The berthing system may continue operations.</i> |
| C | <i>Moderate to major event induced damage observed which may have significantly affected the load bearing capacity of primary structural elements or the functionality of key electrical/mechanical systems.</i> | <i>Repairs or mitigation may be necessary to resume or remain operational. The berthing system may be allowed to resume limited operations.</i> |
| D | <i>Major event induced damage has resulted in localized or widespread failure of primary structural components; or the functionality of key electrical/mechanical systems has been significantly affected. Additional failures are possible or likely to occur.</i> | <i>The berthing system may not resume operations until the deficiencies are corrected.</i> |

Division 3

**SECTION 3103F
STRUCTURAL LOADING CRITERIA**

3103F.1 General. Section 3103F establishes the environmental and operating loads acting on the marine oil terminal (MOT) structures and on moored vessel(s). The analysis procedures are presented in Sections 3104F – 3107F.

3103F.2 Dead loads.

3103F.2.1 General. Dead loads shall include the weight of the entire structure, including permanent attachments such as loading arms, pipelines, deck crane, fire monitor tower, gangway structure, vapor control equipment and mooring hardware. Unit weights specified in Section 3103F.2.2 may be used for MOT structures if actual weights are not available.

3103F.2.2 Unit weights. The unit weights in Table 31F-3-1 may be used for both existing and new MOTs.

**TABLE 31F-3-1
UNIT WEIGHTS**

| MATERIAL | UNIT WEIGHT (pcf)* |
|--------------------------------------|--------------------|
| Steel or cast steel | 490 |
| Cast iron | 450 |
| Aluminum alloys | 175 |
| Timber (untreated) | 40 50 |
| Timber (treated) | 45 60 |
| Concrete, reinforced (normal weight) | 145 160 |
| Concrete, reinforced (lightweight) | 90 120 |
| Asphalt paving | 150 |

* pounds per cubic foot

3103F.2.3 Equipment and piping area loads. The equipment and piping area loads in Table 31F-3-2 may be used, as a minimum, in lieu of detailed as-built data.

**TABLE 31F-3-2
EQUIPMENT AND PIPING AREA LOADS**

| LOCATION | AREA LOADS (psf)*** |
|---------------------------------------|---------------------|
| Open areas | 20* |
| Areas containing equipment and piping | 35** |
| Trestle roadway | 20* |

* Allowance for incidental items such as railings, lighting, miscellaneous equipment, etc.

** 35 psf is for miscellaneous general items such as walkways, pipe supports, lighting and instrumentation. Major equipment weight shall be established and added into this weight for piping manifold, valves, deck crane, fire monitor tower, gangway structure and similar major equipment.

*** pounds per square foot

3103F.3 Live loads and buoyancy. The following vertical live loading shall be considered, where appropriate: uniform loading, truck loading, crane loading and buoyancy. Additionally, MOT specific, nonpermanent equipment shall be identified and used in loading computations.

3103F.4 Earthquake loads.

3103F.4.1 General. Earthquake loads are described in terms of Peak Ground Acceleration (PGA), spectral acceleration and earthquake magnitude. The required seismic analysis procedures (Tables 31F-4-2 and 31F-4-3) are dependent on the risk classification obtained from Table 31F-4-1.

3103F.4.2 Design earthquake motion parameters. The earthquake ground motion parameters of peak ground acceleration, spectral acceleration and earthquake magnitude are modified for site amplification and near fault directivity effects. The resulting values are the design peak ground acceleration (DPGA), design spectral acceleration (DSA) and design earthquake magnitude (DEM).

The peak ground and spectral acceleration may be evaluated using:

1. U.S. Geological Survey (USGS) or California Geological Survey [CGS, formerly the California Division of Mines and Geology (CDMG)] maps as discussed in Section 3103F.4.2.2,
2. A site-specific probabilistic seismic hazard analysis (PSHA) as discussed in Section 3103F.4.2.3.
3. For the Ports of Los Angeles, Long Beach and Port Hueneme, PSHA results are provided in Section 3103F.4.2.3.

Unless stated otherwise, the DSA values are for 5 percent damping; values at other levels may be obtained as per Section 3103F.4.2.9.

The appropriate probability levels associated with DPGA and DSA for different seismic performance levels are provided in Table 31F-4-2. Deterministic earthquake motions, which are used only for comparison to the probabilistic results, are addressed in Section 3103F.4.2.7.

The evaluation of Design Earthquake Magnitude (DEM), is discussed in Section 3103F.4.2.8. This parameter is required when acceleration time histories (Section 3103F.4.2.10) are addressed or if liquefaction potential (Section 3106F.3) is being evaluated.

3103F.4.2.1 Site classes. The following site classes, defined in Section 3106F.2, shall be used in developing values of DSA and DPGA:

S_A , S_B , S_C , S_D , S_E and S_F .

For S_F , a site-specific response analysis is required per Section 3103F.4.2.5.

3103F.4.2.2 Earthquake motions from USGS maps. Earthquake ground motion parameters can be obtained from the Maps 29-32 in the National Earthquake Hazard Reduction Program (NEHRP) design map set discussed in subsection 1.6.1 of [3.1], or the USGS web-site: (<http://earthquake.usgs.gov/research/hazmaps/>). These are available as peak ground acceleration and spectral acceleration values at 5 percent damping for 10 and 2 percent probability of exceedance in 50 years, which correspond to Average Return Periods (ARPs) of 475 and 2,475 years, respectively. The spectral acceleration values are available for 0.2, and 1.0 second spectral periods. In obtaining peak ground acceleration and spectral acceleration values from the USGS web site, the site location can be specified in terms of site longitude and latitude or the zip code when appropriate. The

resulting values of peak ground acceleration and spectral acceleration correspond to surface motions for Site Classification approximately corresponding to the boundary of Site Class S_B and S_C .

Once peak ground acceleration and spectral acceleration values are obtained for 10 and 2 percent probability of exceedence in 50 years, the corresponding values for other probability levels may be obtained. A procedure is presented in subsection 1.6 of Chapter 1 of [3.1].

3103F.4.2.3 Earthquake motions from site-specific probabilistic seismic hazard analyses. Peak ground acceleration and spectral acceleration values can be obtained using site-specific probabilistic seismic hazard analysis (PSHA). In this approach, the seismic sources and their characterization used in the analysis shall be based on the published data from the California Geological Survey, which can be obtained online at the following website: (<http://www.conservation.ca.gov/CGS/Pages/Index.aspx>) [3.2].

Appropriate attenuation relationships shall be used to obtain values of peak ground acceleration and spectral acceleration at the ground surface for site conditions corresponding to the boundary of Site Class S_B and S_C , regardless of the actual subsurface conditions at the site. These results shall be compared to those based on the FEMA/USGS maps discussed in Section 3103F.4.2.2. If the two sets of values are significantly different, a justification for using the characterization chosen shall be provided.

Alternatively, peak ground acceleration and spectral accelerations at the ground surface for the subsurface conditions that actually exist at the site may be directly

obtained by using appropriate attenuation relationships in a site-specific PSHA. This approach is not permissible for Site Classes S_E and S_F .

For site-specific PSHA, peak ground acceleration and spectral acceleration values corresponding to the seismic performance level (See Table 31F-4-2) shall be obtained.

For peak ground acceleration, PSHA may be conducted using the "magnitude weighting" procedure in Idriss [3.3]. The actual magnitude weighting values should follow the Southern California Earthquake Center (SCEC) procedures [3.4]. This magnitude weighting procedure incorporates the effects of duration corresponding to various magnitude events in the PSHA results. The resulting peak ground acceleration shall be used only for liquefaction assessment (see Section 3106F.4).

PSHA have been developed for the Ports of Los Angeles and Long Beach [3.5, 3.6] and provide site-specific information for seismic analyses. Table 31F-3-3 provides response spectra, for a 475 year return period earthquake and 5 percent critical damping. Figure 31F-3-1 provides the corresponding spectra for the two ports. Additionally, these references provide spectra for return periods from 72 to 2,500 years.

For the port of Port Hueneme, a PSHA was performed by Lawrence Livermore National Laboratory [3.7] and the results are shown in Table 31F-3-4 and Figure 31F-3-2. These results are provided only for site classification "S_c" and five percent critical damping. To obtain appropriate values for piles and/or the mudline, the simplified procedures of Section 3103F.4.2.4 may be used.

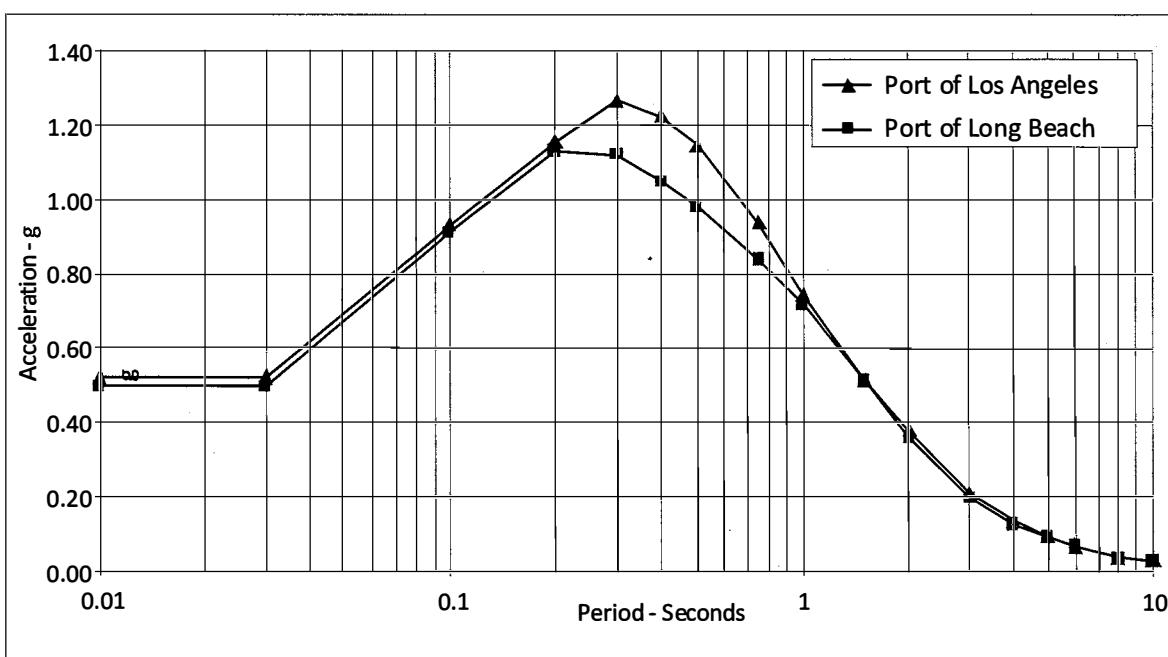


FIGURE 31F-3-1 DESIGN ACCELERATION RESPONSE SPECTRA FOR THE PORTS OF LOS ANGELES AND LONG BEACH, 475 YEAR RETURN PERIOD (5% Critical Damping)

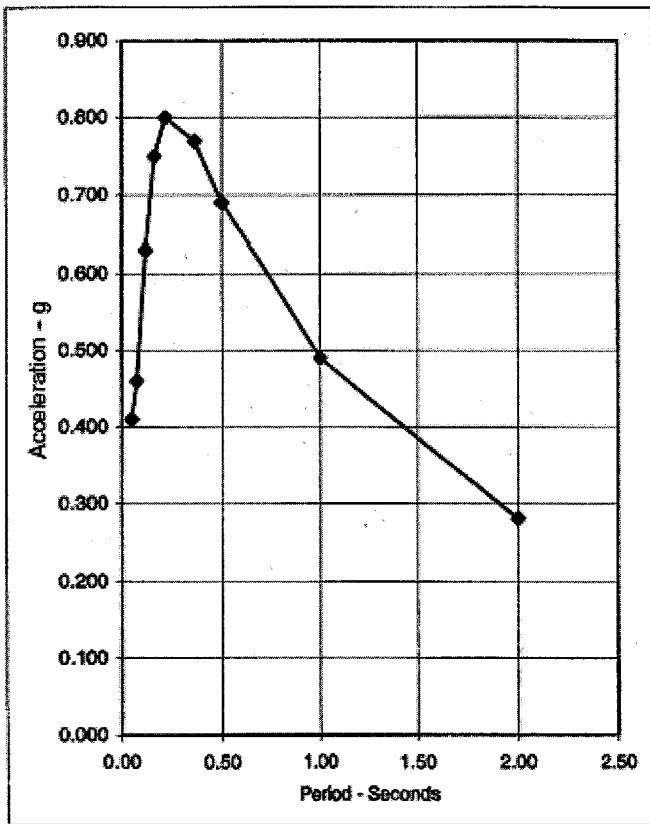


FIGURE 31F-3-2 RESPONSE SPECTRA FOR PORT HUENEME, 475 YEAR RETURN PERIOD (5% Critical Damping)

3103F.4.2.4 Simplified evaluation of site amplification effects. When the MOT Site Class is different from the S_B - S_C boundary, site amplification effects shall be incorporated in peak ground accelerations and spectral accelerations. This may be accomplished using a simplified method or a site-specific evaluation (Section 3103F.4.2.5).

For a given site class, the following procedure [3.1] presents a simplified method that may be used to incorporate the site amplification effects for peak ground acceleration and spectral acceleration computed for the S_B and S_C boundary.

1. Calculate the spectral acceleration values at 0.20 and 1.0 second period:

$$S_{xs} = F_a S_s \quad (3-1)$$

$$S_{xi} = F_v S_i \quad (3-2)$$

where:

F_a = site coefficient obtained from Table 31F-3-5

F_v = site coefficient obtained from Table 31F-3-6

S_s = short period (usually at 0.20 seconds) spectral acceleration value (for the boundary of S_B and S_C) obtained using Section 3103F.4.2.2, or at

the period corresponding to the peak in spectral acceleration values when obtained from Section 3103F.4.2.3

S_1 = spectral acceleration value (for the boundary of S_B and S_C) at 1.0 second period

S_{xs} = spectral acceleration value obtained using the short period S_s and factored by Table 31F-3-5 for the Site Class under consideration.

S_{xi} = spectral acceleration value obtained using the 1.0 second period S_1 and factored by Table 31F-3-6 for the Site Class under consideration.

$$2. Set PGA_x = 0.4S_{xs} \quad (3-3)$$

where:

PGA_x = peak ground acceleration corresponding to the Site Class under consideration.

When the value of PGA_x is less than the peak ground acceleration obtained following Section 3103F.4.2.2 or Section 3103F.4.2.3, an explanation of the results shall be provided.

3. PGA_x , S_{xs} , and S_{xi} constitute three spectral acceleration values for the Site Class under consideration corresponding to periods of 0, S_s (usually 0.2 seconds), and 1.0 second, respectively.

4. The final response spectra, without consideration for near-fault directivity effects, values of S_a for the Site Class under consideration may be obtained using the following equations (for 5 percent critical damping):

for $0 < T < 0.2T_0$

$$S_a = (S_{xs})(0.4 + 3T/T_0) \quad (3-4)$$

where:

T = Period corresponding to calculated S_a

T_0 = Period at which the constant acceleration and constant velocity regions of the design spectrum intersect

for $0.2T_0 < T < T_0$

$$S_a = S_{xs} \quad (3-5)$$

for $T > T_0$

$$S_a = S_{xi}/T \quad (3-6)$$

where:

$$T_0 = S_{xi}/S_{xs} \quad (3-7)$$

The resulting PGA_x is the DPGA. However, the S_a (except for the ports of Los Angeles, Long Beach and Port Hueneme) shall be modified for near-fault directivity effects, per Section 3103F.4.2.6 to obtain the final DSAs.

**TABLE 31F-3-3
DESIGN ACCELERATION RESPONSE SPECTRA FOR THE
PORTS OF LOS ANGELES AND LONG BEACH, 475 YEAR
RETURN PERIOD (5% Critical Damping)**

| Period (sec) | Spectral Acceleration (g's) | |
|---------------------|------------------------------------|---------------------------|
| | Port of Los Angeles | Port of Long Beach |
| 0.01 | 0.520 | 0.500 |
| 0.03 | 0.520 | 0.500 |
| 0.1 | 0.931 | 0.910 |
| 0.2 | 1.154 | 1.132 |
| 0.3 | 1.270 | 1.121 |
| 0.4 | 1.223 | 1.050 |
| 0.5 | 1.148 | 0.980 |
| 0.75 | 0.937 | 0.840 |
| 1.0 | 0.740 | 0.717 |
| 1.5 | 0.510 | 0.510 |
| 2.0 | 0.380 | 0.362 |
| 3.0 | 0.210 | 0.199 |
| 4.0 | 0.135 | 0.128 |
| 5.0 | 0.094 | 0.091 |
| 6.0 | 0.069 | 0.068 |
| 8.0 | 0.041 | 0.041 |
| 10.0 | 0.027 | 0.027 |

**TABLE 31F-3-4
RESPONSE SPECTRA FOR PORT HUENEME,
475 YEAR RETURN PERIOD (5% Critical Damping)**

| SITE CLASS "C" (Shear Wave Velocity from 1200-2500 ft/sec) | | |
|---|-----------------------|------------------------------------|
| Period (sec) | Frequency (Hz) | Spectral Acceleration (g's) |
| 0.03 | 33.33 | 0.41 |
| 0.05 | 20.00 | 0.46 |
| 0.10 | 10.0 | 0.63 |
| 0.15 | 6.67 | 0.75 |
| 0.20 | 5.0 | 0.80 |
| 0.30 | 3.33 | 0.78 |
| 0.50 | 2.00 | 0.69 |
| 1.0 | 1.0 | 0.49 |
| 2.0 | 0.50 | 0.28 |

**TABLE 31F-3-5
VALUES OF F_a**

| SITE CLASS | S_s | | | | |
|-------------------|-------------------------|------------|-------------|------------|------------------|
| | < 0.25 | 0.5 | 0.75 | 1.0 | > 1.25 |
| S_A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| S_B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| S_C | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 |
| S_D | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 |
| S_E | 2.5 | 1.7 | 1.2 | 0.9 | 0.9 |
| S_F | * | * | * | * | * |

Note: Linear interpolation can be used to estimate values of F_a for intermediate values of S_s .

* Site specific dynamic site response analysis shall be performed.

**TABLE 31F-3-6
VALUES OF F_v**

| SITE CLASS | S_1 | | | | |
|-------------------|-------------------------|------------|------------|------------|-----------------|
| | < 0.1 | 0.2 | 0.3 | 0.4 | > 0.5 |
| S_A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| S_B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| S_C | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 |
| S_D | 2.4 | 2.0 | 1.8 | 1.6 | 1.5 |
| S_E | 3.5 | 3.2 | 2.8 | 2.4 | 2.4 |
| S_F | * | * | * | * | * |

Note: Linear interpolation can be used to estimate values of F_v for intermediate values of S_1 .

* Site specific dynamic site response analysis shall be performed.

3103F.4.2.5 Site-specific evaluation of amplification effects. As an alternative to the procedure presented in Section 3103F.4.2.4, a site-specific response analysis may be performed. For S_F , a site specific response analysis is required. The analysis shall be either an equivalent linear or nonlinear analysis. Appropriate acceleration time histories as discussed in Section 3103F.4.2.10 shall be used.

In general, an equivalent linear analysis using, for example, SHAKE91 [3.8] is acceptable when the strength and stiffness of soils are unlikely to change significantly during the seismic shaking, and the level of shaking is not large. A nonlinear analysis should be used when the strength and/or stiffness of soils could significantly change during the seismic shaking or significant nonlinearity of soils is expected because of high seismic shaking levels.

The choice of the method used in site response analysis shall be justified considering the expected stress-strain behavior of soils under the shaking level considered in the analysis.

Site-specific site response analysis may be performed using one-dimensional analysis. However, to the extent that MOTs often involve slopes or earth retaining structures, the one-dimensional analysis should be used judiciously. When one-dimensional analysis cannot be justified or is not adequate, two-dimensional equivalent linear or nonlinear response analysis shall be performed. Site-specific response analysis results shall be compared to those based on the simplified method of Section 3103F.4.2.4 for reasonableness.

For the port areas of Los Angeles, Long Beach and Port Hueneme, the resulting response spectra shall not fall below values obtained in Section 3103F.4.2.3.

The peak ground accelerations obtained from this site-specific evaluation are DPGAs and the spectral accelerations are DSAs as long as the near-fault directivity effects addressed in Section 3103F.4.2.6 are appropriately incorporated into the time histories (Section 3103F.4.2.10).

3103F.4.2.6 Directivity effects. When the site is 15 km (9.3 miles) or closer to a seismic source that can significantly affect the site, near-fault directivity effects shall be reflected in the spectral acceleration values and in the

deterministic spectral acceleration values of Section 3103F.4.2.7. However, Tables 31F-3-3 and 31F-3-4 for the port areas of Los Angeles, Long Beach and Port Hueneme already have these effects included.

Two methods are available for incorporating directivity effects.

1. Directivity effects may be reflected in the spectral acceleration values in a deterministic manner by using, for example, the equation on pg. 213 (and Tables 6 and 7) of Somerville, et al. [39]. The critical seismic sources and their characterization developed as part of the deterministic ground motion parameters (Section 3103F.4.2.7) should be used to evaluate the directivity effects. The resulting adjustments in spectral acceleration values may be applied in the probabilistic spectral acceleration values developed per Section 3103F.4.2.4 or 3103F.4.2.5. Such adjustment can be independent of the probability levels of spectral accelerations.
2. Directivity effects may be incorporated in the results of site specific PSHA per Section 3103F.4.2.3. In this case, the directivity effects will also depend on the probability level of spectral accelerations.

If spectral accelerations are obtained in this manner, the effects of site amplification using either Section 3103F.4.2.4, 3103F.4.2.5 or an equivalent method (if justified) shall be incorporated.

3103F.4.2.7 Deterministic earthquake motions. Deterministic ground motions from "scenario" earthquakes may be used for comparison purposes. Deterministic peak ground accelerations and spectral accelerations may be obtained using the "Critical Seismic Source" with maximum earthquake magnitude and its closest appropriate distance to the MOT. "Critical Seismic Source" is that which results in the largest computed median peak ground acceleration and spectral acceleration values when appropriate attenuation relationships are used. The values obtained from multiple attenuation relationships should be used to calculate the median peak ground acceleration and spectral acceleration values.

For comparison, the values of peak ground accelerations and spectral accelerations may be obtained from the USGS maps [3.1], corresponding to the Maximum Considered Earthquake (MCE). In this case, the median values of peak ground acceleration and spectral acceleration values shall be 213 (see Subsection 1.6 of [3.1]) of the values shown on the USGS maps.

3103F.4.2.8 Design earthquake magnitude. The design earthquake magnitude used in developing site-specific acceleration time histories (Section 3103F.4.2.10) or liquefaction assessment (Section 3106F.3) is obtained using either of the following two methods.

1. The design earthquake may be selected as the largest earthquake magnitude associated with the critical seismic source. The distance shall be taken as the closest distance from the source to the site. The resulting design earthquake shall be associated

with all DPGA values for the site, irrespective of probability levels.

2. The design earthquake (DEQ) may be obtained for each DPGA or DSA value and associated probability level by determining the corresponding dominant distance and magnitude. These are the values of the distance and magnitude that contribute the most to the mean seismic hazards estimates for the probability of interest. They are usually determined by locating the summits of the 3-D surface of contribution of each small interval of magnitude and distance to the total mean hazards estimate. If this 3-D surface shows several modes with approximate weight of more than 20 percent of the total, several DEQs may be considered, and the DEQ leading to the most conservative design parameters shall be used.

3103F.4.2.9 Design spectral acceleration for various damping values. Design spectral acceleration (DSA) values at damping other than 5 percent shall be obtained by using a procedure given in [3.1], and is denoted as DSA_d . The following procedure does not include near-fault directivity effects.

For $0 < T < 0.2 T_0$

$$DSA_d = S_{XS} [(5/B_s - 2)T/T_0 + 0.4] \quad (3-8)$$

For $0.2 T_0 < T < T_0$

$$DSA_d = DSA/B_s \quad (3-9)$$

For $T > T_0$

$$DSA_d = S_1/(B_1 T) \quad (3-10)$$

where:

T = period

$T_0 = S_{XI}/S_{XS}$

B_s = Coefficient used to adjust the short period spectral response, for the effect of viscous damping.

B_1 = Coefficient used to adjust one-second period spectral response, for the effect of viscous damping

Values of B_s and B_1 are obtained from Table 31F-3-7.

Such a procedure shall incorporate the near-fault directivity effects when the MOT is 15 km (9.3 miles) or closer to a significant seismic source.

TABLE 31F-3-7 [3.1]
VALUES OF B_s AND B_1

| DAMPING (%) | B_s | B_1 |
|-------------|-------|-------|
| < 2 | 0.8 | 0.8 |
| 5 | 1.0 | 1.0 |
| 10 | 1.3 | 1.2 |
| 20 | 1.8 | 1.5 |
| 30 | 2.3 | 1.7 |
| 40 | 2.7 | 1.9 |
| > 50 | 3.0 | 2.0 |

Note: Linear interpolation should be used for damping values not specifically listed.

3103F.4.2.10 Development of acceleration time histories. When acceleration time histories are utilized, target spectral acceleration values shall be initially selected corresponding to the DSA values at appropriate probability levels. For each set of target spectral acceleration values corresponding to one probability level, at least three sets of horizontal time histories (one or two horizontal acceleration time histories per set) shall be developed.

Initial time histories shall consider magnitude, distance and the type of fault that are reasonably similar to those associated with the conditions contributing most to the probabilistic DSA values. Preferred initial time histories should have their earthquake magnitude and distance to the seismic source similar to the mode-magnitude and mode-distance derived from the PSHA or from appropriate maps. When an adequate number of recorded time histories are not available, acceleration time histories from simulations may be used as supplements.

Scaling or adjustments, either in the frequency domain or in the time domain (preferably), prior to generating acceleration time histories should be kept to a minimum. When the target spectral accelerations include near-fault directivity effects (Section 3103F.4.2.6), the initial time histories should exhibit directivity effects.

When three sets of time histories are used in the analysis, the envelope of the spectral acceleration values from each time history shall be equal to or higher than the target spectral accelerations. If the envelope values fall below the target values, adjustments shall be made to ensure that the spectral acceleration envelope is higher than target spectral accelerations. If the envelope is not higher, then a justification shall be provided.

When seven or more sets of time histories are used, the average of the spectral acceleration values from the set of time histories shall be equal or higher than the target spectral acceleration values. If the average values fall below the target values, adjustments shall be made to ensure that average values are higher than the target spectral accelerations. If this is not the case, then an explanation for the use of these particular spectral acceleration values shall be provided.

When three sets of time histories are used in the analysis, the maximum value of each response parameter shall be used in the design, evaluation and rehabilitation. When seven or more sets of time histories are used in the analysis, the average value of each response parameter may be used.

3103F.5 Mooring loads on vessels.

3103F.5.1 General. Forces acting on a moored vessel may be generated by wind, waves, current, tidal variations, tsunamis, seiches and hydrodynamic effects of passing vessels. Forces from wind and current acting directly on the MOT structure (not through the vessel in the form of mooring and/or breasting loads) shall be determined in Section 3103F.7.

The vessel's moorings shall be strong enough to hold during all expected conditions of surge, current and weather

and long enough to allow adjustment for changes in draft, drift and tide (2 CCR 2340 (c) (1)) [3.10].

3103F.5.2 Wind loads. Wind loads on a vessel, moored at a MOT, shall be determined using procedures described in this section. Wind loads shall be calculated for each of the load cases identified in Section 3105F.2.

3103F.5.2.1 Design wind speed. The design wind speed is the maximum wind speed of 30-second duration used in the mooring analysis (see Section 3105F).

3103F.5.2.1.1 Operating condition. The operating condition is the wind envelope in which a vessel may conduct transfer operations. It is determined from the mooring analysis (Section 3105F). Transfer operations shall cease, at an existing MOT, when the wind exceeds the maximum velocity of the envelope.

3103F.5.2.1.2 Survival condition. The survival condition is defined as the state wherein a vessel can remain safely moored at the berth during severe winds. For new MOTs, the survival condition threshold is the maximum wind velocity, for a 30-second gust and a 25-year return period, obtained from historical data.

For an existing MOT, a reduced survival condition threshold is acceptable (see Figure 31F-2-1). If the wind rises above these levels, the vessel must depart the berth; it shall be able to depart within 30 minutes (see 2 CCR 2340 (c) (28)) [3.10].

The 30-second duration wind speed shall be determined from the annual maximum wind data. Average annual summaries cannot be used. Maximum wind speed data for eight directions (45-degree increments) shall be obtained. If other duration wind data is available, it shall be adjusted to a 30-second duration, in accordance with Equation (3.12). The 25-year return period shall be used to establish the design wind speed for each direction. In order to simplify the analysis for barges (or other small vessels), they may be considered to be solid free-standing walls (Chapter 6 of ASCE 7 [3.11]). This will eliminate the need to perform a computer assisted mooring analysis.

3103F.5.2.2 Wind speed corrections. Wind speed measured at an elevation of 33 feet (10 meters) above the water surface, with duration of 30 seconds shall be used to determine the design wind speed. If these conditions are not met, the following corrections shall be applied.

The correction for elevation is obtained from the equation:

$$V_w = V_h \left(\frac{33}{h} \right)^{1/7} \quad (3-11)$$

where:

V_w = wind speed at elevation 33 ft. (10 m.)

V_h = wind speed at elevation h

h = elevation above water surface of wind data [feet]

The available wind duration shall be adjusted to a 30-second value, using the following formula:

$$V_{t=30\text{ sec}} = \frac{V_t}{c_t} \quad (3-12)$$

where:

$V_{t=30\text{ sec}}$ = wind speed for a 30-second duration

V_t = wind speed over a given duration

c_t = conversion factor from Figure 31F-3-3

If wind data is available over land only, the following equation shall be used to convert the wind speed from over-land to over-water conditions [3.10]:

$$V_w = 1.10 V_L \quad (3-13)$$

where:

V_w = over water wind speed

V_L = over land wind speed

3103F.5.2.3 Static wind loads on vessels. The "Mooring Equipment Guidelines (MEG3)" [3.13] or the "British Standard Code of Practice for Maritime Structures" [3.14] shall be used to determine the wind loads for all tank vessels.

Alternatively, wind loads for any type of vessel may be calculated using the guidelines in Ferritto et al, 1999 [3.15].

3103F.5.3 Current loads. Environmental loads induced by currents at MOTs shall be calculated as specified in this subsection.

3103F.5.3.1 Design current velocity. Maximum ebb and flood currents, annual river runoffs and controlled releases shall be considered when establishing the design current velocities for both existing and new MOTs.

Local current velocities may be obtained from NOAA [3.16] or other sources, but must be supplemented by site-specific data, if the current velocity is higher than 1.5 knots.

Site-specific data shall be obtained by real time measurements over a one-year period. If this information is not available, a safety factor of 1.25 shall be applied to the best available data until real time measurements are obtained.

If the facility is not in operation during annual river runoffs and controlled releases, the current loads may be adjusted.

Operational dates need to be clearly stated in the definition of the terminal operating limits (see Section 3102F.3.6).

3103F.5.3.2 Current velocity adjustment factors. An average current velocity (V_c) shall be used to compute forces and moments. If the current velocity profile is

known, the average current velocity can be obtained from the following equation:

$$V_c^2 = \frac{1}{T} \int_0^T (v_c)^2 ds \quad (3-14)$$

where:

V_c = average current velocity (knots)

T = draft of vessel

v_c = current velocity as a function of depth (knots)

s = water depth measured from the surface

If the velocity profile is not known, the velocity at a known water depth should be adjusted by the factors provided in Figure 31F-3-4 to obtain the equivalent average velocity over the draft of the vessel.

3103F.5.3.3 Static current loads. The OCIMF [3.13], the British Standard [3.14] or the UFC 4-159-03 [3.17] procedures shall be used to determine current loads for moored tank vessels.

3103F.5.3.4 Sea level rise (SLR). All MOTs shall consider the predicted SLR over the remaining life of the terminal, due to subsidence or climate change combined with maximum high tide and storm surge. Consideration shall include but not be limited to variation in fender locations, additional berthing loads (deeper draft vessels) and any components near the splash zone.

3103F.5.4 Wave loads. When the significant wave period, T_s , is greater than 4 seconds (See Section 3105F.3.1), the transverse wave induced vessel reactions shall be calculated using a simplified dynamic mooring analysis described below.

The horizontal water particle accelerations shall be calculated for the various wave conditions, taken at the mid-depth of the loaded vessel draft. The water particle accelerations shall then be used to calculate the wave excitation forces to determine the static displacement of the vessel. The Froude-Krylov method discussed in Chakrabarti's Chapter 7 [3.18] may be used to calculate the wave excitation forces, by conservatively approximating the vessel as a rectangular box with dimensions similar to the actual dimensions of the vessel. The horizontal water particle accelerations shall be calculated for the various wave conditions, taken at the mid-depth of the loaded vessel draft. The computed excitation force assumes a 90-degree incidence angle with the longitudinal axis of the vessel, which will result in forces that are significantly greater than the forces that will actually act upon the vessel from quartering seas. A load reduction factor may be used to account for the design wave incidence angle from the longitudinal axis of the ship. The overall excursion of the vessel shall be determined for each of the wave conditions by calculating the dynamic response of the linear spring mass system.

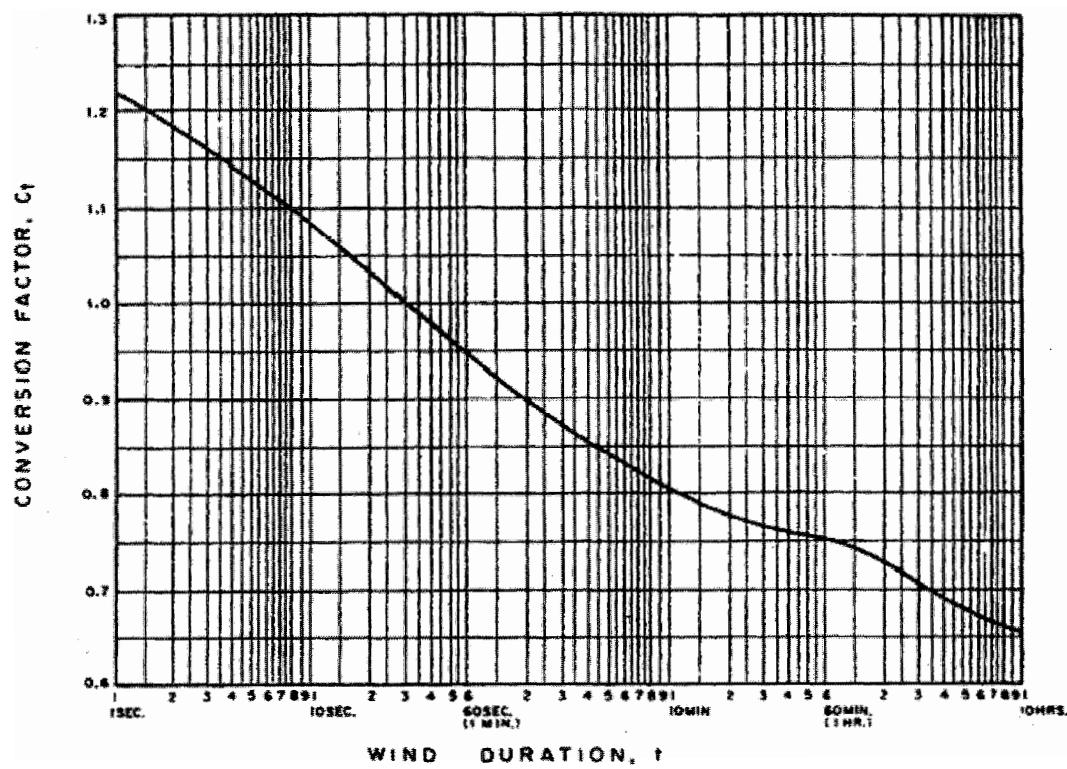


FIGURE 31F-3-3 WIND SPEED CONVERSION FACTOR [3.12]

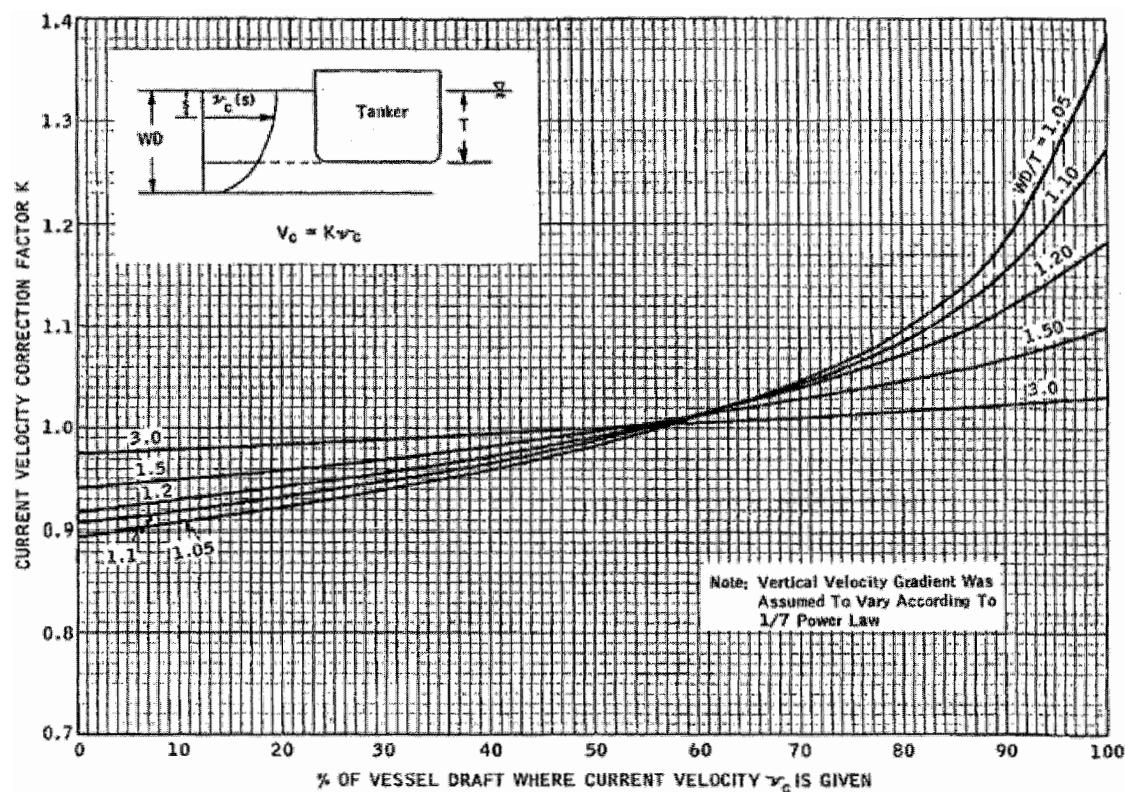


FIGURE 31F-3-4 CURRENT VELOCITY CORRECTION FACTOR (p. 23, OCIMF, 1997 [3.13])

3103F.5.5 Passing vessels. When required in Section 3105F.3, the sway and surge forces, as well as yaw moment, on a moored vessel, due to passing vessels, shall be established considering the following:

1. Ratio of length of moored vessel to length of passing vessel.
2. Distance from moored vessel to passing vessel.
3. Ratio of midship section areas of the moored and passing vessels.
4. Underkeel clearances of the moored and passing vessels.
5. Draft and trim of the moored vessel and draft of the passing vessel.
6. Mooring line tensions.

The passing vessel's speed should take into consideration the ebb or flood current. Normal operating wind and current conditions can be assumed when calculating forces due to a passing vessel. Either method of Kriebel [3.19] or Wang [3.20] may be used to determine forces on a moored vessel. Kriebel's recent wave tank study improves on an earlier work of Seelig [3.21].

3103F.5.6 Seiche. The penetration of long period low amplitude waves into a harbor can result in resonant standing wave systems, when the wave forcing frequency coincides with a natural frequency of the harbor. The resonant standing waves can result in large surge motions if this frequency is close to the natural frequency of the mooring system. Section 3105F.3.3 prescribes the procedure for the evaluation of these effects.

3103F.5.7 Tsunamis. A tsunami may be generated by an earthquake or a subsea or coastal landslide, which may induce large wave heights and excessive currents. The large wave or surge and the excessive currents are potentially damaging, especially if there is a tank vessel moored alongside the MOT wharf.

Tsunamis can be generated either by a distant or near source. A tsunami generated by a distant source (far field event) may allow operators to have an adequate warning for mitigating the risk by depart the MOT and go into deep water. For near-field events, with sources less than 500 miles away, the vessel may not have adequate time to depart. Each MOT shall have a "tsunami plan" describing what actions will be performed, in the event of a distant tsunami.

Recent tsunami studies have been completed for both Southern and Northern California. For the Ports of Los Angeles and Long Beach, one of those recent studies focused on near field tsunamis with predicted return periods of 5,000 to 10,000 years [3.22]. These maximum water levels (run-up) would not normally be used for MOT design. However, because the study also provides actual tidal records from recent distant tsunamis, it should be used for design.

The run-up value for Port Hueneme was obtained from an earlier study by Synolakis et al. [3.23].

Run up-values: Port of Los Angeles and Long Beach = 8 ft.
Port Hueneme = 11 ft.

For the San Francisco Bay, a recent study provides the maximum credible tsunami water levels and current speeds. These results are deterministic and are based on the most severe seismic sources that could reasonably impact MOTs in the San Francisco Bay [3.24]. Table 31F-3-8 provides values for the marine oil terminal locations within San Francisco Bay. Water levels could be positive or negative and current velocities may vary in direction. In order to determine the maximum run-up at a MOT, the largest values should be added to the mean high tide. Further details are available in [3.24].

Loads from tsunami-induced waves can be calculated for various structural configurations [3.25]. Tsunami wave heights in shallow water and particle kinematics can also be obtained. Other structural considerations include uplift and debris impact.

TABLE 31F-3-8
TSUNAMI RUN-UP VALUES (ft) AND CURRENT SPEEDS (ft/sec)
IN THE SAN FRANCISCO BAY AREA [AFTER 3.24]

| S.F. Bay Locale | Maximum Water Levels (ft.) | Current Velocity (ft/sec) |
|-----------------|----------------------------|---------------------------|
| Richmond, outer | 7.5 | 4.9 |
| Richmond, inner | 7.9 | 8.9 |
| Martinez | 2.3 | 1.3 |
| Selby | 2.6 | 1.6 |
| Rodeo | 2.6 | 2.0 |
| Benicia | 2.0 | 1.0 |

3103F.6 Berthing Loads.

3103F.6.1 General. Berthing loads are quantified in terms of transfer of kinetic energy of the vessel into potential energy dissipated by the fender(s). The terms and equations below are based on those in UFC 4-152-01, "Piers and Wharves" [3.26] and PIANC [3.27].

Kinetic energy shall be calculated from the following equation:

$$E_{vessel} = \frac{1}{2} \cdot \frac{W}{g} \cdot V_n^2 \quad (3-15)$$

where:

E_{vessel} = Berthing energy of vessel [ft-lbs]

W = Total weight of vessel and cargo in pounds [long tons $\times 2240$]

g = Acceleration due to gravity [32.2 ft/sec²]

V_n = Berthing velocity normal to the berth [ft/sec]

The following correction factors shall be used to modify the actual energy to be absorbed by the fender system for berthing operations:

$$E_{\text{fender}} = F_A \cdot C_b \cdot C_m \cdot E_{\text{vessel}} \quad (3-16)$$

where:

E_{fender} = Energy to be absorbed by the fender system

F_A = Accidental factor accounting for abnormal conditions such as human error, malfunction, adverse environmental conditions or a combination of these factors. For existing berthing systems, F_A may be taken as 1.0. For new berthing systems, F_A shall be determined in accordance with UFC Section 4-152-01 [3.26] or PIANC Section 4.2.8 [3.27].

C_b = Berthing Coefficient

C_m = Effective mass or virtual mass coefficient (see Section 3103F.6.6)

The berthing coefficient, C_b , is given by:

$$C_b = C_e \cdot C_g \cdot C_d \cdot C_c \quad (3-17)$$

where:

C_e = Eccentricity Coefficient

C_c = Configuration Coefficient

C_g = Geometric Coefficient

C_d = Deformation Coefficient

These coefficients are defined in Sections 3103F.6.2 through 3103F.6.5.

The approximate displacement of the vessel (when only partially loaded) at impact, DT , can be determined from an extension of an equation from Gaythwaite [3.28]:

$$DT = 1.25 DWT(d_{\text{actual}}/d_{\max}) \quad (3-18)$$

where:

DWT = Dead Weight Tonnage (in long tons)

d_{actual} = Actual arrival draft of the vessel

d_{\max} = Maximum loaded vessel draft

The berthing load shall be based on the fender reaction due to the kinetic berthing energy. The structural capacity shall be established based on allowable concrete, steel or timber properties in the structural components, as defined in Section 3107F.

3103F.6.2 Eccentricity coefficient (C_e). During the berthing maneuver, when the vessel is not parallel to the berthing line (usually the wharf face), not all the kinetic energy of the vessel will be transmitted to the fenders. Due to the reaction from the fender(s), the vessel will start to rotate around the contact point, thus dissipating part of its energy. Treating the vessel as a rigid rod of negligible width in the analysis of the energy impact on the fenders leads to the equation:

$$C_e = \frac{k^2}{a^2 + k^2} \quad (3-19)$$

where:

k = Longitudinal radius of gyration of the vessel [ft]

a = Distance between the vessel's center of gravity and the point of contact on the vessel's side, projected onto the vessel's longitudinal axis [ft]

3103F.6.3 Geometric coefficient (C_g): The geometric coefficient, C_g , depends upon the geometric configuration of the ship at the point of impact. It varies from 0.85 for an increasing convex curvature to 1.25 for concave curvature. Generally, 0.95 is recommended for the impact point at or beyond the quarter points of the ship, and 1.0 for broadside berthing in which contact is made along the straight side [3.26].

3103F.6.4 Deformation coefficient (C_d): This accounts for the energy reduction effects due to local deformation of the ship's hull and deflection of the whole ship along its longitudinal axis. The energy absorbed by the ship depends on the relative stiffness of the ship and the obstruction. The deformation coefficient varies from 0.9 for a nonresilient fender to nearly 1.0 for a flexible fender. For larger ships on energy-absorbing fender systems, little or no deformation of the ship takes place; therefore, a coefficient of 1.0 is recommended.

3103F.6.5 Configuration coefficient (C_c): This factor accounts for the difference between an open pier or wharf and a solid pier or wharf. In the first case, the movements of the water surrounding the berthing vessel is not (or is hardly) affected by the berth. In the second case, the water between the berthing vessel and the structure introduces a cushion effect that represents an extra force on the vessel away from the berth and reduces the energy to be absorbed by the fender system.

For open berths and corners of solid piers, $C_c = 1.0$

For solid piers with parallel approach, $C_c = 0.8$

For berths with different conditions, C_c may be interpolated between these values [3.26].

3103F.6.6 Effective mass or virtual mass coefficient (C_m): In determining the kinetic energy of a berthing vessel, the effective or the virtual mass is the sum of vessel mass and hydrodynamic mass. The hydrodynamic mass does not necessarily vary with the mass of the vessel, but is closely related to the projected area of the vessel at right angles to the direction of motion.

Other factors, such as the form of vessel, water depth, berthing velocity, and acceleration or deceleration of the vessel, will have some effect on the hydrodynamic mass. Taking into account both model and prototype experiments, the effective or virtual mass coefficient can be estimated as:

$$C_m = 1 + 2 \cdot \frac{d_{\text{actual}}}{B} \quad (3-20)$$

where:

d_{actual} = Actual arrival draft of the vessel

B = Beam of vessel

The value of C_m for use in design should be a minimum of 1.5 and need not exceed 2.0 [3.26].

3103F.6.7 Berthing velocity and angle. The berthing velocity, V_n , is influenced by a large number of factors such as environmental conditions of the site (wind, current and wave), method of berthing (with or without tugboat assistance), condition of the vessel during berthing (ballast or fully laden) and human factors (experience of the tugboat captain).

The berthing velocity, normal to berth, shall be in accordance with Table 31F-3-9. Site condition is determined from Table 31F-3-10.

Subject to Division approval, if an existing MOT can demonstrate lower velocities by utilizing velocity monitoring equipment, then such a velocity may be used temporarily until the berthing system is compliant with this Code.

In order to obtain the normal berthing velocity, V_n , an approach angle, defined as the angle formed by the fender line and the longitudinal axis of the vessel must be determined. The berthing angles, used to compute the normal berthing velocity, for various vessel sizes are shown in Table 31F-3-11.

**TABLE 31F-3-11
BERTHING ANGLE**

| VESSEL SIZE (DWT) | ANGLE [degrees] |
|-------------------|-----------------|
| Barge | 15 |
| < 10,000 | 10 |
| 10,000 50,000 | 8 |
| > 50,000 | 6 |

3103F.7 Wind and current loads on structures.

3103F.7.1 General. This section provides methods to determine the wind and current loads acting on the structure directly, as opposed to wind and current forces acting on the structure from a moored vessel.

**TABLE 31F-3-9
BERTHING VELOCITY V_n (NORMAL TO BERTH)¹**

| VESSEL SIZE (DWT) | TUG BOAT ASSISTANCE | SITE CONDITIONS | | |
|-------------------|---------------------|-----------------|-------------|-------------|
| | | Unfavorable | Moderate | Favorable |
| ≤ 10,000 | No | 1.31 ft/sec | 0.98 ft/sec | 0.53 ft/sec |
| ≤ 10,000 | Yes | 0.78 ft/sec | 0.66 ft/sec | 0.33 ft/sec |
| 50,000 | Yes | 0.53 ft/sec | 0.39 ft/sec | 0.26 ft/sec |
| ≥ 100,000 | Yes | 0.39 ft/sec | 0.33 ft/sec | 0.26 ft/sec |

1. For vessel sizes not shown, interpolation between velocities may be used.

**TABLE 31F-3-10
SITE CONDITIONS**

| SITE CONDITIONS | DESCRIPTION | WIND SPEED ¹ | SIGNIFICANT WAVE HEIGHT | CURRENT SPEED ² |
|-----------------|---|-------------------------|-------------------------|----------------------------|
| Unfavorable | Strong Wind Strong Currents High Waves | > 38 knots | > 6.5 ft | > 2 knots |
| Moderate | Strong Wind Moderate Current Moderate Waves | ≥ 38 knots | ≤ 6.5 ft | ≤ 2 knots |
| Favorable | Moderate Wind Moderate Current Moderate Waves | < 38 knots | < 6.5 ft | < 2 knots |

1. A 30 second duration measured at a height of 33 ft.

2. Taken at 0.5 x water depth

3103F.7.2 Wind loads. Chapter 6 of ASCE 7[3.11] shall be used to establish minimum wind loads on the structure. Additional information about wind loads may be obtained from Simiu and Scanlan [3.29].

3103F.7.3 Current loads. The current forces acting on the structure may be established using the current velocities, per Section 3103F.5.3.

3103F.8 Load combinations. As a minimum, each component of the structure shall be analyzed for all applicable load combinations given in Table 31F-3-12 or 31F-3-13, depending on component type. For additional load combinations see "Piers and Wharves," DOD UFC 4-152-01 [3.26].

The "vacant condition" is the case wherein there is no vessel at the berth. The "mooring and breasting condition" exists after the vessel is securely tied to the wharf. The "berthing condition" occurs as the vessel impacts the wharf, and the "earthquake condition" assumes no vessel is at the berth, and there is no wind or current forces on the structure.

The use of various load types is discussed below:

3103F.8.1 Dead load (D). Upper and lower bound values of dead load are applied for the vacant condition to check the maximum moment and shear with minimum axial load.

3103F.8.2 Live load (L). The live load on MOT's is typically small and is therefore neglected for combinations including earthquake loads.

3103F.8.3 Buoyancy load (B). Buoyancy forces shall be considered for any submerged or immersed substructures (including pipelines, sumps and structural components).

3103F.8.4 Wind (W) and current (C) on the structure. Wind and currents on the vessel are included in the mooring and

TABLE 31F-3-12
LRFD LOAD FACTORS FOR LOAD COMBINATIONS [3.26]

| LOAD TYPE | VACANT CONDITION | MOORING & BREASTING CONDITION | BERTHING CONDITION | EARTHQUAKE CONDITION ³ | |
|-------------------------------------|------------------|-------------------------------|--------------------|-----------------------------------|-----------------------|
| Dead Load (D) | 1.2 | 0.9 | 1.2 | 1.2 | $1.2 + k^1$ $0.9 k^1$ |
| Live Load (L) | 1.6 | | 1.6 ² | 1.0 | 1.0 |
| Buoyancy (B) | 1.2 | 0.9 | 1.2 | 1.2 | 1.2^1 0.9^1 |
| Wind on Structure (W) | 1.6 | 1.6 | 1.6 | 1.6 | — |
| Current on Structure (C) | 1.2 | 0.9 | 1.2 | 1.2 | 1.2 0.9 |
| Earth Pressure on the Structure (H) | 1.6 | 1.6 | 1.6 | 1.6 | 1.6^4 1.6^4 |
| Mooring/Breasting Load (M) | — | | 1.6 | — | — |
| Berthing Load (B_e) | | | — | 1.6 | |
| Earthquake Load (E) | — | | | 1.0 | 1.0 |

1. $k = 0.50$ (PGA) The k factor ($k=0.5(PGA)$) and buoyancy (B) shall be applied to the vertical dead load (D) only and not to the inertial mass of the structure.
2. The load factor for live load (L) may be reduced to 1.3 for the maximum outrigger float load from a truck crane.
3. For Level 1 and 2 earthquake conditions with strain levels defined in Division 7, the current on structure (C) may not be required.
4. An earth pressure on the structure factor (H) of 1.0 may be used for pile or bulkhead structures.

TABLE 31F-3-13
SERVICE OR ASD LOAD FACTORS FOR LOAD COMBINATIONS [3.26]

| LOAD TYPE | VACANT CONDITION | MOORING & BREASTING CONDITION | BERTHING CONDITION | EARTHQUAKE CONDITION | |
|-------------------------------------|------------------|-------------------------------|--------------------|----------------------|--------------|
| Dead Load (D) | 1.0 | 1.0 | 1.0 | $1 + 0.7k^1$ | $1 - 0.7k^1$ |
| Live Load (L) | 1.0 | 1.0 | 0.75 | | |
| Buoyancy (B) | 1.0 | 1.0 | 1.0 | 1.0 | 0.6 |
| Wind on Structure (W) | 1.0 | 1.0 | 0.75 | | |
| Current on Structure (C) | 1.0 | 1.0 | 1.0 | — | |
| Earth Pressure on the structure (H) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Mooring/Breasting Load (M) | | 1.0 | | | |
| Berthing Load (B_e) | | | 1.0 | | |
| Earthquake Load (E) | | — | — | 0.7 | 0.7 |
| % Allowable Stress | 100 | 100 | 100 | 100 | 100^2 |

1. $k = 0.5$ (PGA)
2. Increase in allowable stress shall not be used with these load combinations unless it can be demonstrated that such increase is justified by structural behavior caused by rate or duration of load. See ASCE 7 [3.11]

breasting condition. The wind and current loads acting on the structure are therefore additional loads that can act simultaneously with the mooring, breasting and/or berthing loads.

3103F.8.5 Earth pressure on the structure (H). The soil pressure on end walls, typically concrete cut-off walls, steel sheet pile walls on wharf type structures and/or piles shall be considered.

3103F.8.6 Mooring line/breasting loads (M). Mooring line and breasting loads can occur simultaneously or individually, depending on the combination of wind and current. Multiple load cases for operating and survival conditions may be required (see Sections 3103F.5.2 and 3105F.2). In addition, loads caused by passing vessels shall be considered for the "mooring and breasting condition." Refer to Sections 3105F.2 and 3105F.3 for the determination of mooring line and breasting loads.

3103F.8.7 Berthing load (B_e). Berthing is a frequent occurrence, and shall be considered as a normal operating load. No increase in allowable stresses shall be applied for ASD.

3103F.8.8 Earthquake loads (E). Performance based seismic analysis methodology requires that the actual displacement demand be limited to defined strains in concrete, steel and timber. For the deck and pile evaluation, two cases of dead load (upper and lower bound) shall be considered in combination with the seismic load.

3103F.9 Safety factors for mooring lines. Safety factors for different material types of mooring lines are given in Table 31F-3-14. The safety factors should be applied to the minimum number of lines specified by the mooring analysis, using the highest loads calculated for the environmental conditions. The minimum breaking load (MBL) of new ropes is obtained from the certificate issued by the manufacturer. If nylon tails are used in combination with steel wire ropes, the safety factor shall be based on the weaker of the two ropes.

3103F.10 Mooring hardware (N/E). Mooring hardware shall include but not be limited to bollards, quick release hooks, other mooring fittings and base bolts. All mooring fittings shall be clearly marked with their safe working loads [3.13] (N). The certificate issued by the manufacturer normally defines the safe working loads of this hardware.

**TABLE 31F-3-14
SAFETY FACTORS FOR ROPES***

| | |
|-----------------|------|
| Steel Wire Rope | 1.82 |
| Nylon | 2.2 |
| Synthetic | 2.0 |
| Polyester Tail | 2.3 |
| Nylon Tail | 2.5 |

*From Mooring Equipment Guidelines', OCIMF[3.30]

3103F.10.1 Quick release hooks. For new MOTs or berthing systems, a minimum of three quick-release hooks are required for each breasting line location for tankers greater than or equal to 50,000 DWT. At least two hooks at each location shall be provided for breasting lines for tankers less than 50,000 DWT. Remote release may be considered for emergency situations.

All hooks and supporting structures shall withstand the minimum breaking load (MBL) of the strongest line with a safety factor of 1.2 or greater. Only one mooring line shall be placed on each quick release hook (N/E).

For multiple quick release hooks, the minimum horizontal load for the design of the tie-down shall be:

$$F_d = 1.2 \times MBL \times [1 + 0.75(n-1)] \quad (3-21)$$

F_d = Minimum factored demand for assembly tie-down.

n = Number of hooks on the assembly.

The capacity of the supporting structures must be larger than F_d (See Section 3107F.5.3).

3103F.10.2 Other fittings. Other fittings include cleats, bitts and bollards.

If the allowable working loads for existing fittings are not available, the values listed in Table 31F-3-15 may be used for typical sizes, bolt patterns and layout. The allowable working loads are defined for mooring line angles up to 60 degrees from the horizontal. The combination of vertical and horizontal loads must be considered.

**TABLE 31F-3-15
ALLOWABLE WORKING LOADS**

| TYPE OF FITTINGS | NO. OF BOLTS | BOLT SIZE (in) | WORKING LOAD (kips) |
|-------------------------|--------------|-------------------------------|---------------------|
| 30 in. Cleat | 4 | 1 ¹ / ₈ | 20 |
| 42 in. Cleat | 6 | 1 ¹ / ₈ | 40 |
| Low Bitt | 10 | 1 ⁵ / ₈ | 60 per column |
| High Bitt | 10 | 1 ³ / ₄ | 75 per column |
| 44 1/2 in. Fit. Bollard | 4 | 1 ³ / ₄ | 70 |
| 44 1/2 in. Fit. Bollard | 8 | 2 ¹ / ₄ | 200 |
| 48 in. Fit. Bollard | 12 | 2 ³ / ₄ | 450 |

Note: This table is modified from Table 6 11, UFC 4 159 03 [3.17]

3103F.10.3 Base bolts. Base bolts are subjected to both shear and uplift. Forces on bolts shall be determined using the following factors:

1. Height of load application on bitts or bollards.

2. Actual vertical angles of mooring lines for the highest and lowest tide and vessel draft conditions, for all sizes of vessels at each particular berth.
3. Actual horizontal angles from the mooring line configurations, for all vessel sizes and positions at each particular berth.
4. Simultaneous loads from more than one vessel.

For existing MOTs, the deteriorated condition of the base bolts and supporting members shall be considered in determining the capacity of the fitting.

3103F.11 Miscellaneous loads. Handrails and guardrails shall be designed for 25 plf with a 200-pound minimum concentrated load in any location or direction.

3103F.12 Symbols.

- a = Distance between the vessel's center of gravity and the point of contact on the vessel's side, projected onto the vessel's longitudinal axis [ft]
- B = Beam of vessel
- B_1 = Coefficient used to adjust one-second period spectral response, for the effect of viscous damping
- B_s = Coefficient used to adjust the short period spectral response, for the effect of viscous damping.
- C_b = Berthing Coefficient
- C_c = Configuration Coefficient
- C_g = Geometric Coefficient
- C_d = Deformation Coefficient
- C_e = Eccentricity Coefficient
- C_m = Effective mass or virtual mass coefficient
- C_t = Windspeed conversion factor
- DSA = Design Spectral Acceleration
- DSA_d = DSA values at damping other than 5 percent
- DT = Displacement of vessel
- DWT = Dead weight tons
- d_{actual} = Arrival maximum draft of vessel at berth
- d_{max} = Maximum vessel draft (in open seas)
- E_{fender} = Energy to be absorbed by the fender system
- E_{vessel} = Berthing energy of vessel [ft-lbs]
- F_a, F_v = Site coefficients from Tables 31F-3-5 and 31F-3-6
- F_A = Accidental factor accounting for abnormal conditions
- g = Acceleration due to gravity [32.2 ft/sec²]
- h = Elevation above water surface [feet]
- K = Current velocity correction factor (Fig 31F-3-4)
- k = Radius of longitudinal gyration of the vessel [ft]
- PGA_x = Peak ground acceleration corresponding to the Site Class under consideration.
- s = Water depth measured from the surface
- S_a = Spectral acceleration

- S_I = Spectral acceleration value (for the boundary of S_B and S_c) at 1.0 second
- $S_A S_F$ = Site classes as defined in Table 31F-6-1
- S_S = Spectral acceleration value (for the boundary of S_B and S_c) at 0.2
- S_{xI} = Spectral acceleration value at 1.0 second corresponding to the Site Class under consideration
- S_{xs} = Spectral acceleration value at 0.2 second corresponding to the period of S_S and the Site Class under consideration
- T = Draft of vessel (see Fig 31F-3-4)
- T = Period (Sec)
- T_0 = Period at which the constant acceleration and constant velocity regions of the design spectrum intersect
- V_c = Average current velocity [knots]
- v_c = Current velocity as a function of depth [knots]
- V_h = Wind speed (knots) at elevation h
- V_L = Over land wind speed
- V_n = Berthing velocity normal to the berth [ft/sec]
- v_t = Velocity over a given time period
- $V_{t, 30sec}$ = Wind speed for a 30 second interval
- V_w = Wind speed at 33ft. (10 m) elevation [knots]
- W = Total weight of vessel and cargo in pounds[displacement tonnage \times 2240]
- WD = Water Depth (Fig 31F-3-4)

3103.F.13 References.

- [3.1] Federal Emergency Management Agency, FEMA -356, Nov. 2000, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.
- [3.2] California Geological Survey, 2003, "Seismic Shaking Hazards in California," Sacramento, CA.
- [3.3] Idriss, I.M., August 1985, "Evaluating Seismic Risk in Engineering Practice," Proceedings, Theme Lecture No. 6, XI International Conference on Soil Mechanics and Foundation Engineering, San Francisco, CA, vol. I, pp. 255-320.
- [3.4] Southern California Earthquake Center (SCEC), March 1999, "Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction in California," University of Southern California, Los Angeles.
- [3.5] Earth Mechanics, Inc., "Port-Wide Ground Motion and Palos Verdes Fault Study – Port of Los Angeles, California, FINAL REPORT," December 22, 2006, Fountain Valley, CA.
- [3.6] Earth Mechanics, Inc., "Port-Wide Ground Motion Study – Port of Long Beach, California, FINAL REPORT," August 7, 2006, Fountain Valley, CA.
- [3.7] Savy, J. and Foxall, W, 2002, "Probabilistic Seismic Hazard Analysis for Southern California Coastal Facilities," 2003, Lawrence Livermore National Laboratory.
- [3.8] Idriss, I.M. and Sun, J.I., 1992, "User's Manual for SHAKE91, A Computer Program for Conducting Equivalent Linear Seismic Response Analyses of Horizontally Layered Soil Deposits," Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.
- [3.9] Somerville, Paul G., Smith, Nancy F., Graves, Robert W., and Abrahamson, Norman A., 1997, "Modification of Empirical Strong Ground Motion Attenuation Relations to Include the Amplitude and Duration Effects of Rupture Directivity," Seismological Research Letters, Volume 68, Number 1, pp.199-222.
- [3.10] California Code of Regulations, "Marine Terminals, Inspection and Monitoring," Title 2, Division 3, Chapter 1, Article 5. California State Lands Commission, Sacramento, CA.
- [3.11] American Society of Civil Engineers, Jan. 2000, "Minimum Design Loads for Buildings and Other Structures," ASCE 7-98, Revision of ANSI/ASCE 9-95, Reston, VA.
- [3.12] Pile Buck Production, 1992, "Mooring Systems," Pile Buck Inc., Jupiter, Florida.
- [3.13] Oil Companies International Marine Forum (OCIMF), 2008, "Mooring Equipment Guidelines (MEG3)," 3rd ed., London, England.
- [3.14] British Standards Institution, 2000, "British Standard Code of Practice for Maritime Structures - Part 1 General Criteria" BS6349, Part 1, London, England.
- [3.15] Ferritto, J., Dickenson, S., Priestley N., Werner, S., Taylor, C., Burke D., Seelig W., and Kelly, S., 1999, "Seismic Criteria for California Marine Oil Terminals," Vol. 1 and Vol. 2, Technical Report TR-2103-SHR, Naval Facilities Engineering Service Center, Port Hueneme, CA.
- [3.16] National Oceanic and Atmospheric Administration, Contact: National PORTS Program Manager, Center for Operational Oceanographic Products and Services, 1305 EW Highway, Silver Spring, MD 20910.
- [3.17] Dept. of Defense, 3 October 2005, Unified Facilities Criteria (UFC) 4-159-03 "Moorings," Washington, D.C.
- [3.18] Chakrabarti, S. K., 1987, "Hydrodynamics of Offshore Structures," Computational Mechanics.
- [3.19] Kriebel, David, "Mooring Loads Due to Parallel Passing Ships", Technical Report TR-6056-OCN, US Naval Academy, 30 September 2005.

- [3.20] Wang, Shen, August 1975, "Dynamic Effects of Ship Passage on Moored Vessels," *Journal of the Waterways, Harbors and Coastal Engineering Division, Proceedings of the American Society of Civil Engineers*, Vol. 101, WW3, Reston, VA.
- [3.21] Seelig, William N., 20 November 2001, "Passing Ship Effects on Moored Ships," *Technical Report TR-6027-OCN*, Naval Facilities Engineering Service Center, Washington, D.C.
- [3.22] Moffatt & Nichol, April 2007, "Tsunami Hazard Assessment for the Ports of Long Beach and Los Angeles – FINAL REPORT", prepared for the Ports of Long Beach and Los Angeles.
- [3.23] Synolakis, C., "Tsunami and Seiche," Chapter 9 in *Earthquake Engineering Handbook*, Chen, W., Scawthorn, C. S. and Arros, J. K., editors, 2002, CRC Press, Boca Raton, FL.
- [3.24] Borrero, Jose, Dengler, Lori, Uslu, Burak and Synolakis, Costas, June 2006, "Numerical Modeling of Tsunami Effects at Marine Oil Terminals in San Francisco Bay," *Report for the Marine Facilities Division of the California State Lands Commission*.
- [3.25] Camfield, Frederick E., February 1980, "Tsunami Engineering," U.S. Army, Corps of Engineers, Coastal Research Center, Special Report No. 6.
- [3.26] Dept. of Defense, "Piers and Wharves," *Unified Facilities Criteria (UFC) 4-152-01*, 28 July 2005, Washington, D.C.
- [3.27] Permanent International Association of Navigation Congresses (PIANC), 2002, "Guidelines for the Design of Fender Systems: 2002," Brussels.
- [3.28] Gaythwaite, John, 2004, "Design of Marine Facilities for the Berthing, Mooring and Repair of Vessels," American Society of Civil Engineers, Reston, VA.
- [3.29] Simiu E. and Scanlan R., 1978, "Wind Effects on Structures: An Introduction to Wind Engineering," Wiley-Interscience Publications, New York.

> Authority: Sections 8755 and 8757, Public Resources Code.
Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 4

SECTION 3104F SEISMIC ANALYSIS AND STRUCTURAL PERFORMANCE

3104F.1 General.

3104F.1.1 Purpose. The purpose of this section is to establish minimum standards for seismic analysis and structural performance. Seismic performance is evaluated at two criteria levels. Level 1 requirements define a performance criterion to ensure MOT functionality. Level 2 requirements safeguard against major structural damage or collapse.

3104F.1.2 Applicability. Section 3104F applies to all new and existing MOTs structures. Structures supporting loading arms, pipelines, oil transfer and storage equipment, critical nonstructural systems and vessel mooring structures, such as mooring and breasting dolphins are included. Catwalks and similar components that are not part of the lateral load carrying system and do not support oil transfer equipment may be excluded.

3104F.1.3 Oil spill risk classification. Each existing MOT shall be categorized into one of three risk classifications (high, medium or low) as shown in Table 31F-4-1, based on the highest of the following:

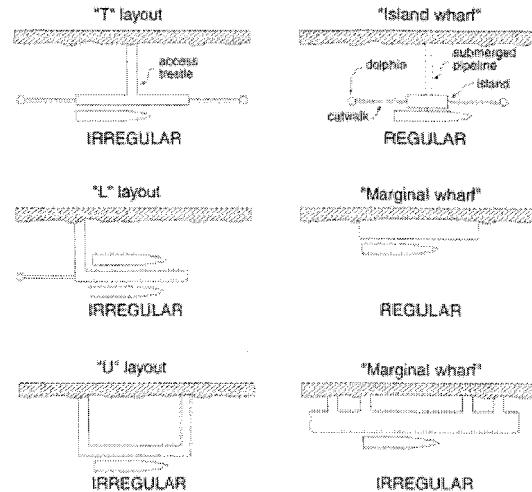
1. Exposed total volume of oil during transfer ("total volume" as calculated in Section 3108F.2.3)
2. Number of oil transfer operations per berthing system per year
3. Maximum vessel size (DWT) that may call at the berthing system

If risk reduction strategies (see Section 3101F.5) are adopted such that the maximum volume of exposed oil during transfer is less than 1,200 barrels, the classification level of the facility may be lowered. All new MOTs are classified as high risk.

3104F.1.4 Configuration classification. Each MOT shall be designated as regular or irregular, in accordance with Figure 31F-4-1.

Irregular configurations, such as the "T" layout, may be analyzed as regular if the presence of expansion joints divides the T-configuration into two or more regular segments. Expansion joints in this context are defined as joints that separate each structural segment in such a manner that each segment will move independently during an earthquake.

If an irregular MOT is divided into seismically isolated sections, an evaluation of the relative movement of pipelines



**FIGURE 31F-4-1
PIER AND WHARF CONFIGURATIONS**

and supports shall be considered, including phase differences (Section 3109F.3).

3104F.2 Existing MOTs

3104F.2.1 Design earthquake motions. Two levels of design seismic performance shall be considered. These levels are defined as follows:

Level 1 Seismic performance:

- Minor or no structural damage
- Temporary or no interruption in operations

Level 2 Seismic performance:

- Controlled inelastic structural behavior with repairable damage
- Prevention of structural collapse
- Temporary loss of operations, restorable within months
- Prevention of major spill (≥ 1200 bbls)

3104F.2.2 Basis for evaluation. Component capacities shall be based on existing conditions, calculated as "best estimates," taking into account the mean material strengths, strain hardening and degradation overtime. The capacity of components with little or no ductility, which may lead to brittle failure scenarios, shall be calculated based on lower bound material strengths. Methods to establish component strength and deformation capacities for typical structural

**TABLE 31F-4-1
MOT RISK CLASSIFICATION**

| RISK CLASSIFICATION | EXPOSED OIL (bbls) | TRANSFERS PER YEAR PER BERTHING SYSTEM | MAXIMUM VESSEL SIZE (DWTx1000) |
|---------------------|--------------------|--|--------------------------------|
| High | ≥ 1200 | N.A. | N.A. |
| Medium | < 1200 | ≥ 90 | ≥ 30 |
| Low | < 1200 | < 90 | < 30 |

materials and components are provided in Section 3107F. Geotechnical considerations are discussed in Section 3106F.

3104F.2.3 Analytical procedures. The objective of the seismic analysis is to verify that the displacement capacity of the structure is greater than the displacement demand, for each performance level defined in Table 31F-4-2. The required analytical procedures are summarized in Table 31F-4-3.

The displacement capacity of the structure shall be calculated using the nonlinear static (pushover) procedure. It is also acceptable to use a nonlinear dynamic procedure for capacity evaluation. Methods used to calculate the displacement demand are linear modal, nonlinear static and nonlinear dynamic.

Any rational method, subject to the Division's approval, can be used in lieu of the required analytical procedures shown in Table 31F-4-3.

3104F.2.3.1 Nonlinear static capacity procedure (pushover). Two-dimensional nonlinear static (pushover) analyses shall be performed; three-dimensional analyses are optional. A model that incorporates the nonlinear load deformation characteristics of all components for the lateral force-resisting system shall be displaced to a target displacement to determine the internal deformations and forces. The target displacement depends on the seismic performance level under consideration. Modeling details are as follows:

3104F.2.3.1.1 Modeling. A series of nonlinear pushover analyses may be required depending on the complexity of the MOT structure. At a minimum, pushover analysis of a two-dimensional model shall be conducted in both the longitudinal and transverse directions. The piles shall be represented by nonlinear elements that capture the moment-curvature/rotation relationships for components with expected inelastic behavior in accordance with Section 3107F. A nonlinear element is not required to represent each pile location. Piles with similar lateral force-deflection

behavior may be lumped in fewer larger springs, provided that the overall torsional effects are captured.

Linear material component behavior is acceptable where nonlinear response will not occur. All components shall be based on effective moment of inertia calculated in accordance with Section 3107F. Specific requirements for timber pile structures are discussed in the next section.

3104F.2.3.1.2 Timber pile supported structures. For all timber pile supported structures, linear elastic procedures may be used. Alternatively, the nonlinear static procedure may be used to estimate the target displacement demand, Δ_d .

A simplified single pile model for a typical timber pile supported structure is shown in Figure 31F-4-2. The pile-deck connections may be assumed to be "pinned." The lateral bracing can often be ignored if it is in poor condition. These assumptions shall be used for the analysis, unless a detailed condition assessment and lateral analysis indicate that the existing bracing and connections may provide reliable lateral resistance.

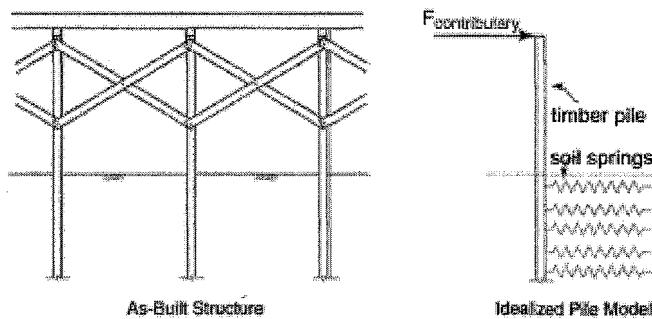


FIGURE 31F-4-2—SIMPLIFIED SINGLE PILE MODEL OF A TIMBER PILE SUPPORTED STRUCTURE

**TABLE 31F-4-2
SEISMIC PERFORMANCE CRITERIA**

| RISK CLASSIFICATION | SEISMIC PERFORMANCE LEVEL | PROBABILITY OF EXCEEDANCE | RETURN PERIOD |
|---------------------|---------------------------|---------------------------|---------------|
| High | Level 1 | 50% in 50 years | 72 years |
| | Level 2 | 10% in 50 years | 475 years |
| Medium | Level 1 | 65% in 50 years | 48 years |
| | Level 2 | 15% in 50 years | 308 years |
| Low | Level 1 | 75% in 50 years | 36 years |
| | Level 2 | 20% in 50 years | 224 years |

**TABLE 31F-4-3
MINIMUM REQUIRED ANALYTICAL PROCEDURES**

| RISK CLASSIFICATION | CONFIGURATION | SUBSTRUCTURE MATERIAL | DISPLACEMENT DEMAND PROCEDURE | DISPLACEMENT CAPACITY PROCEDURE |
|---------------------|-------------------|-----------------------|-------------------------------|---------------------------------|
| High/Medium | Irregular | Concrete/Steel | Linear Modal | Nonlinear Static |
| High/Medium | Regular | Concrete/Steel | Nonlinear Static | Nonlinear Static |
| Low | Regular/Irregular | Concrete/Steel | Nonlinear Static | Nonlinear Static |
| High/Medium/Low | Regular/Irregular | Timber | Nonlinear Static | Nonlinear Static |

A series of single pile analyses may be sufficient to establish the nonlinear springs required for the push-over analysis.

3104F.2.3.1.3 Soil-structure interaction (SSI). Load-deformation characteristics for foundations shall be modeled as per Section 3106F.5. Selection of soil springs shall be based on the following:

1. Effect of the large difference in up and down slope stiffnesses for wharf type structures
2. Effect of upper and lower bound soil parameters, especially for t-z curves used to model batter pile behavior

A separate analysis that captures the demand (Section 3104F.2.3.2) on the piles due to permanent ground deformations, at embankments only, shall be performed.

If a simplified methodology is followed, the piles need to be checked for the following load combinations:

$$\begin{aligned} & 1.0E_{\text{inertial}} \\ & 1.0H_d + 0.25E_{\text{inertial}} \end{aligned}$$

where:

E_{inertial} = Inertial seismic load

H_d = Foundation deformation load

3104F.2.3.2 Nonlinear static demand procedure. A nonlinear static procedure shall be used to determine the displacement demand for all concrete and steel structures, with the exception of irregular configurations with high or moderate seismic risk classifications. The following Sections (3104F.2.3.2.1 through 3104F.2.3.4) describe the procedure of Priestly et al. [4.1]; an alternate procedure is presented in ATC 40 [4.2], which is improved in FEMA 440 [4.3]. A linear modal procedure is required for irregular structures with high or moderate seismic risk classifications, and may be used for all other classifications in lieu of the nonlinear static procedure.

3104F.2.3.2.1 Lateral stiffness. The lateral stiffness, k , is calculated from the force-displacement relation as the total base shear, V_y , corresponding to the yield displacement of the structure Δ_y . Δ_y is the displacement at first yield in the pile/deck connection reinforcement.

3104F.2.3.2.2 Structural period. The fundamental period, T , of the structure in the direction under consideration shall be calculated as follows:

$$T = 2\pi\sqrt{\frac{m}{k}} \quad (4-1)$$

where:

m = mass of structure in kips/g

k = stiffness in direction under consideration in kips/ft

g = gravity, 32 ft/sec² (9.8 meters/sec²)

3104F.2.3.2.3 Target displacement demand. The target displacement demand of the structure, Δ_d , can be calculated by multiplying the spectral

response acceleration, S_A , corresponding to the period, T , by $T^2/4\pi^2$.

$$\Delta_d = S_A \frac{T^2}{4\pi^2} \quad (4-2)$$

If $T < T_0$, where T_0 is the period corresponding to the peak of the acceleration response spectrum, a refined analysis (see Section 3104F.2.3.2.5) shall be used to calculate the displacement demand. Multidirectional excitation shall be addressed per Section 3104F.4.2.

3104F.2.3.2.4 Damping. The displacement demand established in Section 3104F.2.3.2.3 is based on 5 percent damping. Higher damping values obtained from a refined analysis may be used to calculate the displacement demand.

3104F.2.3.2.5 Refined analyses. Refined displacement demand analyses may be calculated as per Chapters 4 and 5 of [4.1] and is briefly summarized below.

1. Determine Δ_d , from Section 3104F.2.3.2.3.
2. From the nonlinear pushover analysis, determine the structural yield displacement Δ_y .
3. The ductility level, μ_Δ , is found from Δ_d/Δ_y . Use the appropriate relationship between ductility and damping, for the component undergoing inelastic deformation, to estimate the effective structural damping, ξ_{eff} . In lieu of more detailed analysis, the relationship shown in Figure 31F-4-3 or equation (4-3) may be used for concrete and steel piles connected to the deck through dowels embedded in the concrete.

$$\xi_{\text{eff}} = 0.05 + \frac{1}{\pi} \left(1 - \frac{1-r}{\sqrt{\mu_\Delta}} - r\sqrt{\mu_\Delta} \right) \quad (4-3)$$

where:

r = ratio of second slope over elastic slope (see Figure 31F-4-5)

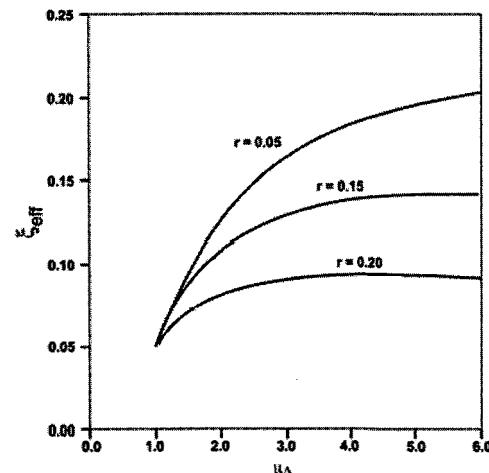
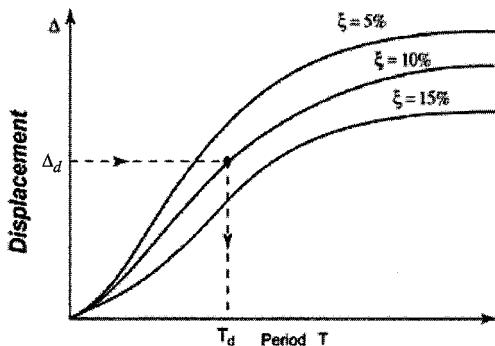


FIGURE 31F-4-3
RELATION BETWEEN DUCTILITY, μ_Δ , AND EFFECTIVE DAMPING, ξ_{eff} [4.1]

4. From the acceleration response spectra, create elastic displacement spectra, S_D , using equation (4-4) for various levels of damping.

$$S_D = \frac{T^2}{4\pi^2} S_A \quad (4-4)$$



**FIGURE 31F-4-4
DESIGN DISPLACEMENT RESPONSE SPECTRA**

5. Using the curve applicable to the effective structural damping, ξ , find the effective period, T_d (see Figure 31F-4-4).
 6. In order to convert from a design displacement response spectra to another spectra for a different damping level, the adjustment factors in Section 3103F.4.2.9 shall be used.
 7. The effective stiffness k_e can then be found from:

$$k_e = \frac{4\pi^2}{T_d^2} M \quad (4-5)$$

where:

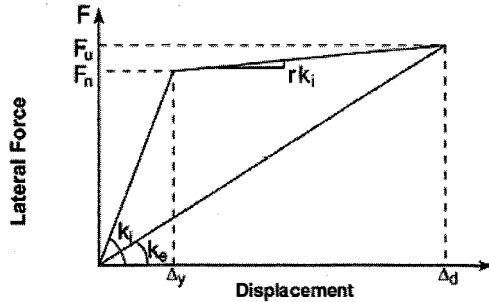
M = mass of deck considered in the analysis.

T_d = effective structural period

8. The required strength F_u can now be estimated by:

$$F_u = k_e \Delta_d \quad (4-6)$$

9. F_u and Δ_d can be plotted on the force-displacement curve established by the pushover analysis. Since this is an iterative process, the intersection of F_u and Δ_d most likely will not fall on the force-displacement curve and a second iteration will be required. An adjusted value of Δ_d taken as the intersection between the force-displacement curve and a line between the origin and F_u and Δ_d can be used to find μ_d .
 10. Repeat the process until a satisfactory solution is obtained (see Figure 31F-4-5).



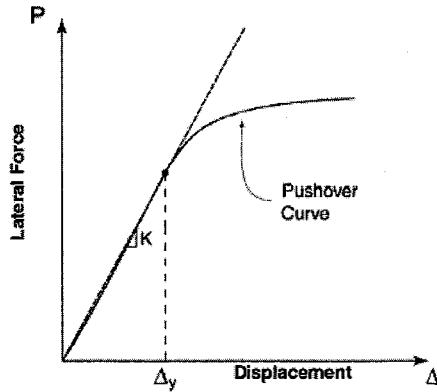
**FIGURE 31F-4-5
EFFECTIVE STIFFNESS, k_e [4.1]**

3104F.2.3.3 Linear modal demand procedure. For irregular concrete/steel structures with moderate or high risk classifications, a linear analysis is required to predict the global displacement demands. A 3-D linear elastic response analysis shall be used, with effective moment of inertia applied to components to establish lateral displacement demands.

Sufficient modes shall be included in the analysis such that 90 percent of the participating mass is captured in each of the principal horizontal directions for the structure. For modal combinations, the complete quadratic combination rule shall be used. Multidirectional excitation shall be accounted for in accordance with Section 3104F.4.2.

The lateral stiffness of the linear elastic response model shall be based on the initial stiffness of the nonlinear pushover curve as shown in Figure 31F-4-6 (also see Section 3106F.5.1). The p-y springs shall be adjusted based on the secant method approach. Most of the p-y springs will typically be based on their initial stiffness; no iteration is required.

If the fundamental period in the direction under consideration is less than T_o as defined in Section 3104F.2.3.2.3, then the displacement demand shall be amplified as specified in Section 3104F.2.3.2.5.



**FIGURE 31F-4-6
STIFFNESS FOR LINEAR MODAL ANALYSIS**

3104F.2.3.4 Nonlinear dynamic analysis. Nonlinear dynamic time history analysis is optional, and if performed, a peer review is required (see Section 3101F.6.1). Multiple acceleration records shall be used, as explained in Section 3103F.4.2.10. The following assumptions may be made:

1. Equivalent "super piles" can represent groups of piles.
2. If the deck has sufficient rigidity (both in-plane and out-of plane) to justify its approximation as a rigid element, a 2-D plan simulation may be adequate.

A time-history analysis should always be compared with a simplified approach to ensure that results are reasonable. Displacements calculated from the nonlinear time history analyses may be used directly in design, but shall not be less than 80 percent of the values obtained from Section 3104F.2.3.2.

3104F.2.3.5 Alternative procedures. Alternative lateral-force procedures using rational analyses based on well-established principles of mechanics may be used in lieu of those prescribed in these provisions. As per Section 3101F.6.1, peer review is required.

3104F.3 New MOTs. The analysis and design requirements described in Section 3104F.2 shall also apply to new MOTs. Additional requirements are as follows:

1. Site-specific response spectra analysis (see Section 3103F.4.2.3).
2. Soil parameters based on site-specific and new borings (see Section 3106F.2.2).

3104F.4 General analysis and design requirements.

3104F.4.1 Load combinations. Earthquake loads shall be used in the load combinations described in Section 3103F.8.

3104F.4.2 Combination of orthogonal effects. The design displacement demand, Δ_d , shall be calculated by combining the longitudinal, Δ_x , and transverse, Δ_y , displacements in the horizontal plane (Figure 31F-4-7):

$$\Delta_d = \sqrt{\Delta_x^2 + \Delta_y^2} \quad (4-7)$$

where:

$$\Delta_x = \Delta_{xy} + 0.3\Delta_{xx} \quad (4-8)$$

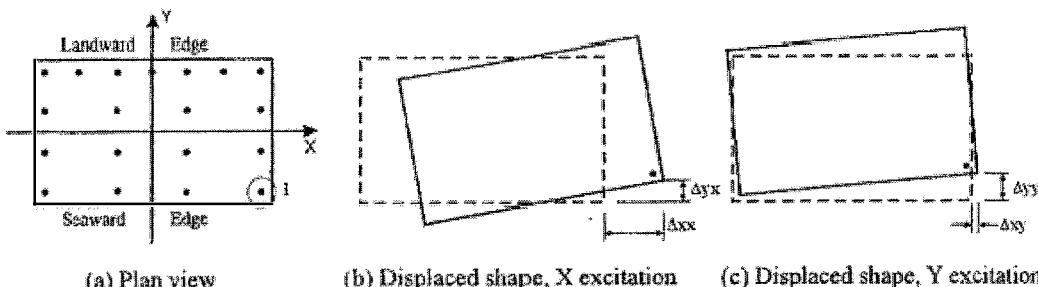


FIGURE 31F-4-7
PLAN VIEW OF WHARF SEGMENT UNDER X AND Y SEISMIC EXCITATIONS [4.3]

$$\text{and } \Delta_y = 0.3\Delta_{yx} + \Delta_{yy} \quad (4-9)$$

or

$$\text{and } \Delta_y = \Delta_{yx} + 0.3\Delta_{yy} \quad (4-10)$$

$$\Delta_x = 0.3\Delta_{xy} + \Delta_{xx} \quad (4-11)$$

whichever results in the greater design displacement demand.

In lieu of combining the displacement demands as presented above, the design displacement demand for marginal wharf type MOTs may be calculated as:

$$\Delta_d = \Delta_y \sqrt{1 + (0.3(1 + 20e/L_l))^2} \quad (4-12)$$

where:

Δ_y = transverse displacement demand

e = eccentricity between center of mass and center of rigidity

L_l = longitudinal length between wharf expansion

This equation is only valid for wharf aspect ratios (length/breadth) greater than 3.

3104F.4.3 P-Δ Effects. The P-Δ effect (i.e., the additional moment induced by the total vertical load multiplied by the lateral deck deflection) shall be considered unless the following relationship is satisfied (see Figure 31F-4-8):

$$\frac{V}{W} \geq 4 \frac{\Delta_d}{H} \quad (4-13)$$

where:

V = base shear strength of the structure obtained from a plastic analysis

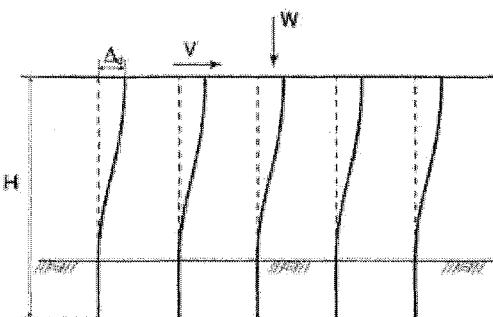
W = dead load of the frame

Δ_d = displacement demand

H = distance from the location of maximum in-ground moment to center of gravity of the deck

For wharf structures where the lateral displacement is limited by almost fully embedded piles, P-Δ effects may be ignored; however, the individual stability of the piles shall be checked in accordance with Section 3107F.2.5.2.

If the landside batter piles are allowed to fail in a Level 2 evaluation, the remaining portion of the wharf shall be checked for P-Δ effects.



**FIGURE 31F-4-8
P-Δ EFFECT**

3104F.4.4 Expansion joints. The effect of expansion joints shall be considered in the seismic analysis.

3104F.4.5 Shear key forces. Shear force across shear keys connecting adjacent wharf segments, V_{sk} , (approximate upper bound to the shear key force [4.4]) shall be calculated as follows:

$$V_{sk} = 15(e/L_l)V_{\Delta T} \quad (4-14)$$

where:

$V_{\Delta T}$ = total segment lateral force found from a push-over analysis

L_l = segment length

e = eccentricity between the center of rigidity and the center of mass

3104F.4.6 Connections. For an existing wharf, the deteriorated conditions at the junction between the pile top and pile cap shall be considered in evaluating the moment capacity. Connection detail between the vertical pile and pile cap shall be evaluated to determine whether full or partial moment capacity can be developed under seismic action.

For new MOTs, the connection details shall develop the full moment capacities.

The modeling shall simulate the actual moment capacity (full or partial) of the joint in accordance with Section 3107F.2.7.

3104F.4.7 Batter piles. Batter piles primarily respond to earthquakes by developing large axial compression or tension forces. Bending moments are generally of secondary importance. Failure in compression may be dictated by the deck-pile connection (most common type), material compression, buckling, or by excessive local shear in deck members adjacent to the batter pile. Failure in tension may be dictated by connection strength or by pile pull out. (p. 3-83 of [4.4]).

When the controlling failure scenario is reached and the batter pile fails, the computer model shall be adjusted to consist of only the vertical pile acting either as a full or partial moment frame based on the connection details between the pile top and pile cap. The remaining displacement capacity, involving vertical piles, before the secondary failure stage develops, shall then be established (see Section 3107F.2.8).

Axial p-z curves shall be modeled. In compression, displacement capacity should consider the effect of the reduction in pile modulus of elasticity at high loads and the increase in effective length for friction piles. This procedure allows the pile to deform axially before reaching ultimate loads, thereby increasing the displacement ductility [4.4].

Horizontal nonlinear p-y springs are only applied to batter piles with significant embedment, such as for landside batter piles in a wharf structure. Moment fixity can be assumed for batter piles that extend well above the ground such as waterside batter piles in a wharf structure or batter piles in a pier type structure.

3104F.5 Nonstructural components. This section covers nonstructural components having a significant mass and/or a critical importance to the operability and safety of the MOT. The weight of nonstructural components shall be included in the dead load of the structure, per Section 3103F.2.

3104F.5.1 Contribution to global response. Nonstructural components including, but not limited to pipelines, loading arms, raised platforms, control rooms and vapor control equipment, may affect the global structural response. In such cases, the seismic characteristics (mass and/or stiffness) of the nonstructural components shall be considered. If the seismic response of nonstructural components is out of phase with the global structural response, then the mass contribution can be neglected in the seismic structural analysis.

3104F.5.2 Seismic loads. In general, for nonstructural components, the evaluation procedures of Section 3110F.8 are adequate.

For pipelines, the seismic analysis shall be performed in accordance with Section 3109F.3, in lieu of Section 3110F.8. If a pipeline analysis has been performed and support reactions are available, they may be used to determine the forces on the support structure.

A pipeline segment under consideration shall extend between two adjacent anchor points. A simplified pipeline analysis may be used when the relative displacement demands of anchor points are considered. As an option, a full nonlinear time-history analysis can be used to capture the nonlinear interaction between the structure and the pipeline.

3104F.5.3 Nonstructural critical systems assessment. A seismic assessment of the survivability and continued operation during a Level 2 earthquake (see Table 31F-4-2) shall be performed for critical systems such as fire protection, emergency shutdown and electrical power systems. The assessment shall consider the adequacy and condition of anchorage, flexibility and seismically-induced interaction. For existing systems, seismic adequacy may be assessed per [4.5].

3104F.6 Symbols.

e = Eccentricity between center of mass and center of rigidity

$E_{inertial}$ = Inertial seismic load

F_u = Required strength at maximum response

H = Distance from maximum in-ground moment to center of gravity of the deck
 H_d = Foundation deformation load
 k = Stiffness in direction under consideration in k/ft
 k_e = Effective stiffness
 L_l = Longitudinal length between wharf expansion joints
 m = Mass of structure in kips/g
 M = Mass of deck considered in the analysis
 r = Ratio of second slope over elastic slope
 S_A = Spectral response acceleration, at T
 S_D = Displacement response spectrum, at T
 S_{ap} = Spectral response acceleration of pipeline segment under consideration
 T = Fundamental period of structure
 T_d = Effective structural period
 V = Base shear strength of the structure obtained from a plastic analysis
 V_y = total base shear
 V_{AT} = total segment lateral force
 V_{sk} = Shear force across shear keys
 W = Dead load of the frame
 W_p = Weight of pipeline segment under consideration
 Δ_d = Design displacement demand
 Δ_x = Longitudinal displacement demand
 Δ_{xx} = X displacement under X direction excitation
 Δ_{xy} = X displacement under Y direction excitation
 Δ_y = Transverse displacement demand
 Δ_{yx} = Y displacement under X direction excitation
 Δ_{yy} = Y displacement under Y direction excitation
 μ_Δ = Ductility level
 ξ_{eff} or ξ = Effective structural damping

3104F.7 References.

- [4.1] Priestley, M.J.N., Sieble, F., Calvi, G.M., 1996, "Seismic Design and Retrofit of Bridges," John Wiley & Sons, Inc., New York, USA.
- [4.2] Applied Technology Council, ATC-40, 1996, "Seismic Evaluation and Retrofit of Concrete Buildings," Vols. 1 and 2, Redwood City, CA.
- [4.3] Applied Technology Council (ATC-55 Project), June 2005, "FEMA 440 Improvement of Nonlinear Static Seismic Analysis Procedures," Redwood City, CA.
- [4.4] Ferritto, J., Dickenson, S., Priestley N., Werner, S., Taylor, C., Burke D., Seelig W., and Kelly, S., 1999, "Seismic Criteria for California Marine Oil Terminals," Vol. 1 and Vol. 2, Technical Report TR-2103-SHR, Naval Facilities Engineering Service Center, Port Hueneme, CA.

[4.5] CalARP Program Seismic Guidance Committee, September 2009, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

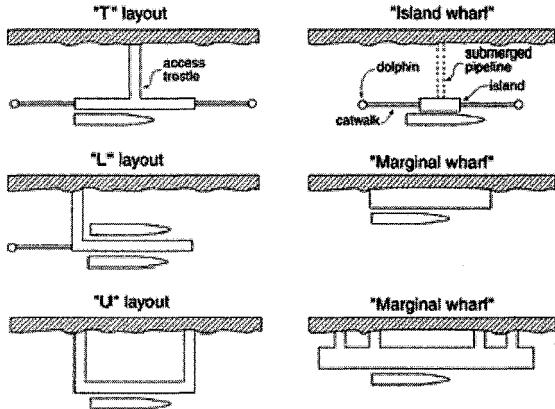
Division 5

SECTION 3105F MOORING AND BERTHING ANALYSIS AND DESIGN

3105F.1 General.

3105F.1.1 Purpose. This section establishes minimum standards for safe mooring and berthing of vessels at MOTs.

3105F.1.2 Applicability. This section applies to onshore MOTs; Figure 31F-5-1 shows typical pier and wharf configurations.



**FIGURE 31F-5-1
TYPICAL PIER AND WHARF CONFIGURATIONS**

3105F.1.3 Mooring/berthing requirements. Multiple berth MOTs shall use the same conditions for each berth unless it can be demonstrated that there are significant differences.

MOTs shall have the following equipment in operation:

1. An anemometer (N/E).
2. A current meter in high velocity current (>1.5 knots) areas (N/E).
3. Remote reading tension load devices in high velocity current (>1.5 knots) areas and/or with passing vessel effects for new MOTs.
4. Mooring hardware in accordance with Section 3103F.10 (N/E).

Berthing systems shall be in accordance with Section 3105F.4 (N/E).

3105F.1.4 New MOTs. Quick release hooks are required at all new MOTs, except for spring line fittings. Quick release hooks shall be sized in accordance with Section 3103F.10. To avoid accidental release, the freeing mechanism shall be activated by a two-step process. Quick release hooks shall be insulated electrically from the mooring structure, and shall be supported so as not to contact the deck.

Section 3105F.5 and the OCIMF guidelines [5.4] shall be used in designing the mooring layout.

3105F.1.5 Analysis and design of mooring components. The existing condition of the MOT shall be used in the mooring analysis (see Section 3102F). Structural characteristics

of the MOT, including type and configuration of mooring fittings such as bollards, bitts, hooks and capstans and material properties and condition, shall be determined in accordance with Sections 3107F.4 and 3103F.10.

The analysis and design of mooring components shall be based on the loading combinations and safety factors defined in Sections 3103F.8 through 3103F.10, and in accordance with ACI 318 [5.1], AISC [5.2] and ANSI/AI/AF&PA NDS [5.3], as applicable.

3105F.2 Mooring analyses. A mooring analysis shall be performed for each berthing system, to justify the safe berthing of the various deadweight capacities of vessels expected at the MOT. The forces acting on a moored vessel shall be determined in accordance with Section 3103F.5. Mooring line and breasting load combinations shall be in accordance with Section 3103F.8.

Two procedures, manual and numerical are available for performing mooring analyses. These procedures shall conform to either the OCIMF document, "Mooring Equipment Guidelines (MEG3)" [5.4] or the Department of Defense "Moorings" document [5.5]. The manual procedure (Section 3105F.2.1) may be used for barges.

A new mooring assessment shall be performed when conditions change, such as any modification in the mooring configuration, vessel size or new information indicating greater wind, current or other environmental loads.

In general, vessels shall remain in contact with the breasting or fendering system. Vessel motion (sway) of up to 2 feet off the breasting structure may be allowed under the most severe environmental loads, unless greater movement can be justified by an appropriate mooring analysis that accounts for potential dynamic effects. The allowable movement shall be consistent with mooring analysis results, indicating that forces in the mooring lines and their supports are within the allowable safety factors. Also, a check shall be made as to whether the movement is within the limitations of the cargo transfer equipment.

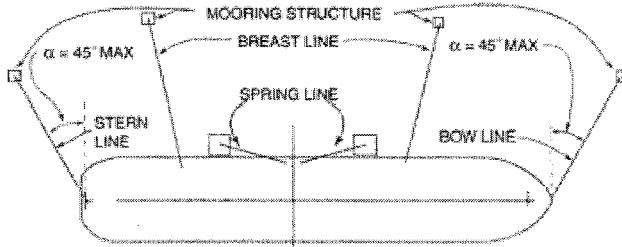
The most severe combination of the environmental loads has to be identified for each mooring component. At a minimum, the following conditions shall be considered:

1. Two current directions (maximum ebb and flood; See Section 3103F.5.3)
2. Two tide levels (highest high and lowest low)
3. Two vessel loading conditions (ballast and maximum draft at the terminal)
4. Eight wind directions (45 degree increments)

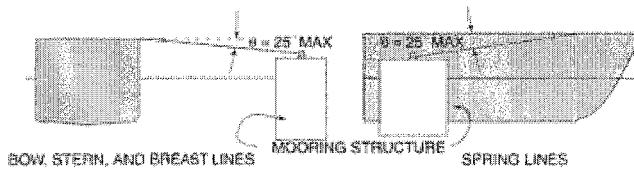
3105F.2.1 Manual procedure. Simplified calculations may be used to determine the mooring forces for barges with favorable site conditions (see Table 31F-3-10) and no passing vessel effects (see Section 3105F.3.2), except if any of the following conditions exist (Figures 31F-5-2 and 31F-5-3, below).

1. Mooring layout is significantly asymmetrical
2. Horizontal mooring line angles (α) on bow and stern exceed 45 degrees

3. Horizontal breast mooring line angles exceed 15 normal to the hull
4. Horizontal spring mooring line angles exceed 10 degrees from a line parallel to the hull



**FIGURE 31F-5-2
HORIZONTAL LINE ANGLES [5.4]**



**FIGURE 31F-5-3
VERTICAL LINE ANGLES [5.4]**

5. Vertical mooring line angles (θ) exceed 25 degrees
6. Mooring lines for lateral loads not grouped at bow and stern

When the forces have been determined and the distance between the bow and stern mooring points is known, the yaw moment can be resolved into lateral loads at the bow and stern. The total environmental loads on a moored vessel are comprised of the lateral load at the vessel bow, the lateral load at the vessel stern and the longitudinal load. Line pretension loads must be added.

Four load cases shall be considered:

1. Entire load is taken by mooring lines
2. Entire load is taken by breasting structures
3. Load is taken by combination of mooring lines and breasting structures
4. Longitudinal load is taken only by spring lines

3105F.2.2 Numerical procedure. A numerical procedure is required to obtain mooring forces for MOTs that cannot use manual procedure. Computer program(s) shall be based on mooring analysis procedures that consider the characteristics of the mooring system, calculate the environmental loads and provide resulting mooring line forces and vessel motions (surge and sway).

3105F.3 Wave, passing vessel, seiche and tsunami.

3105F.3.1 Wind waves. MOTs are generally located in sheltered waters such that typical wind waves can be assumed not to affect the moored vessel if the significant wave period, T_s , is less than 4 seconds. However, if the period is equal to or greater than 4 seconds, then a simplified dynamic analy-

sis (See Section 3103F.5.4) is required. The wave period shall be established based on a 1-year significant wave height, H_s . For MOTs within a harbor basin, the wave period shall be based on the locally generated waves with relatively short fetch.

3105F.3.2 Passing vessels. These forces generated by passing vessels are due to pressure gradients associated with the flow pattern. These pressure gradients cause the moored vessel to sway, surge, and yaw, thus imposing forces on the mooring lines.

Passing vessel analysis shall be conducted when all of the following conditions exist (See Figure 31F-5-4):

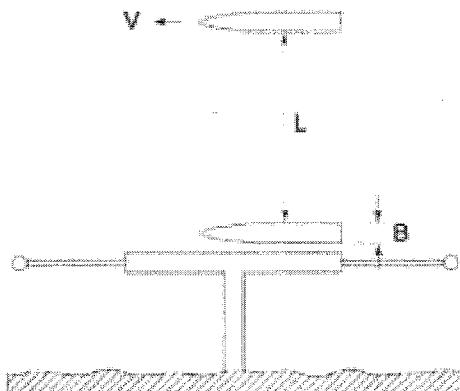
1. Passing vessel size is greater than 25,000 DWT.
2. Distance L is 500 feet or less
3. Vessel speed V is greater than V_{crit}

where:

$$V_{crit} = 1.5 + \frac{L}{500-2B} \cdot 4.5 \text{ (knots)} \quad (5-1)$$

Exception: If $L \leq 2B$, passing vessel loads shall be considered.

L and B are shown in Figure 31F-5-4, in units of feet. V is defined as the speed of vessel over land minus the current velocity, when traveling with the current, or the speed of vessel over land plus the current velocity, when traveling against the current.



**FIGURE 31F-5-4
PASSING VESSEL**

When such conditions (1, 2 and 3 above) exist, the surge and sway forces and the yaw moment acting on the moored vessel shall, as a minimum, be established in accordance with Section 3103F.5 or by dynamic analysis.

For MOTs located in ports, the passing distance, L , may be established based on channel width and vessel traffic patterns. The guidelines established in the Department of Defense, UFC 4-150-06, Figure 5-17 [5.6] for interior channels may be used. The "vertical bank" in Figure 5-17 of [5.6] shall be replaced by the side of the moored vessel when establishing the distance, "L".

For MOTs, not located within a port, the distance, "L," must be determined from observed traffic patterns.

The following passing vessel positions shall be investigated:

1. Passing vessel is centered on the moored ship. This position produces maximum sway force.
2. The midship of the passing vessel is fore or aft of the centerline of the moored ship by a distance of 0.40 times the length of the moored ship. This position is assumed to produce maximum surge force and yaw moment at the same time.

The mooring loads due to a passing vessel shall be added to the mooring loads due to wind and current.

3105F.3.3 Seiche. A seiche analysis is required for existing MOTs located within a harbor basin and which have historically experienced seiche. A seiche analysis is required for new MOTs inside a harbor basin prone to penetration of ocean waves.

The standing wave system or seiche is characterized by a series of "nodes" and "antinodes." Seiche typically has wave periods ranging from 20 seconds up to several hours, with wave heights in the range of 0.1 to 0.4 ft [5.6].

The following procedure may be used, as a minimum, in evaluating the effects of seiche within a harbor basin. In more complex cases where the assumptions below are not applicable, dynamic methods are required.

1. Calculate the natural period of oscillation of the basin. The basin may be idealized as rectangular, closed or open at the seaward end. Use Chapter 2 of UFC 4-150-06 [5.6] to calculate the wave period and length for different modes. The first three modes shall be considered in the analysis.
2. Determine the location of the moored ship with respect to the antinode and node of the first three modes to determine the possibility of resonance.
3. Determine the natural period of the vessel and mooring system. The calculation shall be based on the total mass of the system and the stiffness of the mooring lines in surge. The surge motion of the moored vessel is estimated by analyzing the vessel motion as a harmonically forced linear single degree of freedom spring mass system. Methods outlined in a paper by F.A. Kilner [5.7] can be used to calculate the vessel motion.
4. Vessels are generally berthed parallel to the channel; therefore, only longitudinal (surge) motions shall be considered, with the associated mooring loads in the spring lines. The loads on the mooring lines (spring lines) are then determined from the computed vessel motion and the stiffness of those mooring lines.

3105F.3.4 Tsunami. Run-up and current velocity shall be considered in the tsunami assessment. Table 31F-3-8 provides run-up values for the San Francisco Bay area, Los Angeles/Long Beach Harbors and Port Hueneme.

3105F.4 Berthing analysis and design. The analysis and design of berthing components shall be based on the loading combinations and safety factors defined in Sections 3103F.8 and 3103F.9 and in accordance with ACI 318 [5.1], AISC [5.2], and ANSI/AF&PA NDS [5.3], as applicable.

3105F.4.1 Berthing energy demand. The kinetic berthing energy demand shall be determined in accordance with Section 3103F.6.

3105F.4.2 Berthing energy capacity. For existing MOTs, the berthing energy capacity shall be calculated as the area under the force-deflection curve for the combined structure and fender system as indicated in Figure 31F-5-5. Fender piles may be included in the lateral analysis to establish the total force-deflection curve for the berthing system. Load-deflection curves for other fender types shall be obtained from manufacturer's data. The condition of offenders shall be taken into account when performing the analysis.

When batter piles are present, the fender system typically absorbs most of the berthing energy. This can be established by comparing the force-deflection curves for the fender system and batter piles. In this case only the fender system energy absorption shall be considered.

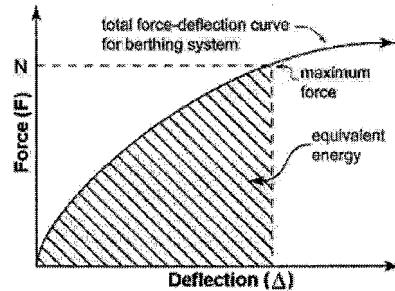


FIGURE 31F-5-5
BERTHING ENERGY CAPACITY

3105F.4.3 Tanker contact length.

3105F.4.3.1 Continuous fender system. A continuous fender system consists of fender piles, chocks, wales, and rubber or spring fender units.

The contact length of a ship during berthing depends on the spacing of the fender piles and fender units, and the connection details of the chocks and wales to the fender piles.

The contact length, L_c , can be approximated by the chord formed by the curvature of the bow and the berthing angle as shown in Equation 5-2 below.

$$L_c = 2r \sin \alpha \quad (5-2)$$

where:

L_c = contact length

r = Bow radius

α = Berthing angle

In lieu of detailed analysis to determine the contact length, Table 31F-5-1 may be used. The contact length

for a vessel within the range listed in the table can be obtained by interpolation.

**TABLE 31F-5-1
CONTACT LENGTH**

| VESSEL SIZE (DWT) | CONTACT LENGTH |
|--------------------|----------------|
| 330 | 25 ft |
| 1,000 to 2,500 | 35 ft |
| 5,000 to 26,000 | 40 ft |
| 35,000 to 50,000 | 50 ft |
| 65,000 | 60 ft |
| 100,000 to 125,000 | 70 ft |

3105F.4.3.2 Discrete fender system. For discrete fender systems (i.e., not continuous), one fender unit or breasting dolphin shall be able to absorb the entire berthing energy.

3105F.4.4 Longitudinal and vertical berthing forces. The longitudinal and vertical components of the horizontal berthing force shall be calculated using appropriate coefficients of friction between the vessel and the fender. In lieu of as-built data, the values in Table 31F-5-2 may be used for typical fender/vessel materials:

**TABLE 31F-5-2
COEFFICIENT OF FRICTION**

| CONTACT MATERIALS | FRICTION COEFFICIENT |
|-------------------|----------------------|
| Timber to Steel | 0.4 to 0.6 |
| Urethane to Steel | 0.4 to 0.6 |
| Steel to Steel | 0.25 |
| Rubber to Steel | 0.6 to 0.7 |
| UHMW* to Steel | 0.1 to 0.2 |

*Ultra high molecular weight plastic rubbing strips.

Longitudinal and vertical forces shall be determined by:

$$F = \mu N \quad (5-3)$$

where:

F = longitudinal or vertical component of horizontal berthing force

μ = coefficient of friction of contact materials

N = maximum horizontal berthing force (normal to fender)

3105F.4.5 Design and selection of new fender systems. For guidelines on new fender designs, refer to the Department of Defense "Piers and Wharves" document (UFC 4-152-01) [5.8] and the PIANC Guidelines for the Design of Fenders Systems: 2002 [5.9]. Also see Section 3103F.6.

3105F.5 Layout of new MOTs. The number and spacing of independent mooring dolphins and breasting dolphins depends on the DWT and length overall (LOA) of vessels to be accommodated.

Breasting dolphins shall be positioned adjacent to the parallel body of the vessel when berthed. A minimum of two breasting dolphins shall be provided. The spacing of breasting dolphins shall be adequate for all sizes of vessels that may berth at the MOT.

Mooring dolphins shall be set back from the berthing line (fender line) for a distance between 115 ft and 165 ft, so that longer bow, stern and breast lines can be deployed.

For a preliminary layout, the guidelines in the British Standards, Part 4, Section 2 [5.10], may be used in conjunction with the guidelines below.

1. If four breasting dolphins are provided, the spacing between exterior breasting dolphins shall be between 0.3 and 0.4 LOA of the maximum sized vessel expected to call at the MOT. The spacing between interior breasting dolphins shall be approximately 0.3 to 0.4 LOA of the minimum sized vessel expected to call at the MOT.
2. If only two breasting dolphins are provided, the spacing between the dolphins shall be the smaller (0.3LOA) of the guidelines specified above.
3. If bow and stern lines are used for mooring, the spacing between exterior mooring dolphins shall be 1.35 times the LOA of the maximum sized vessel expected to call at the MOT.
4. The spacing between interior mooring dolphins shall be 0.8 times the LOA of the maximum sized vessel expected to call at the MOT.

The final layout of the mooring and breasting dolphins shall be determined based on the results of the mooring analysis that provides optimal mooring line and breasting forces for the range of vessels to be accommodated. The breasting force under the mooring condition shall not exceed the maximum fender reaction of the fender unit when it is being compressed at the manufacturers rated deflection.

3105F.6 Symbols.

- α = Berthing angle. It also indicates the angle of horizontal mooring lines, see Fig 5-2.
- Δ = Deflection
- θ = Vertical mooring line angles
- B = Beam of vessel
- F = Longitudinal or vertical component of horizontal normal berthing force
- L = Distance between passing and moored vessels
- L_c = Contact length
- N = Maximum horizontal berthing force
- r = Bow radius
- μ = Coefficient of friction of contact materials
- V = Ground speed (knots)
- V_c = Maximum current (knots).
- V_{crit} = Ground speed (knots) above which passing loads must be considered
- V_w = Maximum wind speed (knots)

3105F.7 References.

- [5.1] American Concrete Institute, ACI 318-05, 2005, "Building Code Requirements for Structural Concrete (318-05) and Commentary (318R-05)," Farmington Hills, Michigan.

- [5.2] American Institute of Steel Construction Inc. (AISC), 2005, "Steel Construction Manual," Thirteenth Edition, Chicago, IL.
- [5.3] American Forest & Paper Association, 2005, "National Design Specification for Wood Construction," ANSI/AF&PA NDS-2005, Washington, D.C.
- [5.4] Oil Companies International Marine Forum (OCIMF), 2008, "Mooring Equipment Guidelines (MEG3)," 3rd Ed., London, England.
- [5.5] Department of Defense, 3 October 2005, "Moorings", Unified Facilities Criteria (UFC) 4-152-03, Washington D.C., USA.
- [5.6] Department of Defense, 12 December 2001, "Military Harbors and Coastal Facilities", Unified Facilities Criteria (UFC) 4-150-06, Washington D.C., USA.
- [5.7] Kilner F.A., 1961, "Model Tests on the Motion of Moored Ships Placed on Long Waves." Proceedings of 7th Conference on Coastal Engineering, August 1960, The Hague, Netherlands, published by the Council on Wave Research - The Engineering Foundation.
- [5.8] Department of Defense, 28 July 2005, "Piers and Wharves," Unified Facilities Criteria (UFC), 4-152-01, Washington D.C., USA.
- [5.9] Permanent International Association of Navigation Congresses (PIANC), 2002, "Guidelines for the Design of Fender Systems: 2002," Brussels.
- [5.10] British Standards Institution, 1994, "British Standard Code of Practice for Maritime Structures - Part 4. Code of Practice for Design of Fendering and Mooring Systems," BS6349, London, England.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 6

SECTION 3106F GEOTECHNICAL HAZARDS AND FOUNDATIONS

3106F.1 General.

3106F.1.1 Purpose. This section provides minimum standards for analyses and evaluation of geotechnical hazards and foundations.

3106F.1.2 Applicability. The requirements provided herein apply to all new and existing MOTs.

3106F.1.3 Seismic loading. The seismic loading for geotechnical hazard assessment and foundation analyses is provided in Section 3103F.4.

3106F.2 Site characterization.

3106F.2.1 Site classes. Each MOT shall be assigned at least one site class, based on site-specific geotechnical information. Site Classes S_A , S_B , S_C , S_D , and S_E are defined in Table 31F-6-1 and Site Class S_F is defined as follows:

1. Soils vulnerable to significant potential loss of stiffness, strength, and/or volume under seismic loading, such as liquefiable soils, quick and highly sensitive clays, and collapsible weakly cemented soils.
2. Peats and/or highly organic clays, where the thickness of peat or highly organic clay exceeds 10 feet.
3. Very high plasticity clays with a plasticity index (PI) greater than 75, where depth of clay exceeds 25 feet.
4. Very thick soft/medium stiff clays, where the depth of clay exceeds 120 feet.

3106F.2.2 Site-specific information. In general, geotechnical characterization shall be based on site-specific information. This information may be obtained from existing or new sources. However, if existing or nonsite specific information is used, the geotechnical engineer of record shall provide adequate justification for its use.

Site-specific investigations shall include, at a minimum, borings and/or cone penetration tests, soil classifications, configuration, foundation loading and an assessment of seismic

hazards. The array (number and depths) of exploratory borings and cone penetration tests (CPT) will depend on the proposed or existing structures and site stratigraphy. The investigation or testing activities shall be completed following the procedures in Section 5 of SCEC [6.3]. CPT data may also be used by first converting to standard penetration test (SPT) data, using an appropriate method, that reflects the effects of soil gradation. If geotechnical data other than SPT and CPT are used, an adequate explanation and rationale shall be provided.

Quantitative soil information is required to a depth of 100 feet below the mudline, for assigning a Site Class (see Table 31F- 6-1). When data to a depth of 100 feet is unavailable, other information such as geologic considerations may be used to determine the Site Class.

3106F.3 Liquefaction. A liquefaction assessment shall address triggering and the resulting hazards, using residual shear strengths of liquefiable soils.

3106F.3.1 Triggering assessment. Liquefaction triggering shall be expressed in terms of the factor of safety (SF):

$$SF = CRR/CSR \quad (6-1)$$

where:

CRR = Cyclic Resistance Ratio

CSR = The Cyclic Stress Ratio induced by Design Peak Ground Acceleration (DPGA) or other postulated shaking

The CRR shall be determined from Figure 7.1 in SCEC [6.3]. If available, both the SPT and CPT data can be used.

CSR shall be evaluated using the simplified procedure in Section 3106F.3.1.1 or site-specific response analysis procedures in Section 3106F.3.1.2.

Shaking-induced shear strength reductions in liquefiable materials are determined as follows:

$$1. SF > 1.4$$

Reductions of shear strength for the materials for postearthquake conditions may be neglected.

**TABLE 31F-6-1
SITE CLASSES**

| SITE CLASS | SOIL PROFILE NAME/GENERIC DESCRIPTION | AVERAGE VALUES FOR TOP 100 FEET OF SOIL PROFILE | | |
|-------------------|--|---|---|---|
| | | Shear Wave Velocity, V_s [ft/sec] | Standard Penetration Test [blows/ft] | Undrained Shear Strength, S_u [psf] |
| S_A | Hard Rock | > 5,000 | — | — |
| S_B | Rock | 2,500 to 5,000 | — | — |
| S_C | Very Stiff/Dense Soil and Soft Rock | 1,200 | > 50 | > 2,000 |
| S_D | Stiff/Dense Soil Profile | 600 to 1,200 | 15 to 50 | 1,000 to 2,000 |
| S_E | Soft/Loose Soil Profile | < 600 | < 15 | < 1,000 |
| S_F | Defined in Section 3106F.2.1 | | | |

Notes:

1. Site Class S_F shall require site specific geotechnical information as discussed in Sections 3106F.2.2 and 3103F.4.
2. Site Class S_E also includes any soil profile with more than 10 feet of soft clay defined as a soil with a plasticity index, $PI > 20$, water content > 40 percent and $S_u < 500$ psf.
3. The plasticity index, PI , and the moisture content shall be determined in accordance with ASTM D4318 [6.1] and ASTM D2216 [6.2], respectively.

2. $1.0 < SF < 1.4$

A strength value intermediate to the material's initial strength and residual undrained shear strength should be selected based on the level of residual excess pore water pressure expected to be generated by the ground shaking (e.g., Figure 10 of Seed and Harder, [6.4]).

3. $SF \leq 1.0$

Reduction of the material shear strength to a residual undrained shear strength level shall be considered, as described in Section 3106F.3.2.

3106F.3.1.1 Simplified procedure. The simplified procedure to evaluate liquefaction triggering shall follow Section 7 of SCEC [6.3]. Cyclic stress ratio (CSR) is used to define seismic loading, in terms of the Design Peak Ground Acceleration (DPGA) and Design Earthquake Magnitude (DEM). DPGA and DEM are addressed in Section 3103F.4.2. CSR is defined as:

$$CSR = 0.65 \left(\frac{DPGA}{g} \right) \left(\frac{\sigma_v}{\sigma'_v} \right) \left(\frac{r_d}{r_{MSF}} \right) \quad (6-2)$$

where:

g = gravitational constant

σ_v = the vertical total stress

σ'_v = the vertical effective stress

r_d = a stress reduction factor

r_{MSF} = the magnitude scaling factor

For values of r_{MSF} and r_d , see SCEC [6.3] Figures 7.2 and 7.3, respectively. To evaluate r_{MSF} , the DEM value associated with DPGA shall be used.

3106F.3.1.2 Site specific response procedure. In lieu of the simplified procedure, either one-dimensional or two-dimensional site response analysis may be performed using the ground motion parameters discussed in Section 3103F.4. The computed cyclic stresses at various points within the pertinent soil layers shall be expressed as values of CSR.

3106F.3.2 Residual strength. The residual undrained shear strength may be estimated from Figure 7.7 of SCEC [6.3]. When necessary, a conservative extrapolation of the range should be made. Under no circumstances, shall the residual shear strength be higher than the shear strength based on effective strength parameters.

The best estimate value should correspond to $1/3$ from the lower bound of the range for a given value of equivalent clean sand SPT blowcount. When a value other than the " $1/3$ value" is selected for the residual shear strength, the selection shall be justified. An alternate method is provided in Stark and Mesri [6.5]. The residual strength of liquefied soils may be obtained as a function of effective confining pressures if a justification is provided. The resulting residual shear strength shall be used as the postearthquake shear strength of liquefied soils.

3106F.4 Other geotechnical hazards. For a SF less than 1.4, the potential for the following hazards shall be evaluated:

1. Flow slides
2. Slope movements
3. Lateral spreading
4. Ground settlement and differential settlement
5. Other surface manifestations

These hazards shall be evaluated, using the residual shear strength described above (Section 3106F.3.2).

3106F.4.1 Stability of earth structures. If a slope failure could affect the MOT, a stability analysis of slopes and earth retaining structures shall be performed. The analysis shall use limit equilibrium methods that satisfy all of the force and/or moment equilibrium conditions and determine the slope stability safety factor.

1. Slope stability safety factor ≥ 1.2

Flow slides can be precluded; however, seismically induced ground movements shall be addressed.

2. $1.0 \leq$ Slope stability safety factor < 1.2

Seismically induced ground movements should be evaluated using the methods described below.

3. Slope stability safety factor < 1.0

Mitigation measures shall be implemented per Section 3106F.6.

3106F.4.2 Simplified ground movement analysis. The seismically induced ground settlement may be estimated using Section 7.6 of SCEC [6.3]. Surface manifestation of liquefaction may be evaluated using Section 7.7 of SCEC. Results shall be evaluated to determine if mitigation measures are required.

Seismically induced deformation or displacement of slopes shall be evaluated using the Makdisi-Seed [6.6] simplified method as described below.

The stability analysis shall be used with the residual shear strengths of soils to estimate the yield acceleration coefficient, K_y , associated with the critical potential movement plane. In general, the DPGA shall be used as K_{max} (see [6.6]) and DEM as the earthquake magnitude, M . These parameters shall be used together with the upper bound curves Figures 9-11 of [6.6], to estimate the seismically induced ground movement along the critical plane.

However, the value of K_{max} may be different from the DPGA value to include the effects of amplification, incoherence, etc. When such adjustments are made in converting DPGA to K_{max} a justification shall be provided. Linear interpolation using the upper bound curves in Figure 10 (ordinate scale should be divided by 10) in [6.6] or Figure 4-10 in Ferritto et al [6.7] can be used to estimate the seismically induced ground movement for other earthquake magnitudes.

For the Ports of Los Angeles and Long Beach, Newmark displacement curves are available and are site-specific

[3.5, 3.6]. Curves are provided for both Level 1 and Level 2 earthquakes, and plot yield acceleration versus lateral displacement.

For screening purposes only, lateral spreading shall be evaluated, using the simplified equations in Youd et al. [6.8]. The total seismically induced ground displacement shall include all contributory directions.

1. When the resulting displacement from the screening method is > 0.1 ft., the Makdisi-Seed simplified method or other similar methods shall be used to estimate lateral spreading.
2. If the computed displacement from the simplified method(s) is ≤ 0.5 ft., the effects can be neglected.
3. If the computed displacements using simplified methods are > 0.5 ft., the use of a detailed ground movement analysis (see Section 3106F.4.3) may be considered.
4. If the final resulting displacement, regardless of the method used, remains > 0.5 ft., it shall be considered in the structural analysis.

3106F.4.3 Detailed ground movement analysis. As an alternative to the simplified methods discussed above, a two-dimensional (2-D) equivalent linear or nonlinear dynamic analysis of the MOT and/or slopes and earth retaining systems may be performed.

An equivalent linear analysis is adequate when the stiffness and/or strength of the soils involved are likely to degrade by less than one-third, during seismic excitation of less than 0.5 g's. Appropriate time histories need to be obtained to calculate seismically induced displacement (see Section 3103F.4.2). Such analysis should account for the accumulating effects of displacement if double-integration of acceleration time histories is used. The seismic stresses or stress time histories from equivalent linear analysis may be used to estimate seismically induced deformation.

A nonlinear analysis should be used if the stiffness and/or strength of the soils involved are likely to degrade by more than one-third during seismic motion.

If the structure is included in the analysis, the ground motion directly affects the structural response. Otherwise, the uncoupled, calculated movement of the soil on the structure shall be evaluated.

3106F.5 Soil structure interaction. Two separate loading conditions for the piles shall be considered: (1) Inertial loading under seismic conditions, and (2) Kinematic loading from lateral ground spreading. Inertial loading is associated with earthquake-induced lateral loading on a structure, while kinematic loading refers to loading on foundation piles from earthquake induced lateral deformations of the slope/embankment/dike system. Simultaneous application of these loading conditions shall be evaluated with due consideration of the phasing and locations of these loads on foundation elements. The foundation design shall meet the structural perfor-

mance requirements of this Code, when subjected to both inertial and kinematic loadings.

3106F.5.1 Soil parameters. Soil structure interaction (SSI) shall be addressed for the seismic evaluation of MOT structures. SSI may consist of linear or non-linear springs (and possibly dash-pots) for various degrees of freedom, including horizontal, vertical, torsional, and rotational, as required by the structural analysis.

Pile capacity parameters may be evaluated using the procedures in Chapter 4 of FEMA 356 [6.9]. The "p-y" curves, "t-z" curves, and tip load — displacement curves for piles (nonlinear springs for horizontal and vertical modes and nonlinear vertical springs for the pile tip, respectively) and deep foundations shall be evaluated using Section 6 of API RP 2A-WSD [6.10] including the consideration of pile group effects. Equivalent springs (and dashpots) representing the degrading properties of soils may be developed.

Where appropriate, alternative procedures can be used to develop these parameters. Rationale for the use of alternative procedures shall be provided. One simplified method is presented in Chapter 4 of the UFC 3-220-01A [6.11] and provides deflection and moment for an isolated pile, subject to a lateral load.

3106F.5.2 Shallow foundations. Shallow foundations shall be assumed to move with the ground. Springs and dashpots may be evaluated as per Gazetas [6.12].

3106F.5.3 Underground structures. Buried flexible structures or buried portions of flexible structures including piles and pipelines shall be assumed to deform with estimated ground movement at depth.

As the soil settles, it shall be assumed to apply shear forces to buried structures or buried portions of structures including deep foundations.

3106F.6 Mitigation measures and alternatives. If the hazards and consequences addressed in Sections 3106F.3 and 3106F.4 are beyond the specified range, the following options shall be considered:

1. Perform a more sophisticated analysis
2. Modify the structure
3. Modify the foundation soil

Examples of possible measures to modify foundation soils are provided in Table 4-1 of [6.7].

3106F.7 Symbols.

SF = Safety Factor

CRR = Cyclic Resistance Ratio

CSR = Cyclic Stress Ratio induced by DPGA

g = Gravitational constant

σ_v = the vertical total stress

σ'_v = the vertical effective stress

r_d = a stress reduction factor

r_{MSF} = the magnitude scaling factor

3106F.8 References.

- [6.1] American Society for Testing and Materials (ASTM), 2002, "D4318-00 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils," West Conshohocken , PA.
- [6.2] American Society for Testing and Materials (ASTM), 2002, "D2216-98 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," West Conshohocken , PA.
- [6.3] Southern California Earthquake Center (SCEC), March 1999, "Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction in California," University of Southern California, Los Angeles.
- [6.4] Seed, R.B. and Harder, C.F., 1999, SPT-Based Analysis of Cyclic Pore Pressure Generation and Undrained Residual Strength, Proceedings of the H.B. Seed Memorial Symposium, Editor: J.M. Duncan, BiTech Publishers Ltd., v. 2, pp. 351-376.
- [6.5] Stark, T.D., and Mesri, G., 1992, Undrained shear strength of liquefied sands for stability analysis, *Journal of Geotechnical Engineering, American Society of Civil Engineers*, v118, n11, pp 1727-1747.
- [6.6] Makdisi, F.I. and Seed, H.B., "Simplified Procedure for Estimating Dam and Embankment Earthquake-Induced Deformations," ASCE Journal of the Geotechnical Engineering Division, Vol. 104, No. 7, pp. 849-867.
- [6.7] Ferritto, J., Dickenson, S., Priestley N., Werner, S., Taylor, C., Burke D., Seelig W., and Kelly, S., 1999, "Seismic Criteria for California Marine Oil Terminals," Vol.1 and Vol.2, Technical Report TR-2103-SHR, Naval Facilities Engineering Service Center, Port Hueneme, CA.
- [6.8] Youd, T. L., Hansen, C. M., and Bartlett, S. F., "Revised MLR Equations for Predicting Lateral Spread Displacement" Proceedings of the 7th U.S.-Japan Workshop on Earthquake Resistant Design of Lifeline Facilities and Countermeasures Against Soil Liquefaction, 1999."
- [6.9] Federal Emergency Management Agency, FEMA -356, Nov. 2000, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.
- [6.10] American Petroleum Institute, December 2000, Recommended Practice 2A-WSD (API RP 2A-WSD), "Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms—Working Stress Design," Washington, D.C.
- [6.11] Department of Defense, 16 January 2004, Unified Facilities Criteria (UFC) 3-220-01A, "Deep Foundations," Washington, D.C.
- [6.12] Gazetas, G., "Formulas and Charts for Impedances of Surface and Embedded Foundations," *Journal of Geotechnical Engineering, ASCE*, Vol. 117, No. 9, September, 1991.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 7

SECTION 3107F STRUCTURAL ANALYSIS AND DESIGN OF COMPONENTS

3107F.1 General.

3107F.1.1 Purpose. This section establishes the minimum performance standards for structural components. Evaluation procedures for seismic performance, strength and deformation characteristics of concrete, steel and timber components are prescribed herein. Analytical procedures for structural systems are presented in Section 3104F.

3107F.1.2 Applicability. This section addresses MOTs constructed using the following structural components:

1. Reinforced concrete decks supported by batter and/or vertical concrete piles
2. Reinforced concrete decks supported by batter and/or vertical steel piles, including pipe piles filled with concrete
3. Reinforced concrete decks supported by batter and/or vertical timber piles
4. Timber decks supported by batter or vertical timber, concrete or steel pipe piles
5. Retaining structures constructed of steel, concrete sheet piles or reinforced concrete

3107F.2 Concrete deck with concrete or steel piles.

3107F.2.1 Component strength. The following parameters shall be established in order to compute the component strength:

1. Specified concrete compressive strengths
2. Concrete and steel modulus of elasticity
3. Yield and tensile strength of mild reinforcing and prestressed steel and corresponding strains
4. Confinement steel strength and corresponding strains
5. Embedment length
6. Concrete cover
7. Yield and tensile strength of structural steel
8. Ductility

In addition, for "existing" components, the following conditions shall be considered:

9. Environmental effects, such as reinforcing steel corrosion, concrete spalling, cracking and chemical attack
10. Fire damage
11. Past and current loading effects, including overload, fatigue or fracture
12. Earthquake damage
13. Discontinuous components
14. Construction deficiencies

3107F.2.1.1 Material properties. Material properties of existing components, not determined from testing procedures, and of new components, shall be established using the following methodology.

The strength of structural components shall be evaluated based on the following values (Section 5.3 of [7.1] and pp. 3-73 and 3-74 of [7.2]):

Specified material strength shall be used for nonductile components (shear controlled), all mechanical, electrical and mooring equipment (attachments to the deck) and for all non seismic load combinations:

$$f'_c = 1.0 f_c \quad (7-1a)$$

$$f'_y = 1.0 f_y \quad (7-1b)$$

$$f'_p = 1.0 f_p \quad (7-1c)$$

In addition, these values (7-1a, 7-1b and 7-1c) may be used conservatively as alternatives to determine the nominal strength of ductile components (N).

Expected lower bound estimates of material strength shall be used for determination of moment-curvature relations and nominal strength of all ductile components:

$$f'_c = 1.3 f_c \quad (7-2a)$$

$$f'_y = 1.1 f_y \quad (7-2b)$$

$$f'_p = 1.0 f_p \quad (7-2c)$$

Upper bound estimates of material strength shall be used for the determination of moment-curvature relations, to obtain the feasible maximum demand on capacity protected members:

$$f'_c = 1.7 f_c \quad (7-3a)$$

$$f'_y = 1.3 f_y \quad (7-3b)$$

$$f'_p = 1.1 f_p \quad (7-3c)$$

where:

f_c' = Specified compressive strength of concrete

f_y' = Specified yield strength of reinforcement or specified minimum yield stress steel

f_p' = Specified yield strength of prestress strands

"Capacity Design" (Section 5.3 of [7.1]) ensures that the strength at protected components (such as pile caps and decks), joints and actions (such as shear), is greater than the maximum feasible demand (over strength), based on realistic upper bound estimates of plastic hinge flexural strength. An additional series of nonlinear analyses using moment curvature characteristics of pile hinges may be required.

Alternatively, if a moment-curvature analysis is performed that takes into account the strain hardening of the steel, the demands used to evaluate the capacity protected components may be estimated by multiplying the moment-curvature values by 1.25.

Based on a historical review of the building materials used in the twentieth century, guidelines for tensile and yield properties of concrete reinforcing bars and the compressive strength of structural concrete have been established (see Tables 6-1 to 6-3 of FEMA 356 [7.3]). The values shown in these tables can be used as default properties, only if as-built information is not available and testing is not performed. The values in Tables 31F-7-1 and 31F-7-2, are adjusted according to equations (7-1) through (7-3).

3107F.2.1.2 Knowledge factor (*k*). Knowledge factor, *k*, shall be applied on a component basis.

The following information is required, at a minimum, for a component strength assessment:

1. Original construction records, including drawings and specifications.

2. A set of "as-built" drawings and/or sketches, documenting both gravity and lateral systems (Section 3102F.1.5) and any postconstruction modification data.
3. A visual condition survey, for structural components including identification of the size, location and connections of these components.
4. In the absence of material properties, values from limited in-situ testing or conservative estimates of material properties (Tables 31F-7-1 and 31F-7-2).
5. Assessment of component conditions, from an in-situ evaluation, including any observable deterioration.
6. Detailed geotechnical information, based on recent test data, including risk of liquefaction, lateral spreading and slope stability.

**TABLE 31F-7-1
COMPRESSIVE STRENGTH OF STRUCTURAL CONCRETE (psi)¹**

| TIME FRAME | PILING | BEAMS | SLABS |
|--------------|-------------|-------------|-------------|
| 1900 1919 | 2,500 3,000 | 2,000 3,000 | 1,500 3,000 |
| 1920 1949 | 3,000 4,000 | 2,000 3,000 | 2,000 3,000 |
| 1950 1965 | 4,000 5,000 | 3,000 4,000 | 3,000 4,000 |
| 1966-present | 5,000-6,000 | 3,000-5,000 | 3,000 5,000 |

1. Concrete strengths are likely to be highly variable for an older structure.

**TABLE 31F-7-2
TENSILE AND YIELD PROPERTIES OF REINFORCING BARS FOR VARIOUS ASTM SPECIFICATIONS AND PERIODS
(after Table 6-2 of [7.3])**

| ASTM | STEEL TYPE | YEAR RANGE ³ | GRADE | STRUCTURAL ¹ | INTERMEDIATE ¹ | HARD ¹ | 60 | 70 | 75 |
|------|------------------------|-------------------------|----------------------------------|-------------------------|---------------------------|-------------------|----|----|----|
| | | | | 33 | 40 | 50 | | | |
| | | | Minimum Yield ² (psi) | 33,000 | 40,000 | 50,000 | | | |
| A15 | Billet | 1911 1966 | | X | X | X | | | |
| A16 | Rail ⁴ | 1913 1966 | | | | X | | | |
| A61 | Rail ⁴ | 1963 1966 | | | | | X | | |
| A160 | Axle | 1936 1964 | | X | X | X | | | |
| A160 | Axle | 1965 1966 | | X | X | X | X | | |
| A408 | Billet | 1957 1966 | | X | X | X | | | |
| A431 | Billet | 1959 1966 | | | | | | X | |
| A432 | Billet | 1959 1966 | | | | | X | | |
| A615 | Billet | 1968 1972 | | | X | | X | | X |
| A615 | Billet | 1974 1986 | | | X | | X | | |
| A615 | Billet | 1987 1997 | | | X | | X | | X |
| A616 | Rail ⁴ | 1968 1997 | | | | X | X | | |
| A617 | Axle | 1968 1997 | | | X | | X | | |
| A706 | Low-Alloy ⁵ | 1974 1997 | | | | | | X | |
| A955 | Stainless | 1996 1997 | | | X | | X | | X |

General Note: An entry "X" indicates that grade was available in those years.

1. The terms structural, intermediate and hard became obsolete in 1968.
2. Actual yield and tensile strengths may exceed minimum values.
3. Until about 1920, a variety of proprietary reinforcing steels were used. Yield strengths are likely to be in the range from 33,000 psi to 55,000 psi, but higher values are possible. Plain and twisted square bars were sometimes used between 1900 and 1949.
4. Rail bars should be marked with the letter "R."
5. ASTM steel is marked with the letter "W."

The knowledge factor, k , is 1.0 when comprehensive knowledge as specified above is utilized. Otherwise, the knowledge factor shall be 0.75 (see Table 2-1 of FEMA 356 [7.3]).

3107F.2.2 Component stiffness. Stiffness that takes into account the stress and deformation levels experienced by the component shall be used. Nonlinear load-deformation relations shall be used to represent the component load-deformation response. However, in lieu of using nonlinear methods to establish the stiffness and moment curvature relation of structural components, the equations of Table 31F-7-3 may be used to approximate the effective elastic stiffness, EI_e , for lateral analyses (see Section 3107F.5 for definition of symbols).

**TABLE 31F-7-3
EFFECTIVE ELASTIC STIFFNESS**

| CONCRETE COMPONENT | EI_e / EI_g |
|---|--|
| Reinforced Pile | $0.3 + N/(f'_c A_g)$ |
| Pile/Deck Dowel Connection ¹ | $0.3 + N/(f'_c A_g)$ |
| Prestressed Pile ¹ | $0.6 < EI_e / EI_g < 0.75$ |
| Steel Pile | 1.0 |
| Concrete w/ Steel Casing | $\frac{E_s I_s + 0.25 E_c I_c}{(E_s I_s + E_c I_c)}$ |
| Deck | 0.5 |

1. The pile/deck connection and prestressed pile may also be approximated as one member with an average stiffness of $0.42 EI_e / EI_g$ (Ferritto et al., 1999 [7.2])

N = is the axial load level.

E_s = Young's modulus for steel

I_s = Moment of inertia for steel section

E_c = Young's modulus for concrete

I_c = Moment of inertia for uncracked concrete section

3107F.2.3 Deformation capacity of flexural members. Stress-strain models for confined and unconfined concrete, mild and prestressed steel presented in Section 3107F.2.4 shall be used to perform the moment-curvature analysis.

The stress-strain characteristics of steel piles shall be based on the actual steel properties. If as-built information is not available, the stress-strain relationship may be obtained per Section 3107F.2.4.2.

For concrete in-filled steel piles, the stress-strain model for confined concrete shall be in accordance with Section 3107F.2.4.1.

Each structural component expected to undergo inelastic deformation shall be defined by its moment-curvature relation. The displacement demand and capacity shall be calculated per Sections 3104F.2 and 3104F.3, as appropriate.

The moment-rotation relationship for concrete components shall be derived from the moment-curvature analysis per Section 3107F.2.5.4 and shall be used to determine lateral displacement limitations of the design. Connection details shall be examined per Section 3107F.2.7.

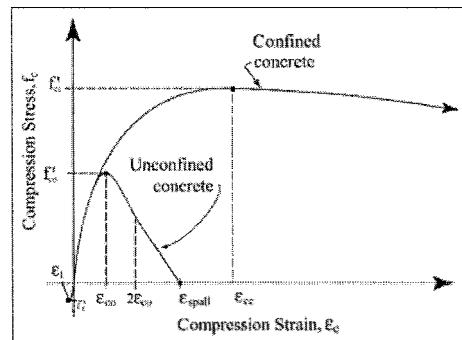
3107F.2.4 Stress-Strain models.

3107F.2.4.1 Concrete. The stress-strain model and terms for confined and unconfined concrete are shown in Figure 31F-7-1.

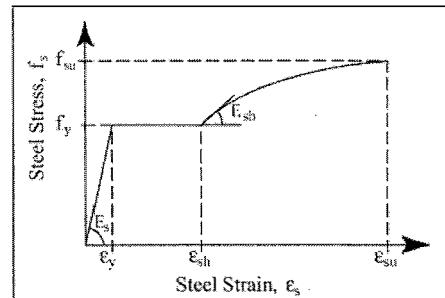
3107F.2.4.2 Reinforcement steel and structural steel. The stress-strain model and terms for reinforcing and structural steel are shown in Figure 31F-7-2.

3107F.2.4.3 Prestressed steel. The stress-strain model of Blakeley and Park [7.4] may be used for prestressed steel. The model and terms are illustrated in Figure 31F-7-3.

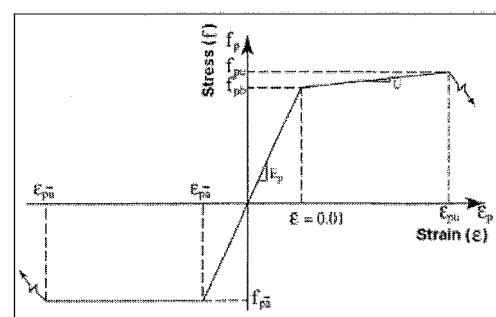
3107F.2.4.4 Alternative stress-strain models. Alternative stress-strain models are acceptable if adequately documented and supported by test results, subject to Division approval.



**FIGURE 31F-7-1
STRESS-STRAIN CURVES FOR CONFINED AND UNCONFINED CONCRETE [7.1]**



**FIGURE 31F-7-2
STRESS-STRAIN CURVE FOR MILD REINFORCING STEEL OR STRUCTURAL STEEL [7.1]**



**FIGURE 31F-7-3
STRESS-STRAIN CURVE FOR PRESTRESSED STEEL [7.4]**

3107F.2.5 Concrete piles.

3107F.2.5.1 General. The capacity of concrete piles is based on permissible concrete and steel strains corresponding to the desired performance criteria.

Different values may apply for plastic hinges forming at in-ground and pile-top locations. These procedures are applicable to circular, octagonal, rectangular and square pile cross sections.

3107F.2.5.2 Stability. Stability considerations are important to pier-type structures. The moment-axial load interaction shall consider effects of high slenderness ratios (kl/r). An additional bending moment due to axial load eccentricity shall be incorporated unless:

$$e/h \leq 0.10 \quad (7-4)$$

where:

e = eccentricity of axial load

h = width of pile in considered direction

3107F.2.5.3 Plastic hinge length. The plastic hinge length is required to convert the moment-curvature relationship into a moment-plastic rotation relationship for the nonlinear pushover analysis.

The pile's plastic hinge length, L_p (above ground), when the plastic hinge forms against a supporting member is:

$$L_p = 0.08L + 0.15f_{ye}d_{bl} \geq 0.3f_{ye}d_{bl} \quad (7-5)$$

where:

L = the distance from the critical section of the plastic hinge to the point of contraflexure

d_{bl} = the diameter of the longitudinal reinforcement

f_{ye} = design yield strength of longitudinal reinforcement (ksi)

If a large reduction in moment capacity occurs due to spalling, then the plastic hinge length shall be:

$$L_p = 0.3f_{ye}d_{bl} \quad (7-6)$$

When the plastic hinge forms in-ground, the plastic hinge length may be determined from Figure 31F-7-4 (see page 311 of [7.1]).

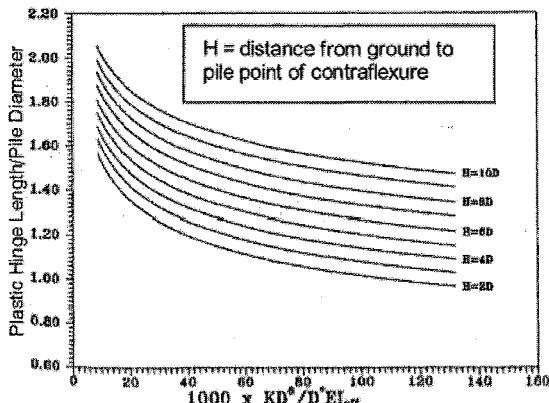


FIGURE 31F-7-4
INFLUENCE OF PILE/SOIL STIFFNESS RATIO ON PLASTIC HINGE LENGTH (after Fig. 5.30 of [7.1])

The stiffness parameter (x -axis) is:

$$\frac{KD^6}{[D^*]EI_e} \quad (7-7)$$

where:

EI_e = the effective stiffness

K = the subgrade modulus

D = pile diameter

D^* = reference diameter of 6 ft

If site specific soil information is not available then the values for K in Table 31F-7-4 may be used.

TABLE 31F-7-4
SUBGRADE MODULUS K

| SOIL TYPE | Avg Undrained Shear Strength [psf] | Subgrade Modulus K [lb/in ³] |
|----------------------------------|------------------------------------|--|
| Soft Clay | 250 500 | 30 |
| Medium Clay | 500 1000 | 100 |
| Stiff Clay | 1000 2000 | 500 |
| Very Stiff Clay | 2000 4000 | 1000 |
| Hard Clay | 4000 8000 | 2000 |
| Loose Sand (above WT/submerged) | | 25/20 |
| Medium Sand (above WT/submerged) | | 90/60 |
| Sand (above WT/submerged) | | 275/125 |

3107F.2.5.4 Plastic rotation. The plastic rotation, ϕ_p , can be determined from Equation 7-8, by using moment-curvature analysis and applicable strain limitations, as shown in Figure 31F-7-5.

The plastic rotation is:

$$\theta_p = L_p \phi_p = L_p (\phi_m - \phi_y) \quad (7-8)$$

where:

L_p = plastic hinge length

ϕ_p = plastic curvature

ϕ_m = maximum curvature

ϕ_y = yield curvature

The maximum curvature, ϕ_m shall be determined by the concrete or steel strain limit state at the prescribed performance level, whichever comes first.

Alternatively, the maximum curvature, ϕ_m may be calculated as:

$$\phi_m = \frac{\epsilon_{cm}}{C_u} \quad (7-9)$$

where:

ϵ_{cm} = max limiting compression strain for the prescribed performance level (Table 31F-7-5)

C_u = neutral-axis depth, at ultimate strength of section

The yield curvature, ϕ_y , is the curvature at the intersection of the secant stiffness, EI_c , through first yield and the nominal strength, ($\epsilon_c = 0.004$)

$$\phi_y = \frac{M_y}{EI_c} \quad (7-10)$$

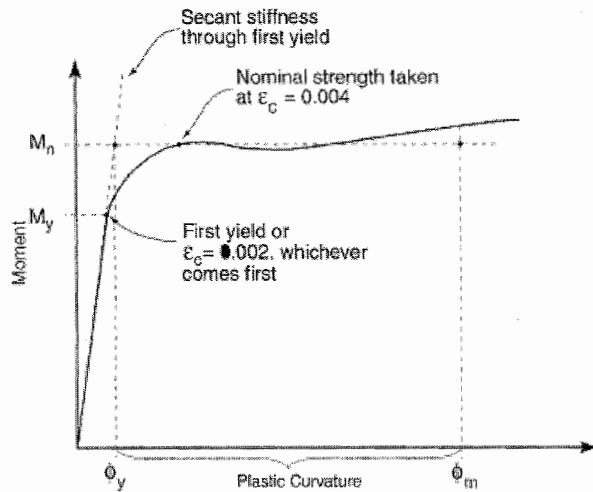


FIGURE 31F-7-5
MOMENT CURVATURE ANALYSIS

3107F.2.5.5 Ultimate concrete and steel flexural strains. Strain values computed in the nonlinear push-over analysis shall be compared to the following limits.

3107F.2.5.5.1 Unconfined concrete piles: An unconfined concrete pile is defined as a pile having no confinement steel or one in which the spacing of the confinement steel exceeds 12 inches.

Ultimate concrete compressive strain:

$$\epsilon_{cu} = 0.005 \quad (7-11)$$

3107F.2.5.5.2 Confined concrete piles:

Ultimate concrete compressive strain [7.1]:

$$\epsilon_{cu} = 0.004 + (1.4\rho_s f_{yh} \epsilon_{sm})/f'_{cc} \geq 0.005 \quad (7-12)$$

$$\epsilon_{cu} \leq 0.025$$

where:

ρ_s = effective volume ratio of confining steel

f_{yh} = yield stress of confining steel

ϵ_{sm} = strain at peak stress of confining reinforcement, 0.15 for grade 40, 0.10 for grade 60

f'_{cc} = confined strength of concrete approximated by $1.5 f'_c$

3107F.2.5.6 Component acceptance/damage criteria. The maximum allowable concrete strains may not exceed the ultimate values defined in Section 3107F.2.5.5. The following limiting values (Table 31F-7-5) apply for each performance level for both existing and new structures. The "Level 1 or 2" refer to the seismic performance criteria (see Section 3104F.2.1).

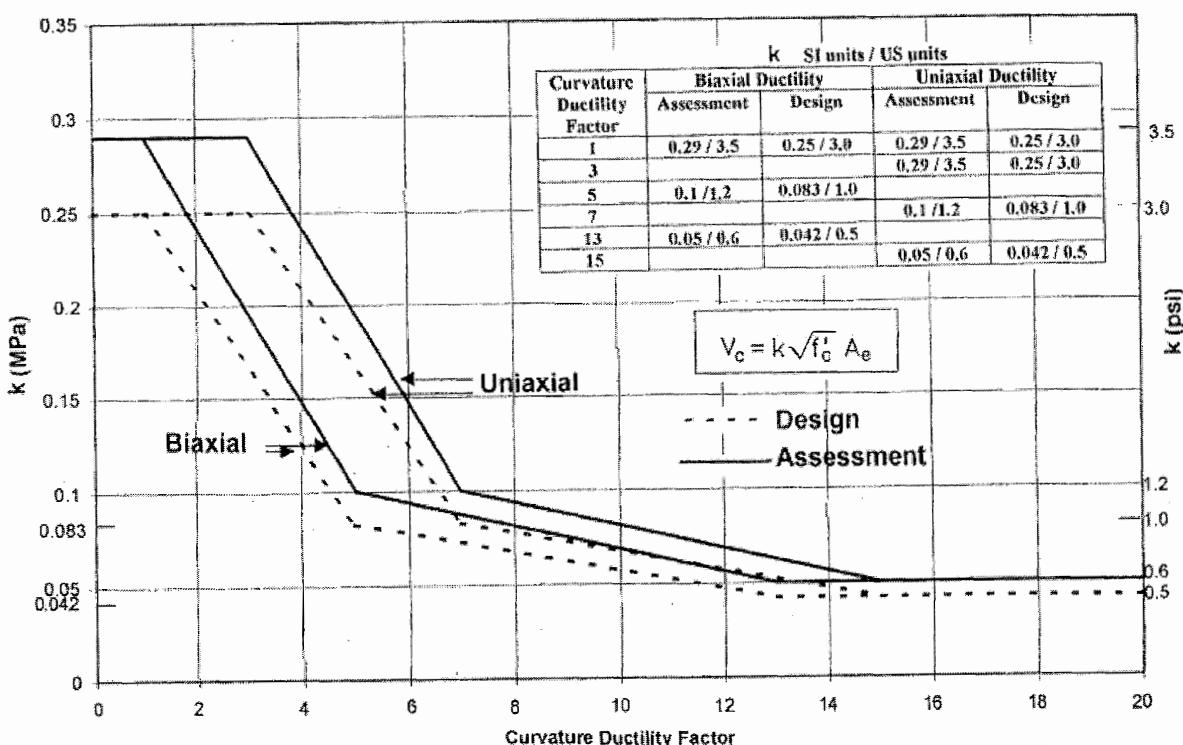


FIGURE 31F-7-6
CONCRETE SHEAR MECHANISM
(from Fig. 3-30 of [7.2])

For all nonseismic loading combinations, concrete components shall be designed in accordance with the ACI requirements [7.5].

Note that for existing facilities, the pile/deck hinge may be controlled by the capacity of dowel reinforcement in accordance with Section 317F.2.7.

**TABLE 31F-7-5
LIMITS OF STRAIN**

| COMPONENT STRAIN | LEVEL 1 | LEVEL 2 |
|--------------------------|--|---|
| MCCS Pile/deck hinge | $\epsilon_c \leq 0.004$ | $\epsilon_c \leq 0.025$ |
| MCCS In ground hinge | $\epsilon_c \leq 0.004$ | $\epsilon_c \leq 0.008$ |
| MRSTS Pile/deck hinge | $\epsilon_s \leq 0.01$ | $\epsilon_s \leq 0.05$ |
| MRSTS In ground hinge | $\epsilon_s \leq 0.01$ | $\epsilon_s \leq 0.025$ |
| MPSTS In ground hinge | $\epsilon_p \leq 0.005$ (incremental) | $\epsilon_p \leq 0.025$ (total strain) |

MCCS = Maximum Concrete Compression Strain, ϵ_c

MRSTS = Maximum Reinforcing Steel Tension Strain, ϵ_s

MPSTS = Maximum Prestressing Steel Tension Strain, ϵ_p

3107F.2.5.7 Shear design. If expected lower bound of material strength Section 3107F.2.1.1 Equations (7-2a, 7-2b, 7-2c) are used in obtaining the nominal shear strength, a new nonlinear analysis utilizing the upper bound estimate of material strength Section 3107F.2.1.1 Equations (7-3a, 7-3b, 7-3c) shall be used to obtain the plastic hinge shear demand. An alternative conservative approach is to multiply the maximum shear demand, V_{max} from the original analysis by 1.4 (Section 8.16.4.4.2 of ATC-32 [7.6]):

$$V_{design} = 1.4V_{max} \quad (7-13)$$

If moment curvature analysis that takes into account strain-hardening, an uncertainty factor of 1.25 may be used:

$$V_{design} = 1.25V_{max} \quad (7-14)$$

Shear capacity shall be based on nominal material strengths, and reduction factors according to ACI-318 [7.5].

As an alternative, the method of Kowalski and Priestley [7.7] may be used. Their method is based on a three-parameter model with separate contributions to shear strength from concrete (V_c), transverse reinforcement (V_s), and axial load (V_p) to obtain nominal shear strength (V_n):

$$V_n = V_c + V_s + V_p \quad (7-15)$$

A shear strength reduction factor of 0.85 shall be applied to the nominal strength, V_n , to determine the design shear strength. Therefore:

$$V_{design} \leq 0.85V_n \quad (7-16)$$

The equations to determine V_c , V_s and V_p are:

$$V_c = k\sqrt{f'_c} A_c \quad (7-17)$$

where:

k = factor dependent on the curvature ductility

$$\mu_\phi = \frac{\phi}{\phi_y}, \text{ within the plastic hinge region, from}$$

Figure 31F-7-6. For regions greater than $2D_p$ (see Equation 7-18) from the plastic hinge location, the strength can be based on $\mu_\phi = 1.0$ (see Ferritto et. al. [7.2]).

f'_c = concrete compressive strength

$A_e = 0.8A_g$ is the effective shear area

Circular spirals or hoops [7.2]:

$$V_s = \frac{\frac{\pi}{2} A_{sp} f_{yh} (D_p - c - c_o) \cot(\theta)}{s} \quad (7-18)$$

where:

A_{sp} = spiral or hoop cross section area

f_{yh} = yield strength of transverse or hoop reinforcement

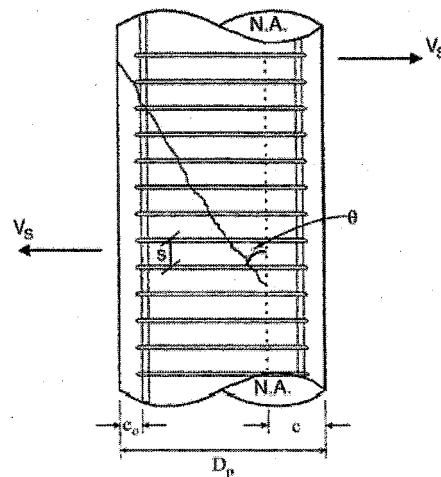
D_p = pile diameter or gross depth (in case of a rectangular pile with spiral confinement)

c = depth from extreme compression fiber to neutral axis (I.V.A.) at flexural strength (see Fig. 31F-7-7)

c_0 = concrete cover to center of hoop or spiral (see Fig. 31F-7-7)

θ = angle of critical crack to the pile axis (see Fig. 31F-7-7) taken as 30° for existing structures, and 35° for new design

s = spacing of hoops or spiral along the pile axis



**FIGURE 31F-7-7
TRANSVERSE SHEAR MECHANISM**

Rectangular hoops or spirals [7.2]:

$$V_s = \frac{A_h f_{yh} (D_p - c - c_o) \cot(\theta)}{s} \quad (7-19)$$

where:

A_h = total area of transverse reinforcement, parallel to direction of applied shear cut by an inclined shear crack

Shear strength from axial mechanism, V_p (see Fig. 31F-7-8):

$$V_p = \Phi(N_u + F_p) \tan \alpha \quad (7-20)$$

where:

N_u = external axial compression on pile including seismic load. Compression is taken as positive; tension as negative

F_p = prestress compressive force in pile

α = angle between line joining centers of flexural compression in the deck/pile and in-ground hinges, and the pile axis

Φ = 1.0 for existing structures, and 0.85 for new design

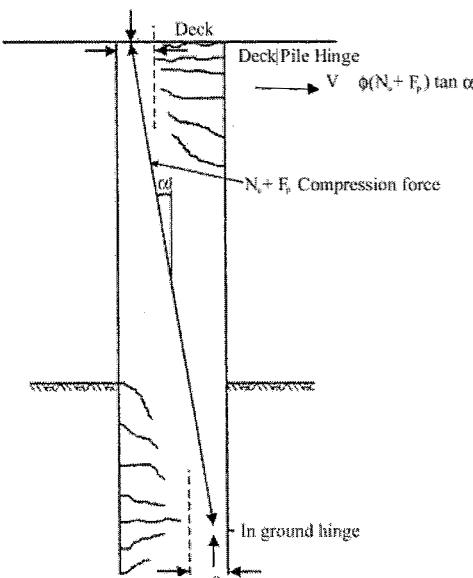


FIGURE 31F-7-8
AXIAL FORCE SHEAR MECHANISM

3107F.2.6 Steel piles.

3107F.2.6.1 General. The capacity of steel piles is based on allowable strains corresponding to the desired performance criteria and design earthquake.

3107F.2.6.2 Stability. Section 3107F.2.5.2 applies to steel piles.

3107F.2.6.3 Plastic hinge length. The plastic hinge length depends on the section shape and the slope of the moment diagram in the vicinity of the plastic hinge.

For plastic hinges forming in steel piles at the deck/pile interface and where the hinge forms in the steel section rather than in a special connection detail (such as a reinforced concrete dowel connection), allowance should be made for strain penetration into the pile cap. This increase

may be taken as $0.25D_p$ where D_p is the pile diameter or pile depth in the direction of the applied shear force.

3107F.2.6.4 Ultimate flexural strain capacity. The following limiting value applies:

Strain at extreme-fiber, $\epsilon_u \leq 0.035$

3107F.2.6.5 Component acceptance/damage criteria. The maximum allowable strain may not exceed the ultimate value defined in Section 3107F.2.6.4. Table 31F-7-6 provides limiting strain values for each performance level, for both new and existing structures.

Steel components for noncompact hollow piles ($D_p/t < 0.07 \times E/f_y$) and for all nonseismic loading combinations shall be designed in accordance with AISC [7.8].

TABLE 31F-7-6
STRUCTURAL STEEL STRAIN LIMITS, ϵ_u

| COMPONENTS | LEVEL 1 | LEVEL 2 |
|----------------------|---------|---------|
| Concrete Filled Pipe | 0.008 | 0.030 |
| Hollow Pipe | 0.008 | 0.025 |

Level 1 or 2 refer to the seismic performance criteria (Section 3104E2.1)

3107F.2.6.6 Shear design. The procedures of Section 3107F.2.5.7, which are used to establish V_{design} are applicable to steel piles.

The shear capacity shall be established from the AISC [7.8]. For concrete filled pipe, equation (7-15) may be used to determine shear capacity; however, V_{pile} must be substituted for V_s .

$$V_{pile} = (\pi/2) t f_{y,pile} (D_p - c - c_o) \cot \theta \quad (7-21)$$

where:

t = steel pile wall thickness

$f_{y,pile}$ = yield strength of steel pile

c_0 = distance from outside of steel pipe to center of hoop or spiral

[All other terms are as listed for Equation (7-18)].

3107F.2.7 Pile/deck connection strength.

3107F.2.7.1 Joint shear capacity. The joint shear capacity shall be computed in accordance with ACI 318 [7.5]. For existing MOTs, the method [7.1, 7.2] given below may be used:

1. Determine the nominal shear stress in the joint region corresponding to the pile plastic moment capacity.

$$v_j = \frac{0.9M_p}{\sqrt{2l_{dv}} D_p^2} \quad (7-22)$$

where:

v_j = Nominal shear stress

M_p = Overstrength moment demand of the plastic hinge (the maximum possible moment in the

pile) as determined from the procedure of Section 3107F.2.5.7.

l_{dv} = Vertical development length, see Figure 31F-7-9

D_p = Diameter of pile

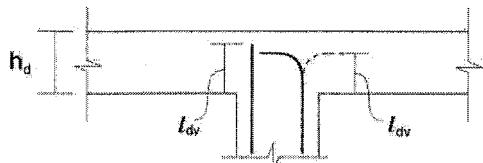


FIGURE 31F-7-9
DEVELOPMENT LENGTH

2. Determine the nominal principal tension p_t , stress in the joint region:

$$p_t = \frac{-f_a}{2} + \sqrt{\left(\frac{f_a}{2}\right)^2 + v_j^2} \quad (7-23)$$

where:

$$f_a = \frac{N}{(D_p + h_d)^2} \quad (7-24)$$

is the average compressive stress at the joint center caused by the pile axial compressive force N and h_d is the deck depth. Note, if the pile is subjected to axial tension under seismic load, the value of N , and f_a will be negative.

If $p_t > 5.0\sqrt{f_c}$, psi, joint failure will occur at a lower moment than the column plastic moment capacity M_p . In this case, the maximum moment that can be developed at the pile/deck interface will be limited by the joint principal tension stress capacity, which will continue to degrade as the joint rotation increases, as shown in Figure 31F-7-10. The moment capacity of the connection at which joint failure initiates can be established from Equations 7-26 and 7-27.

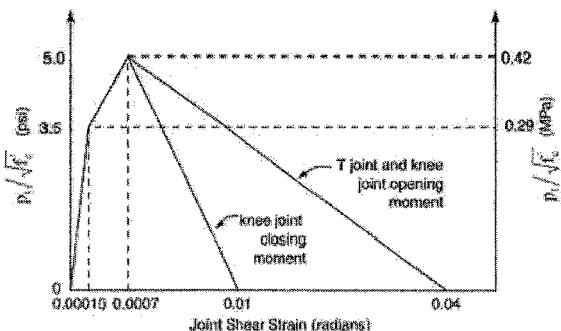


FIGURE 31F-7-10
DEGRADATION OF EFFECTIVE
PRINCIPAL TENSION STRENGTH WITH JOINT
SHEAR STRAIN (rotation) [7.1, pg. 564]

For $p_t = 5.0\sqrt{f_c}$, determine the corresponding joint shear stress, v_j :

$$v_j = \sqrt{p_t(p_t - f_a)} \quad (7-25)$$

3. The moment capacity of the connection can be approximated as:

$$M_c = \left(\frac{1}{90}\right)\sqrt{2}v_j l_{dv} D_p^2 \leq M_p \quad (7-26)$$

This will result in a reduced strength and effective stiffness for the pile in a pushover analysis. The maximum displacement capacity of the pile should be based on a drift angle of 0.04 radians.

If no mechanisms are available to provide residual strength, the moment capacity will decrease to zero as the joint shear strain increases to 0.04 radians, as shown in Figure 31F-7-11.

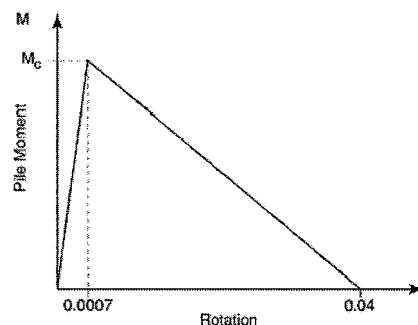


FIGURE 31F-7-11
REDUCED PILE MOMENT CAPACITY

If deck stirrups are present within $h_d/2$ of the face of the pile, the moment capacity, $M_{c,r}$ at the maximum plastic rotation of 0.04 radians may be increased from zero to the following (see Figure 31F-7-12):

$$M_{c,r} = 2A_s f_y (h_d - d_c) + N \left(\frac{D_p}{2} - d_c \right) \quad (7-27)$$

A_s = Area of slab stirrups on one side of joint

h_d = See Figure 31F-7-9 (deck thickness)

d_c = Depth from edge of concrete to center of main reinforcement

In addition, the bottom deck steel (A_s , deckbottom) area within $h_d/2$ of the face of the pile shall satisfy:

$$A_{s,deckbottom} \geq 0.5 \cdot A_s \quad (7-28)$$

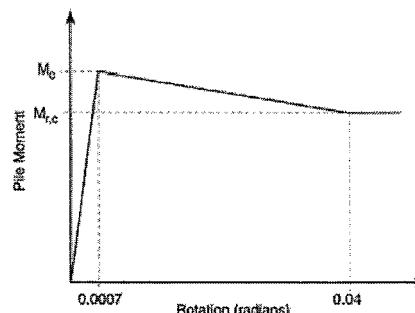


FIGURE 31F-7-12
JOINT ROTATION

4. Using the same initial stiffness as in Section 3107F.2.5.4, the moment-curvature relationship established for the pile top can now be adjusted to account for the joint degradation.

The adjusted yield curvature, ϕ'_y , can be found from:

$$\phi'_y = \frac{\phi_y M_c}{M_n} \quad (7-29)$$

M_n is defined in Figure 31F-7-5.

The plastic curvature, ϕ_p , corresponding to a joint rotation of 0.04 can be calculated as:

$$\phi_p = \frac{0.04}{L_p} \quad (7-30)$$

Where L_p is given by equation 7-5.

The adjusted ultimate curvature, ϕ'_u , can now be calculated as:

$$\phi'_u = \phi_p + \frac{\phi_y M_{c,r}}{M_n} \quad (7-31)$$

Note that $M_{c,r} = 0$ unless deck stirrups are present as discussed above. Examples of adjusted moment curvature relationships are shown in Figure 31F-7-13.

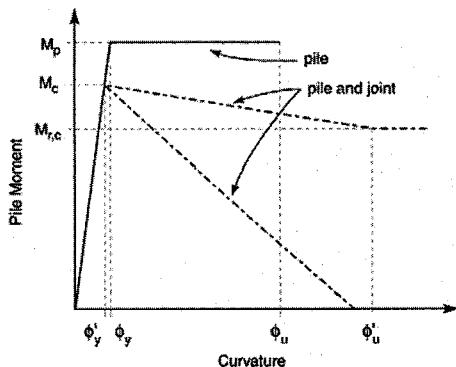


FIGURE 31F-7-13
EQUIVALENT PILE CURVATURE

3107F.2.7.2 Development Length. The development length, l_{dc} is:

$$l_{dc} \geq \frac{0.025 \cdot d_b \cdot f_{ye}}{\sqrt{f_c}} \quad (7-32)$$

where:

d_b = dowel bar diameter

f_{ye} = expected yield strength of dowel

f_c = compressive strength of concrete

In assessing existing details, actual or estimated values for f_{ye} and f_c rather than nominal strength should be used in accordance with Section 3107F.2.1.1.

When the development length is less than that calculated by the equation 7-32, the moment capacity shall be calculated using a proportionately reduced yield strength, $f_{ye,r}$ for the vertical pile reinforcement:

$$f_{ye,r} = f_{ye} \cdot \frac{l_d}{l_{dc}} \quad (7-33)$$

where:

l_d = actual development length

f_{ye} = expected yield strength of dowel

3107F.2.8 Batter piles.

3107F.2.8.1 Existing ordinary batter piles. Wharves or piers with ordinary (not fused, plugged or having a seismic release mechanism) batter piles typically have a very stiff response when subjected to lateral loads in the direction of the batter. The structure often maintains most of its initial stiffness all the way to failure of the first row of batter piles. Since batter piles most likely will fail under a Level 2 seismic event, the following method may be used to evaluate the post-failure behavior of the wharf or pier:

1. Identify the failure mechanism of the batter pile-deck connection (refer to Section 3104F.4.7) for typical failure scenarios and the corresponding lateral displacement.
2. Release the lateral load between the batter pile and the deck when the lateral failure displacement is reached.
3. Push on the structure until subsequent failure(s) have been identified.

As an example, following these steps will result in a force-displacement (pushover) curve similar to the one shown in Figure 31F-7-14 for a wharf supported by one row of batter piles.

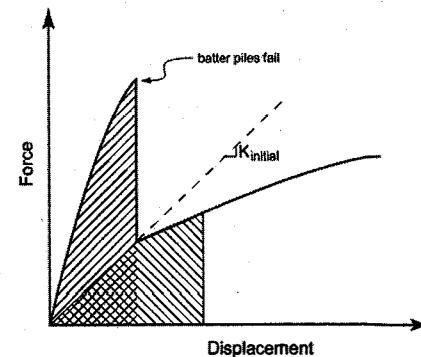


FIGURE 31F-7-14
PUSHOVER CURVE FOR ORDINARY BATTER PILES

When the row of batter piles fail in tension or shear, stored energy will be released. The structure will therefore experience a lateral displacement demand following the nonductile pile failures. If the structure can respond to this displacement demand without exceeding other structural limita-

tions, it may be assumed that the structure is stable and will start to respond to further shaking with a much longer period and corresponding lower seismic demands. The wharf structure may therefore be able to sustain larger seismic demands following the loss of the batter piles than before the loss of pile capacity, because of a much softer seismic response.

The area under the pushover curve before the batter pile failures is compared to the equivalent area under the post-failure pushover curve (refer to Figure 31F-7-14). If no other structural limitations are reached with the new displacement demand, it is assumed that the structure is capable of absorbing the energy. It should be noted that even though the shear failure is nonductile, it is expected that energy will be absorbed and the damping will increase during the damage of the piles. The above method is, therefore, considered conservative.

Following the shear failure of a batter pile row, the period of the structure increases such that equal displacement can be assumed when estimating the post-failure displacement demand. The new period may be estimated from the initial stiffness of the post-failure system as shown in Figure 31F-7-14. A new displacement demand can then be calculated in accordance with Section 3104F.2.

3107F.2.8.2 Nonordinary Batter Piles. For the case of a plugged batter pile system, an appropriate displacement force relationship considering plug friction may be used in modeling the structural system.

For fused and seismic release mechanism batter pile systems, a nonlinear modeling procedure shall be used and peer reviewed (Section 3101F.6.1).

3107F.2.9 Concrete pile caps with concrete deck. Pile caps and decks are capacity protected components. Use the procedure of Section 3107F.2.5.7 to establish the over strength demand of the plastic hinges. Component capacity shall be based on nominal material strengths, and reduction factors according to ACI-318 [7.5].

3107F.2.9.1 Component acceptance/damage criteria. For new pile caps and deck, Level 1 seismic performance shall utilize the design methods in ACI-318 [7.5]; Level 2 seismic performance shall be limited to the following strains:

$$\text{Deck/pile cap: } \epsilon_c \leq 0.005$$

$$\text{Reinforcing steel tension strain: } \epsilon_s \leq 0.01$$

For existing pile caps and deck, the limiting strain values are defined in Table 31F-7-5.

Concrete components for all nonseismic loading combinations shall be designed in accordance with ACI 318 [7.5].

3107F.2.9.2 Shear capacity (strength). Shear capacity shall be based on nominal material strengths; reduction factors shall be in accordance with ACI 318 [7.5].

3107F.2.10 Concrete detailing. For new MOTs, the required development splice length, cover and detailing shall conform to ACI 318 [7.5], with the following exceptions:

1. For pile/deck dowels, the development length may be calculated in accordance with Section 3107F.2.7.2.
2. The minimum concrete cover for prestressed concrete piles shall be three inches, unless corrosion inhibitors are used, in which case a cover of two-and-one-half inches is acceptable.
3. The minimum concrete cover for wharf beams and slabs, and all concrete placed against soil shall be three inches, except for headed reinforcing bars (pile dowels or shear stirrups) the cover may be reduced to two-and-one-half inch cover at the top surface only. If corrosion inhibitors are used, a cover of two-and-one-half inches is acceptable.

3107F.3 Timber piles and deck components.

3107F.3.1 Component strength. The following parameters shall be established in order to assess component strength:

New and existing components:

1. Modulus of rupture
2. Modulus of elasticity
3. Type and grade of timber

Existing components only:

1. Original cross-section shape and physical dimensions
2. Location and dimension of braced frames
3. Current physical condition of members including visible deformation
4. Degradation may include environmental effects (e.g., decay, splitting, fire damage, biological and chemical attack) including its effect on the moment of inertia, I
5. Loading and displacement effects (e.g., overload, damage from earthquakes, crushing and twisting)

Section 3104F.2.2 discusses existing material properties. At a minimum, the type and grade of wood shall be established. The adjusted design stress values in the ANSI/AF&PA NDS [7.9] may be used as default values by replacing the Format Conversion Factor of ANSI/AF&PA NDS [7.9] with the factor 2.8 divided by the Resistance Factor (Table N1 [7.9]).

For deck components, the adjusted design stresses shall be limited to the values of ANSI/AF&PA NDS [7.9]. Piling deformation limits shall be calculated based on the strain limits in accordance with Section 3107F.3.3.3.

The values shown in the ANSI/AF&PA NDS [7.9] are not developed specifically for MOTs and can be used as default properties only if as-built information is not available, the member is not

damaged and testing is not performed. To account for the inherent uncertainty in establishing component capacities for existing structures with limited knowledge about the actual material properties, a reduction (knowledge) factor of $k = 0.75$ shall be included in the component strength and deformation capacity analyses in accordance with Section 3107F.2.1.2.

The modulus of elasticity shall be based on tests or the ANSI/AF&PA NDS Tables 6A and 6B [7.9]. Alternatively the values shown in Table 31F-7-7 may be used for typical timber piles.

**TABLE 31F-7-7 [after (7.9)]
MODULUS OF ELASTICITY (E) FOR TYPICAL TIMBER PILES**

| SPECIES | E (psi) |
|---------------------------|-----------|
| Pacific Coast Douglas Fir | 1,500,000 |
| Red Oak | 1,250,000 |
| Red Pine | 1,280,000 |
| Southern Pine | 1,500,000 |

3107F.3.2 Deformation capacity of flexural members. The displacement demand and capacity of existing timber structures may be established per Section 3104F.2.

The soil spring requirements for the lateral pile analysis shall be in accordance with Section 3106F.

A linear curvature distribution may be assumed along the full length of a timber pile.

The displacement capacity of a timber pile can then be established per Section 3107F.3.3.2.

3107F.3.3 Timber piles.

3107F.3.3.1 Stability. Section 3107F.2.5.2 shall apply to timber piles.

3107F.3.3.2 Displacement capacity. A distinction shall be made between a pier-type pile, with a long unsupported length and a wharf-landside-type pile with a short unsupported length between the deck and soil. The effective length, L , is the distance between the pinned deck/pile connection and in-ground fixity as shown in Figure 31F-7-15. For pier-type (long unsupported length) vertical piles, three simplified procedures to determine fixity or displacement capacity are described in UFC 4-151-10 [7.10], UFC 3-220-01A [7.11] and Chai [7.12].

In order to determine fixity in soft soils, another alternative is to use Table 31F-7-8.

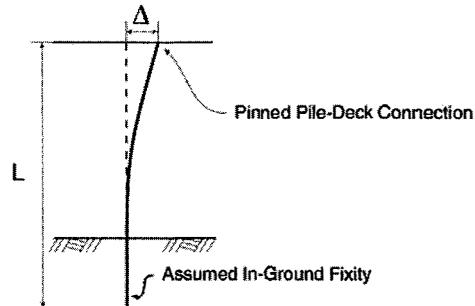
The displacement capacity, Δ , for a pile pinned at the top, with effective length, L , (see Table 31F-7-8 and UFC 4-151-10[7.10]), and moment, M , is:

$$\Delta = \frac{ML^2}{3EI} \quad (7-34)$$

where:

E = Modulus of elasticity

I = Moment of inertia



**FIGURE 31F-7-15
ASSUMED IN-GROUND FIXITY**

Assuming linear curvature distribution along the pile, the allowable curvature, ϕ_a can be established from:

$$\phi_a = \frac{\varepsilon_a}{c_u} \quad (7-35)$$

where:

ε_a = allowable strain limit according to Section 3107F.3.3.3

c_u = distance to neutral axis which can be taken as $D_p/2$, where D_p is the diameter of the pile

The curvature is defined as:

$$\phi = \frac{M}{EI} \quad (7-36)$$

The maximum allowable moment therefore becomes:

$$M = \frac{2\varepsilon_a L^2}{D_p EI} \quad (7-37)$$

The displacement capacity is therefore given by:

$$\Delta = \frac{2\varepsilon_a L^2}{3D_p} \quad (7-38)$$

**TABLE 31F-7-8
DISTANCE BELOW GROUND TO POINT OF FIXITY**

| PILE EI _g | SOFT CLAYS | LOOSE GRANULAR & MEDIUM CLAYS |
|---------------------------------------|------------|-------------------------------|
| < 10 ¹⁰ lb in ² | 10 feet | 8 feet |
| > 10 ¹⁰ lb in ² | 12 feet | 10 feet |

3107F.3.3.3 Component acceptance/damage criteria. The following limiting strain values apply for each seismic performance level for existing structures:

**TABLE 31F-7-9
LIMITING STRAIN VALUES FOR TIMBER**

| EARTHQUAKE LEVEL | MAX. TIMBER STRAIN |
|------------------|--------------------|
| Level 1 | 0.002 |
| Level 2 | 0.004 |

For new and alternatively, for existing structures ANSI/AF&PA NDS [7.9] may be used.

Timber components for all nonseismic loading combinations shall be designed in accordance with ANSI/AF&PA NDS [7.9].

3107F.3.3.4 Shear design. To account for material strength uncertainties, the maximum shear demand, V_{max} established from the single pile lateral analysis shall be multiplied by 1.2:

$$V_{demand} = 1.2V_{max} \quad (7-39)$$

The factored maximum shear stress demand τ_{max} in a circular pile can then be determined:

$$\tau_{max} = \frac{10}{9} \frac{V_{demand}}{\pi \cdot r^2} \quad (7-40)$$

where:

r = radius of pile

For the seismic load combinations, the maximum allowable shear stress, $\tau_{capacity}$, is the design shear strength, τ_{design} , from the ANSI/AF&PA NDS [7.9] multiplied by a factor of 2.8.

$$\tau_{capacity} = 2.8\tau_{design} \quad (7-41)$$

The shear capacity must be greater than the maximum demand.

3107F.4 Retaining structures. Retaining structures constructed of steel or concrete shall conform to AISC [7.8] or ACI 318 [7.5] respectively. For the determination of static and seismic loads on the sheet pile and sheet pile behavior, the following references are acceptable: NCEL [7.13], Strom and Ebeling [7.14], and PIANC TC-7(Technical Commentary - 7) [7.15]. The applied loads and analysis methodology shall be determined by a California registered geotechnical engineer, and may be subject to peer review.

3107F.5 Mooring and berthing components. Mooring components include bitts, bollards, cleats, pelican hooks, capstans, mooring dolphins and quick release hooks.

Berthing components include fender piles and fenders, which may be camels, fender panels or wales.

Applicable safety factors to be applied to the demand are provided in Section 3103F.10.

3107F.5.1 Component strength. The following parameters shall be established in order to calculate component strength:

New and existing components:

1. Yield and tensile strength of structural steel
2. Structural steel modulus of elasticity
3. Yield and tensile strength of bolts
4. Concrete infill compressive strength
5. Concrete infill modulus of elasticity

Additional parameters for existing components:

1. Condition of steel including corrosion
2. Effective cross-sectional areas
3. Condition of embedment material such as concrete slab or timber deck

3107F.5.2 Mooring and berthing component demand. The maximum mooring line forces (demand) shall be estab-

lished per Section 3105F. Multiple lines may be attached to the mooring component at varying horizontal and vertical angles. Mooring components shall therefore be checked for all the mooring analysis load cases. The maximum demand on breasting dolphins and fender piles shall be established according to Sections 3103F.6 and 3105F.

3107F.5.3 Capacity of mooring and berthing components. The structural and connection capacity of mooring components bolted to the deck shall be established in accordance with AISC [7.8], ACI-318 [7.5], ANSI/AF&PA NDS [7.9] as appropriate. The mooring component capacity may be governed by the strength of the deck material. Therefore, a check of the deck capacity to withstand mooring component loads shall be performed.

3107F.6 Symbols.

A_e = Effective shear area

A_g = Uncracked, gross section area

A_h = Total area of transverse reinforcement, parallel to direction of applied shear cut by an inclined shear crack

A_s = Area of reinforcing steel

A_{sp} = Spiral or hoop cross section area

c = Depth from extreme compression fiber to neutral axis at flexural strength

c_0 = Outside of steel pipe to center of hoop or spiral or concrete cover to center of hoop or spiral

c_u = Value of neutral axis depth at ultimate strength of section

D = Pile diameter

D^* = Reference diameter of 6 ft

d_b = Dowel bar diameter

d_c = Depth from edge of concrete to center of reinforcement

d_{bl} = Diameter of the longitudinal reinforcement

D_c = Depth of pile cap

D_p = Pile diameter or gross depth (in case of a rectangular pile with spiral confinement)

e = Eccentricity of axial load

ϵ_a = Allowable strain limit

ϵ_{cm} = Max extreme fiber compression strain

ϵ_{dcu} = Ultimate concrete compressive strain

ϵ_{sm} = Strain at peak stress of confining reinforcement

ϵ_u = Ultimate steel strain

E = Modulus of elasticity

f'_c = Concrete compression strength

f'_{cc} = Confined strength of concrete

F_p = Prestress compression force in pile

f_p = Yield strength of prestress strands

f_y = Yield strength of steel

f_{ye} = Design yield strength of longitudinal or dowel reinforcement (ksi)
 f_{yh} = Yield stress of confining steel
 f_{yh} = Yield strength of transverse or hoop reinforcement
 $f_{y,pile}$ = Yield strength of steel pile
 $f_{ye,r}$ = Reduced dowel yield strength
 h = Width of pile in considered direction
 h_d = Deck depth
 H = Distance from ground to pile point of contraflexure
 I_c = Moment of inertia of uncracked section
 I_e = Effective moment of inertia
 I_g = Gross moment of inertia
 K = Subgrade modulus
 k = Factor dependent on the curvature ductility $\mu_\phi = \phi/\phi_y$ within the plastic hinge region
 k = Knowledge factor
 L = The distance from the critical section of the plastic hinge to the point of contraflexure
 L_p = Plastic hinge length
 l_{dc} = Minimum development length
 l_d = Existing development length
 l_{dv} = Vertical development length
 M_c = Moment capacity of the connection
 $M_{c,r}$ = Moment capacity at plastic rotation
 M_n = Moment at secant stiffness
 M_p = Moment as determined from a pushover analysis at displacements corresponding to the damage control limit state
 M_y = Moment at first yield
 N = Pile axial compressive force
 N_u = External axial compression on pile including load due to earthquake action
 ρ_s = Effective volume ratio of confining steel
 ρ_t = Nominal principal tension
 r = Radius of circular pile
 s = Spacing of hoops or spiral along the pile axis
 t = Pile wall thickness
 Δ = Displacement
 Φ = 1.0 for existing structures, and 0.85 for new design
 Θ = Angle of critical crack to the pile axis (taken as 30° for existing structures, and 35° for new design)
 Θ_p = Plastic rotation
 α = Angle between line joining centers of flexural compression in the deck/pile and in-ground hinges, and the pile axis
 ϕ_a = Allowable curvature

ϕ_m = Maximum curvature
 ϕ_p = Plastic curvature
 ϕ_u = Ultimate curvature
 ϕ'_u = Adjusted ultimate curvature
 ϕ_y = Yield curvature
 ϕ'_y = Adjusted yield curvature
 τ_{max} = Maximum shear stress
 V_c = Concrete shear strength
 v_j = Joint shear stress
 V_{design} = Design shear strength
 V_{max} = Maximum shear demand
 V_n = Nominal shear strength
 V_s = Transverse reinforcement shear capacity (strength)
 V_{pile} = Shear strength of steel pile

3107F.6 References.

- [7.1] Priestley, M.J.N, Seible, F. and Calvi, G.M. "Seismic Design and Retrofit of Bridges," 1996, New York.
- [7.2] Ferritto, J., Dickenson, S., Priestley N., Werner, S., Taylor, C., Burke D., Seelig W., and Kelly, S., 1999, "Seismic Criteria for California Marine Oil Terminals, Vol.1 and Vol.2," Technical Report TR-2103-SHR, Naval Facilities Engineering Service Center, Port Hueneme, CA.
- [7.3] Federal Emergency Management Agency, FEMA -356, Nov. 2000, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.
- [7.4] Blakeley, J.P., Park, R., "Prestressed Concrete Sections with Cyclic Flexure," Journal of the Structural Division, American Society of Civil Engineers, Vol. 99, No. ST8, August 1973, pp. 1 71 7-1 742, Reston, VA.
- [7.5] American Concrete Institute, ACI318-05, 2005, "Building Code Requirements for Structural Concrete (318-05) and Commentary (318R-05)," Farmington Hills, Michigan.
- [7.6] Applied Technology Council, 1996, ATC-32, "Improved Seismic Design Criteria for California Bridges: Provisional Recommendations," Redwood City, CA.
- [7.7] Kowalski, M.J. and Priestley, M.J.N., "Shear Strength of Ductile Bridge Columns," Proc. 5th Caltrans Seismic Design Workshop, Sacramento, June 1998.
- [7.8] American Institute of Steel Construction (AISC), 2005, "Steel Construction Manual," Thirteenth Edition, Chicago, IL

- [7.9] American Forest & Paper Association, 2005, "National Design Specification for Wood Construction," ANSI/AF&PA NDS-2005, Washington, D.C.
- [7.10] Department of Defense, 10 September 2001, Unified Facilities Criteria (UFC) 4-151-10, "General Criteria for Waterfront Construction, Washington, D.C.
- [7.11] Department of Defense, 16 January 2004, Unified Facilities Criteria (UFC) 3-220-01A, "Deep Foundations," Washington, D.C.
- [7.12] Chai, Y.H., "Flexural Strength and Ductility of Extended Pile-Shafts, I: Analytical Model", Journal of Structural Engineering, May 2002, pp. 586–594.
- [7.13] Ebeling, Robert M. and Morrison, Ernest E., Jr., "The Seismic Design of Waterfront Retaining Structures", U.S. Army Technical Report ITL-92-11/U.S. Navy Technical Report NCEL TR 939, Dept. of Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, MS, November 1992.
- [7.14] Strom, Ralph W. and Robert M. Ebeling, "State of the Practice in the Design of Tall, Stiff, and Flexible Tieback Retaining Walls", Information Technology Laboratory, Engineer Research and Development Center, U.S. Army Corps of Engineers, Vicksburg, MS, December 2001.
- [7.15] Permanent International Association of Navigation Congresses (PIANC), "Seismic Design Guidelines for Port Structures," Technical Commentary-7, Working Group No. 34 of the Maritime Navigation Commission International Navigation Association, A.A. Balkema, Lisse, Netherlands. 2001.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 8

SECTION 3108F FIRE PREVENTION, DETECTION AND SUPPRESSION

3108F.1 General. This section provides minimum standards for fire prevention, detection and suppression at MOTs. See Section 3101F.3 for definitions of "new" (N) and "existing" (E).

3108F.2 Hazard assessment and risk analysis.

3108F.2.1 Fire hazard assessment and risk analysis (N/E). A fire hazard assessment and risk analysis shall be performed, considering the loss of commercial power, earthquake and other relevant events.

3108F.2.2 Fire Protection Assessment (N/E). A site-specific Fire Protection Assessment shall be prepared by a registered engineer or a competent fire protection professional. The assessment shall consider the hazards and risks identified per Section 3108F.2.1 and shall include, but not be limited to, the elements of prefire planning as discussed in Section 9 of [8.1] and Chapter 3 of [8.2]. The Fire Protection Assessment shall include goals, resources, organization, strategy and tactics, including the following:

1. MOT characteristics (e.g., tanker/manifold, product pipelines, etc.)
2. Product types and fire scenarios
3. Possible collateral fire damage to adjacent facilities
4. Fire-fighting capabilities, including availability of water (flow rates and pressure), foam type and associated shelf life, proportioning equipment, and vehicular access [8.1, 8.3]
5. The selection of appropriate extinguishing agents [8.1, 8.2]
6. Calculation of water and foam capacities, as applicable, consistent with area coverage requirements [8.1]
7. Coordination of emergency efforts
8. Emergency escape routes [8.2, 8.3]
9. Requirements for fire drills, training of personnel, and the use of equipment
10. Life safety
11. Rescue for terminal and vessel personnel [8.1]
12. Cooling water for pipelines and valves exposed to the heat
13. Contingency planning when supplemental fire support is not available. Mutual aid agreements can apply to water and land based support
14. Consideration of adverse conditions, such as electrical power failure, steam failure, fire pump failure, an earthquake or other damage to the fire water system.

The audit team shall review and field verify the fire-fighting equipment locations and condition and may check its operability.

3108F.2.3 Cargo liquid and fire hazard classifications (N/E). The cargo liquid hazard classes are defined in Table 31F-8-1, as either High (H_C) or Low (L_C), depending on the flash point.

Fire hazard classifications (Low, Medium or High) are defined in Table 31F-8-2, and are based on the cargo liquid hazard class and the sum of all stored and flowing volumes, prior to the emergency shut down system (ESD) stopping the flow of oil.

The stored volume is the sum of the H_C and L_C liquid hazard class piping volumes (V_{SH} and V_{SL}), if the piping is not stripped.

During a pipeline leak, a quantity of oil is assumed to spill at the maximum cargo flow rate until the ESD is fully effective. The ESD valve closure is required to be completed in 60 seconds if installed prior to November 1, 1980 or in 30 seconds if installed after that date (2 CCR 2380(h)(3))[8.3]. The flowing volume is the sum of the H_C and L_C liquid hazard class volumes (V_{FH} and V_{FL}), and shall be calculated as follows:

$$V_F = Q_C \times \Delta t \times (1/3,600) \quad (8-1)$$

where:

V_F = Flowing Volume (V_{FH} or V_{FL}) [bbl]

Q_C = Cargo Transfer Rate [bbl/hr]

Δt = ESD time, 30 or 60 seconds

3108F.3 Fire prevention.

3108F.3.1 Ignition source control.

3108F.3.1.1 Protection from ignition by static electricity, lightning or stray currents shall be in accordance with API RP 2003 [8.5](N/E).

3108F.3.1.2 Requirements to prevent electrical arcing shall be in conformity with 2 CCR 2341 [8.3] (N/E).

3108F.3.1.3 Multiberth terminal piers shall be constructed so as to provide a minimum of 100 ft between adjacent manifolds (N).

3108F.3.2 Emergency shutdown systems. An essential measure of fire prevention is communications in conjunction with the emergency shutdown. The ESD and isolation system shall conform to 2 CCR 2380 (h) [8.3] and 33 CFR 154.550 [8.6]. An ESD system shall include or provide:

1. An ESD valve, located near the dock manifold connection or loading arm (N/E).
2. ESD valves, with "Local" and "Remote" actuation capabilities (N).
3. Remote actuation stations strategically located, so that ESD valve(s) may be shut within required times (N).

**TABLE 31F-8-1
CARGO LIQUID HAZARD CLASS**

| CLASS | CRITERION | REFERENCE | EXAMPLES |
|----------------|--|---------------------------------------|--------------------------------------|
| Low (L_C) | Flash Point $\geq 140^{\circ}\text{F}$ | ISGOTT (Chapter 1, [8.4])—Nonvolatile | #6 Heavy Fuel Oil, residuals, bunker |
| High (H_C) | Flash Point $< 140^{\circ}\text{F}$ | ISGOTT (Chapter 1, [8.4]) Volatile | Gasoline, JP4, crude oils |

**TABLE 31F-8-2
FIRE HAZARD CLASSIFICATIONS**

| CLASS | STORED VOLUME (bbl) | | | FLOWING VOLUME (bbl) | | CRITERIA (bbis)* |
|--------|---------------------|----------|----------|----------------------|----------|--|
| | Stripped | V_{SL} | V_{SH} | V_{FL} | V_{FH} | |
| LOW | y | n | n | y | y | $V_{FL} \geq V_{FH}$, and $V_T \leq 1200$ |
| LOW | n | y | n | y | n | $V_{SL} + V_{FL} \leq 1200$ |
| MEDIUM | n | n | y | n | y | $V_{SH} + V_{FH} \leq 1200$ |
| MEDIUM | y | n | n | y | y | $V_{FH} > V_{FL}$, and $V_T \leq 1200$ |
| HIGH | y | n | n | y | y | $V_T > 1200$ |
| HIGH | n | y | y | y | y | $V_T > 1200$ |
| HIGH | n | y | n | y | n | $V_{SL} + V_{FL} > 1200$ |
| HIGH | n | n | y | n | y | $V_{SH} + V_{FH} > 1200$ |

y = yes

n = no

Stripped = product purged from pipeline following product transfer event.

V_{SL} = stored volume of low hazard class product

V_{SH} = stored volume of high hazard class product

V_{FL} = volume of low hazard class product flowing through transfer line during 30–60 secs. ESD.

V_{FH} = volume of high hazard class product flowing through transfer line during 30–60 secs. ESD.

$V_T = V_{SL} + V_{SH} + V_{FL} + V_{FH}$ = Total Volume (stored and flowing)

* Quantities are based on maximum flow rate, including simultaneous transfers.

4. Multiple actuation stations installed at strategic locations, so that one such station is located more than 100 ft from areas classified as Class I, Group D, Division 1 or 2 [8.7]. Actuation stations shall be wired in parallel to achieve redundancy and arranged so that fire damage to one station will not disable the ESD system (N).
5. Communications or control circuits to synchronize simultaneous closure of the shore isolation valves (SIVs) with the shut down of loading pumps (N).
6. A manual reset to restore the ESD system to an operational state after each initiation (N).
7. An alarm to indicate failure of the primary power source (N).
8. A secondary (emergency) power source (N).
9. Periodic testing of the system (N/E).
10. Fire proofing of motors and control cables that are installed in areas classified as Class I, Group D, Division 1 or 2 [8.7]. Fire proofing shall, at a minimum, comply with the recommendations of API Publication 2218 (see Section 6 of [8.8]) (N).

3108F.3.3 Shore Isolation Valves (SIV). Shore isolation valve(s) shall:

1. Be located onshore for each cargo pipeline. All SIVs shall be clustered together, for easy access (N).

2. Be clearly identified together with associated pipeline (N/E).
3. Have adequate lighting (N/E).
4. Be provided with communications or control circuits to synchronize simultaneous closure of the ESD system with the shut down of loading pumps (N).
5. Have a manual reset to restore the SIV system to an operational state after each shut down event (N).
6. Be provided with thermal expansion relief to accommodate expansion of the liquid when closed. Thermal relief piping shall be properly sized and routed around the SIV, into the downstream segment of the pipeline or into other containment (N/E).

SIVs installed in pipelines carrying hazard class, HC liquids, or at a MOT with a risk classification "Medium" or "High" (see Table 31F-4-1), shall be equipped with "Local" and "Remote" actuation capabilities. Local control SIVs may be motorized and/or operated manually (N).

3108F.4 Fire detection. An MOT shall have a permanently installed automated fire detection or sensing system (N).

Fire detection systems shall be tested and maintained per the manufacturer or the local enforcing agency requirements. Specifications shall be retained. The latest testing and maintenance records shall be readily accessible to the Division (N/E).

3108F.5 Fire alarms. Automatic and manual fire alarms shall be provided at strategic locations. The fire alarm system shall be arranged to provide a visual and audible alarm that can be readily discerned by all personnel at the MOT. Additionally, visual and audible alarms shall be displayed at the Facility's Control Center (N/E).

If the fire alarm system is integrated with the ESD system, the operation shall be coordinated with the closure of SIVs, block valves and pumps to avoid adverse hydraulic conditions (N/E).

Fire alarms shall be tested and maintained in accordance with NFPA-72 [8.9] or the local enforcing agency requirements. Specifications shall be retained. The latest testing and maintenance records shall be readily accessible to the Division (N/E).

3108F.6 Fire suppression. Table 31F-8-3 gives the minimum provisions for fire-water flow rates and fire extinguishers. The table includes consideration of the fire hazard classification (Low, Medium or High), the cargo liquid hazard class (Low or High) and the vessel or barge size. The minimum provisions may have to be augmented for multi-berth terminals or those conducting simultaneous transfers, in accordance with the risks identified in the Fire Protection Assessment.

3108F.6.1 Coverage (N/E). The fire suppression system shall provide coverage for:

1. Marine structures including the pier/wharf and approach trestle
2. Terminal cargo manifold
3. Cargo transfer system including loading arms, hoses and hose racks
4. Vessel manifold
5. Sumps

6. Pipelines

7. Control stations

3108F.6.2 Fire hydrants. Hydrants shall be located not greater than 150 ft apart, along the wharf and not more than 300 ft apart on the approach trestle [8.4] (N).

Additional hose connections shall be provided at the base of fixed monitors and upstream of the water and foam isolation valves. Connections shall be accessible to fire trucks or mutual aid equipment as identified in the Fire Protection Assessment (N/E).

Hydrants and hoses shall be capable of applying two independent water streams covering the cargo manifold, transfer system, sumps and vessel manifold (N/E).

3108F.6.3 Fire water. The source of fire water shall be reliable and provide sufficient capacity as determined in the Fire Protection Assessment. Water-based fire protection systems shall be tested and maintained per NFPA 25 [8.10], as adopted and amended by the State Fire Marshal, or the local enforcing agency requirements. Specifications shall be retained. The latest testing and maintenance records shall be readily accessible to the Division (N/E).

1. All wet systems shall be kept pressurized (jockey pump or other means) (N/E).
2. Wet system headers shall be equipped with a low-pressure alarm wired to the control room (N).
3. Fire pumps shall be installed at a distance of at least 100 ft from the nearest cargo manifold area (N).
4. Hose connections for fireboats or tugboats shall be provided on the MOT fire water line, and at least one connection shall be an international shore fire connection at each berth [8.4]. Connections shall be installed at a safe access distance from the high-risk

TABLE 31F-8-3
MINIMUM FIRE SUPPRESSION PROVISIONS (N/E)

| FIRE HAZARD CLASSIFICATION (From Table 31F-8-2) | VESSEL AND CARGO LIQUID HAZARD CLASS (From Table 31F-8-1) | MINIMUM PROVISIONS |
|--|--|--|
| LOW | Barge with L_C (including drums) | 500 gpm of water 2 x 20 lb portable dry chemical and 2 x 110 lb wheeled dry chemical extinguishers or the equivalent. |
| | Barge with H_C (including drums) Tankers < 50 KDWT, handling L_C or H_C | 1,500 gpm of water 2 x 20 lb portable dry chemical and 2 x 165 lb wheeled dry chemical extinguishers or the equivalent |
| MEDIUM | Tankers < 50 KDWT handling L_C | 1,500 gpm of water 2 x 20 lb portable dry chemical and 2 x 165 lb wheeled dry chemical extinguishers or the equivalent. |
| | Tankers < 50 KDWT, handling H_C | 2,000 gpm of water 4 x 20 lb portable dry chemical and 2 x 165 lb wheeled dry chemical extinguishers or the equivalent. |
| HIGH | Tankers < 50 KDWT, handling L_C or H_C | 3,000 gpm of water 4 x 20 lb portable dry chemical and 2 x 165 lb wheeled dry chemical extinguishers or the equivalent. |
| LOW, MEDIUM, HIGH | Tankers > 50 KDWT, handling L_C or H_C | 3,000 gpm of water 6 x 20 lb portable dry chemical and 4 x 165 lb wheeled dry chemical extinguishers or the equivalent. |

Notes: L_C and H_C are defined in Table 31F-8-1. KDWT = Dead Weight Tons (Thousands)

areas such as sumps, manifolds and loading arms (N/E).

3108F.6.4 Foam supply (N/E). Product flammability, foam type, water flow rates and application duration shall be considered in foam supply calculations.

Fixed foam proportioning equipment shall be located at a distance of at least 100 ft from the high-risk areas such as sump, manifold and loading arms, except where hydraulic limits of the foam delivery system require closer proximity.

MOTs shall have a program to ensure that foam is replaced according to the manufacturer's recommendations.

3108F.6.5 Fire monitor systems. Fire monitors shall be located to provide coverage of MOT cargo manifolds, loading arms, hoses, and vessel manifold areas. This coverage shall provide at least two independent streams of water/foam. Monitors shall be located to provide an unobstructed path between the monitor and the target area (N/E).

If the vessel manifold is more than 30 ft above the wharf deck, the following factors shall be considered, in order to determine if monitors located on elevated masts or towers are required (N/E):

1. Maximum tanker freeboard
2. Tidal variations
3. Pier/wharf/loading platform elevation
4. Winds
5. Fire water line pressure

Sprinklers and/or remotely controlled water/foam monitors shall be installed to protect personnel, escape routes, shelter locations and the fire water system (N).

Isolation valves shall be installed in the fire water and the foam lines in order to segregate damaged sections without disabling the entire system. Readily accessible isolation valves shall be installed 100–150 ft from the manifold and the loading arm/hose area (N).

3108F.6.6 Supplemental fire suppression systems (E). A supplemental system is an external waterborne or land-based source providing suppressant and equipment. Supplemental systems may not provide more than one-quarter of the total water requirements specified in the Fire Protection Assessment.

Additionally, supplementary systems shall not be considered in a Fire Protection Assessment, unless available within 20 minutes following the initiation of a fire alarm. Mutual aid may be considered as part of the supplemental system.

3108F.7 Critical systems seismic assessment (N/E). Fire detection and protection systems, and emergency shutdown systems shall have a seismic assessment per Section 3104F.5.3. For equipment anchorages and supports, see Section 3110F.8.

3108F.8 References.

- [8.1] American Petroleum Institute, 1998, API Recommended Practice 2001 (API RP 2001), "Fire Protection in Refineries," 7th ed., Washington, D.C.

[8.2] Oil Companies International Marine Forum (OCIMF), 1987, "Guide on Marine Terminal Fire Protection and Emergency Evacuation," 1st ed., Witherby, London.

[8.3] 2 CCR 2300-2407 (Title 2, California Code of Regulations, Sections 2300-2407).

[8.4] International Chamber of Shipping (ICS), Oil Companies International Marine Forum (OCIMF), International Association of Ports and Harbors (IAPH), 2006, "International Safety Guide for Oil Tankers and Terminals (ISGOTT)," 5th ed., Witherby, London.

[8.5] American Petroleum Institute, 1998, API Recommended Practice 2003 (API RP 2003), "Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents," 6th ed., Washington, D.C.

[8.6] 33 CFR 154.550 (Title 33, Code of Federal Regulations, Section 154.550).

[8.7] National Fire Protection Association, 2008, NFPA 70 (Article 500), "National Electrical Code," Quincy, MA.

[8.8] American Petroleum Institute, 1999, API Publication 2218, "Fireproofing Practices in Petroleum and Petrochemical Processing Plants," 2nd ed., Washington, D.C.

[8.9] National Fire Protection Association, 2010, NFPA 72, "National Fire Alarm and Signaling Code," Quincy, MA.

[8.10] National Fire Protection Association, 2011, NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," Quincy, MA.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 9

SECTION 3109F PIPING AND PIPELINES

3109F.1 General. This section provides minimum engineering standards for piping, pipelines, valves, supports and related appurtenances at MOTs. This section applies to piping and pipelines used for transferring:

1. Oil (see Section 3101F.1) to or from tank vessels or barges
2. Oil within the MOT
3. Vapors, including Volatile Organic Compounds (VOCs)
4. Inerting or enriching gases to vapor control systems

Additionally, it also applies to piping or pipelines providing services, which includes stripping, sampling, venting, vapor control and fire water.

See Section 3101F.3 for definitions of "new" (N) and "existing" (E).

3109F.2 Oil piping and pipeline systems. All pressure piping and pipelines for oil service shall conform to the provisions of API Standard 2610 [9.1], ASME B31.3 [9.2] or B31.4 [9.3] as appropriate, including the following:

1. All piping/pipelines shall be documented on current P&ID's (N/E).
2. Piping and pipeline systems shall be installed above deck (N).
3. The systems shall be arranged in a way not to obstruct access to and removal of other piping components and equipment (N).
4. Flexibility shall be achieved through adequate expansion loops or joints (N/E).
5. A guide or lateral restraint shall be provided just past the elbow where a pipe changes direction in order to minimize excessive axial stress (N).
6. Piping shall be routed to allow for movement due to thermal expansion and seismic displacement, without exceeding the allowable stresses in the supports, and anchor connections (see Section 3109F.3) (N/E).
7. Plastic piping shall not be used unless designated for oil service (N/E).
8. If a flanged connection exists within 20 pipe diameters from the end of any replaced section, the pipe shall be replaced up to and including the flange.
9. Pipelines shall be seamless, electric-resistance-welded or electric-fusion-welded (N).
10. Piping greater than 2 inches in diameter shall be butt-welded. Piping 2 inches and smaller shall be socket welded or threaded.
11. Pipeline connections directly over the water shall be welded (N). Flanged connections not over water shall have secondary containment (N).

12. Pipelines that do not have a valid and certified Static Liquid Pressure Test (SLPT) [9.4] shall be marked "OUT OF SERVICE." Out-of-service piping and pipelines shall be purged, gas-free and physically isolated from sources of oil.
13. If a pipeline is "out-of-service" for 3 or more years, it will require Division approval prior to re-use.

3109F.3 Pipeline stress analysis (N/E). Pipeline stress analysis shall be performed for:

1. New piping and pipelines
2. Significant rerouting/relocation of existing piping
3. Any replacement of "not in-kind" piping
4. Any significant rearrangement or replacement of "not in-kind" anchors and/or supports
5. Significant seismic displacements calculated from the structural assessment

Pipeline stress analysis shall be performed in accordance with ASME B31.4 [9.3], considering all relevant loads and corresponding displacements determined from the structural analysis described in Section 3104F. Seismic loading of above-grade pipelines may be analyzed in accordance with ASME B31.E [9.5].

Flexibility analysis for piping, considering supports, shall be performed in accordance with ASME B31.4 [9.3] by using the largest temperature differential imposed by normal operation, start-up, shutdown or abnormal conditions. Thermal loads shall be based upon maximum and minimum local temperatures; heat traced piping shall use the maximum attainable temperature of the heat tracing system.

To determine forces at sliding surfaces, the coefficients of static friction shown in Table 31F-9-1 shall be used.

**TABLE 31F-9-1
COEFFICIENTS OF STATIC FRICTION**

| SLIDING SURFACE MATERIALS | COEFFICIENT OF STATIC FRICTION |
|---------------------------|--------------------------------|
| Teflon on Teflon | 0.10 |
| Plastic on Steel | 0.35 |
| Steel on Steel | 0.40 |
| Steel on Concrete | 0.45 |
| Steel on Timber | 0.49 |

3109F.4 Anchors and supports. Anchors and supports shall conform to ASME B31.3 [9.2], ASME B31.4 [9.3], API Standard 2610 [9.1] and the ASCE Guidelines [9.6](N).

A seismic assessment shall be performed for existing anchors and supports using recommendations in Section 7 of CalARP [9.7] or Chapter 11 of FEMA 356 [9.8], as appropriate (E).

3109F.5 Appurtenances.

3109F.5.1 Valves and fittings. Valves and fittings shall meet the following requirements:

1. Conform to ASME B31.3 [9.2], ASME B31.4 [9.3], API Standard 609 [9.9] and ASME B16.34 [9.10], as appropriate, based on their service (N).

2. Conform to Section 8 of [9.1] (N/E).
3. Stems shall be oriented in a way not to pose a hazard in operation or maintenance (N/E).
4. Nonductile iron, cast iron, and low-melting temperature metals shall not be used in any hydrocarbon service, fire water or foam service (N/E).
5. Double-block and bleed valves shall be used for manifold valves. (N/E).
6. Isolation valves shall be fire-safe, in accordance with API Standard 607 [9.11] (N).
7. Swing check valves shall not be installed in vertical down-flow piping (N/E).
8. Pressure relief devices shall be used in any closed piping system that has the possibility of being over pressurized due to temperature increase (thermal relief valves) or surging (N/E).
9. Pressure relief devices shall be sized in accordance with API RP 520 [9.12] (N). Set pressures and accumulating pressures shall be in accordance with [9.12] (N/E).
10. Discharge from pressure relief valves shall be directed into lower pressure piping for recycling or proper disposal. Discharge shall never be directed into the open environment, unless secondary containment is provided (N/E).
11. Threaded, socket-welded, flanged and welded fittings shall conform to Section 8 of [9.1] (N/E).

3109F.5.2 Valve actuators (N/E).

1. Actuators shall have a readily accessible, manually operated overriding device to operate the valve during a power loss.
2. Torque switches shall be set to stop the motor closing operation at a specified torque setting.
3. Limit switches shall be set to stop the motor opening operation at a specified limit switch setting.
4. Critical valves shall be provided with thermal insulation. The insulation shall be inspected and maintained at periodic intervals. Records of thermal insulation inspections and condition shall be maintained for at least 6 years.
5. Electrical insulation for critical valves shall be measured for resistance following installation and retested periodically. These records shall be maintained for at least 6 years.

3109F.6 Utility and auxiliary piping systems. Utility and auxiliary piping includes service for:

1. Stripping and sampling
2. Vapor control
3. Fire water and foam
4. Natural gas
5. Compressed air, venting and nitrogen

Stripping and sampling piping shall conform to Section 3109F.2 (N/E).

Vapor return lines and VOC vapor inerting and enriching (natural gas) piping shall conform to 33 CFR 154.808 [9.13] and API RP 1124 [9.14] (N/E).

Firewater and foam piping and fittings shall meet the following requirements:

1. Conform to ASME B16.5 [9.15]
2. Fire mains shall be carbon steel pipe (N/E)
3. High density polyethylene (HDPE) piping may be used for buried pipelines (N/E)
4. Piping shall be color-coded (N/E)

Compressed air, venting and nitrogen piping and fittings shall conform to ASME B 31.3 [9.2] (N). Utility and auxiliary piping shall have external visual inspections, similar to that defined in Section 10.1 of API 574 [9.16] (N/E).

3109F.7 References.

- [9.1] American Petroleum Institute (API), 2005, API Standard 2610, "Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities," 2nd ed., Washington, D.C.
- [9.2] American Society of Mechanical Engineers (ASME), 2010, ASME B31.3, "Process Piping," New York.
- [9.3] American Society of Mechanical Engineers (ASME), 2009, ASME B31.4, "Pipeline Transportation Systems For Liquid Hydrocarbons And Other Liquids," New York.
- [9.4] 2 CCR 2560 - 2571 (Title 2, California Code of Regulations (CCR), Sections 2560-2571).
- [9.5] American Society of Mechanical Engineers (ASME), 2008, B31.E, "Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems," New York.
- [9.6] American Society of Civil Engineers, 2011, "Guidelines for Seismic Evaluation and Design of Petrochemical Facilities," 2nd ed., New York.
- [9.7] CalARP Program Seismic Guidance Committee, September 2009, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.
- [9.8] Federal Emergency Management Agency, Nov. 2000, FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.
- [9.9] American Petroleum Institute (API), 1997, API Standard 609, "Butterfly Valves: Double Flanged, Lug- and Wafer-Type," 5th ed., Washington, D.C.
- [9.10] American Society of Mechanical Engineers (ASME), 1996, ASME B16.34, "Valves Flanged Threaded And Welding End," New York.
- [9.11] American Petroleum Institute (API), 1996, API Standard 607, "Fire Test for Soft-Seated Quar-

- || *ter-Turn Valves," 4th ed., 1993 (reaffirmed 4/1996), Washington, D.C.*
- || [9.12] *American Petroleum Institute (API), 2000, API RP 520, "Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries, Part I—Sizing and Selection," 7th ed., and Part II—Installation, 2003, 5th ed., Washington, D.C.*
- || [9.13] *33 CFR 154.808 — Vapor Control Systems, General (Title 33, Code of Federal Regulations (CFR), Section 154.808).*
- || [9.14] *American Petroleum Institute (API), 1991, Recommended Practice 1124 (API RP 1124), "Ship, Barge, and Terminal Hydrocarbon Vapor Collection Manifolds," 1st ed., Washington, D.C.*
- [9.15] *American Society of Mechanical Engineers (ASME), 1996, ASME B16.5, "Pipe Flanges and Flanged Fittings," New York.*
- [9.16] *American Petroleum Institute (API), 2009, API RP 574, "Inspection Practices for Piping System Components," 3rd ed., Washington, D.C.*

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 10

**SECTION 3110F
MECHANICAL AND ELECTRICAL EQUIPMENT**

3110F.1 General. This section provides the minimum standards for mechanical and electrical equipment at MOTs.

See Section 3101F.3 for definitions of "new" (N) and "existing" (E).

3110F.2 Marine loading arms.

3110F.2.1 General criteria. Marine loading arms and ancillary systems shall conform to 2 CCR 2380 (b) [10.1], 33 CFR 154.510 [10.2] and the "Design and Construction Specification for Marine Loading Arms," [10.3].

The following shall be considered when determining the loading arm maximum allowable extension limits:

1. Vessel sizes and manifold locations
2. Lowest-low water level (datum)
3. Highest-high water level
4. Maximum vessel surge and sway
5. Maximum width of fendering system

3110F.2.2 Electrical and hydraulic power systems.

3110F.2.2.1 Pressure and control systems (N).

1. Pressure gauges shall be mounted in accordance with ASME B40.100-1 998 [10.4].
2. The hydraulic drive cylinders shall be mounted and meet either the mounting requirements of ANSI/(NFPA) T3.6.7 R2 -1 996 [10.5] or equivalent.
3. In high velocity current (>1.5 knots) areas, all new marine loading arms shall be fitted with quick disconnect couplers and emergency quick release systems in conformance with Sections 6.0 and 7.0 of [10.3]. In complying with this requirement, attention shall be paid to the commentary and guidelines in Part III of reference [10.3].
4. Out-of-limit, balance and the approach of out-of-limit alarms shall be located at or near the loading arm console.

3110F.2.2.2 Electrical components (N). The following criteria shall be implemented:

1. Equipment shall be provided with a safety disconnecting device to isolate the entire electrical system from the electrical mains in accordance with Article 430 of the National Electrical Code (NEC), [10.6].
2. Motor controllers and 3-pole motor overload protection shall be installed and sized in accordance with Article 430, NEC [10.6].
3. Control circuits shall be limited to 120 volts and shall comply with Articles 500 and 501 of the NEC [10.6]. Alternatively, intrinsically safe wiring and

controls may be provided in accordance with Article 504, NEC [10.6] and ANSI/UL Std. No. 913 [10.7].

4. Grounding and bonding shall comply with the requirements of Article 430, NEC [10.6] and Section 3111F.

Section 3111F includes requirements for electrical equipment, wiring, cables, controls and electrical auxiliaries located in hazardous areas.

3110F.2.2.3 Remote operation. The remote control system, where provided, shall conform to the recommendations of the OCIMF [10.3]. The remote operation shall be facilitated by either a pendant control system or by a hand-held radio controller (N).

The pendant control system shall be equipped with a plug-in capability to an active connector located either in the vicinity of the loading arms, or at the loading arm outboard end on the triple swivel, and hard-wired into the control console. The umbilical cord running from the triple swivel to the control console shall be attached to the loading arm. Other umbilical cords shall have sufficient length to reach the maximum operational limits (N).

The radio controller if installed shall comply with 2 CCR 2370(e) [10.8] and 47CFR Part 15 [10.9] requirements for transmitters operating in an industrial environment (N/E).

3110F.3 Oil transfer hoses (N/E). Hoses for oil transfer service shall be in compliance with 2 CCR 2380 (a) [10.10] and 33 CFR 154.500 [10.11].

Hoses with diameters of 6 inches or larger shall have flanges that meet ANSIB1 6.5 [10.12]. Hoses with diameters of 4 inches or less may have quick disconnect fittings provided that they meet ASTM F-1122 [10.13].

3110F.4 Lifting equipment: winches and cranes. Lifting equipment shall conform to [10.14], [10.15], [10.16] and [10.17]. Electrical equipment shall conform to the provisions of Section 3111F.

3110F.4.1 Winches.

1. Winches and ancillary equipment shall be suitable for a marine environment (N/E).
2. Winches shall be provided with a fail-safe braking system, capable of holding the load under all conditions, including a power failure (N/E).
3. Winches shall be fully reversible (N).
4. Shock, transient and abnormal loads shall be considered when selecting winch systems (N).
5. Winches shall have limit switches and automatic trip devices to prevent over-travel of the drum in either direction. Limit switches shall be tested, and demonstrated to function correctly under operating condi-

tions without inducing undue tensions or slack in the winch cables (N/E).

6. Under all operating conditions, there shall be at least two full turns of cable on grooved drums, and at least three full turns on ungrooved drums (N/E).
7. Moving winch parts which present caught-in hazards to personnel shall be guarded (N/E).
8. Winches shall have clearly identifiable and readily accessible stop controls (N/E).

3110F.4.2 Cranes (N/E).

1. Cranes shall not be loaded in excess of the manufacturer's rating except during performance tests.
2. Drums on load-hoisting equipment shall be equipped with positive holding devices.
3. Under all operating conditions, there shall be at least two full turns of cable on grooved drums, and at least three full turns on ungrooved drums.
4. Braking equipment shall be capable of stopping, lowering, and holding a load of at least the full test load.
5. When not in use, crane booms shall be lowered to ground level or secured to a rest support against displacement by wind loads or other outside forces.
6. Safety systems including devices that affect the safe lifting and handling, such as interlocks, limit switches, load/moment and overload indicators with shutdown capability, emergency stop switches, radius and locking indicators, shall be provided [10.18].

3110F.5 Shore-to-vessel access for personnel. This section applies to shore-to-vessel means of access for personnel and equipment provided by the terminal. This includes ancillary structures and equipment, which support, supplement, deploy and maneuver such vessel access systems.

Shore-to-vessel access for personnel shall conform to 29 CFR 1918.22 [10.19], Sections 19(b) and 21(b) of [10.20], Chapter 16.4 of [10.21] and the following:

1. Shore-to-vessel access systems shall be designed to withstand the forces from dead, live, wind, vibration, impact loads and the appropriate combination of these loads. The design shall consider all the critical positions of the system in the stored, maintenance, maneuvering and deployed positions, where applicable (N).
2. The minimum live load shall be 50 psf on walkways and 25 plf with a 200 pounds minimum concentrated load in any location or direction on handrails (N).
3. The walkway shall be not less than 36 inches in width (N) and not less than 20 inches for existing walkways (E).
4. The shore-to-vessel access system shall be positioned so as to not interfere with the safe passage or evacuation of personnel (N/E).
5. Guardrails shall be provided on both sides of the access systems with a clearance between the inner most surfaces of the guardrails of not less than 36 inches and

shall be maintained for the full length of the walkway (N).

6. Guardrails shall be at a height not less than 33 inches above the walkway surface and shall include an intermediate rail located midway between the walkway surface and the top rail (N/E).
7. The walkway surface, including self-leveling treads, if so equipped, shall be finished with a safe nonslip footing accommodating all operating gangway inclinations (N/E).
8. Under no circumstances shall the operating inclination of the walkway exceed 60 degrees from the horizontal or the maximum angle recommended by the manufacturer, whichever is less (N/E).
9. The undersides of aluminum gangways shall be protected with hard plastic or wooden strips to prevent being dragged or rubbed across any steel deck or component (N/E).

3110F.6 Sumps, discharge containment and ancillary equipment. Sumps, discharge containment and ancillary equipment shall conform to 2 CCR 2380(f) [10.22], 33 CFR 1 54.530 [10.23] and the following:

1. Sumps for oil drainage shall be equipped with pressure/vacuum vents, automatic draining pumps and shall be tightly covered (N/E).
2. Sumps which provide drainage for more than one berth should be equipped with liquid seals so that a fire on one berth does not spread via the sump (N/E).
3. Sumps shall be located at least 25ft from the manifolds, base of the loading arms or hose towers (N).
4. Conduct periodic integrity testing of the sump containers and periodic integrity and leak testing of the related valves and piping.

3110F.7 Vapor control systems. Vapor control systems shall conform to 33 CFR 154.800 through 154.850 [10.24] and API Standard 2610 [10.25]. The effects of seismic, wind, dead, live and other loads shall be considered in the analysis and design of individual tie-downs of components, such as of steel skirts, vessels, controls and detonation arresters. The analysis and design shall include the load transfer to supporting deck/pile structures or foundation elements.

3110F.8 Equipment anchors and supports. For new (N) electrical and mechanical equipment, the seismic lateral loads (demand) shall be calculated using the methods of Section 6.4 of FEMA 450 [10.26]. The design for load transfer to the wharf deck shall use the same procedures as for mooring and berthing components (see Section 3107F.5.3).

For existing (E) equipment, the seismic assessment shall be performed in accordance with CalARP [10.27], FEMA 356 [10.28] or ASCE Guidelines [10.29].

3110F.9 Equipment and systems maintenance (N/E). Mechanical and electrical equipment critical to oil spill prevention, such as, but not limited to: mooring line quick release and loading arm quick disconnect systems, shall be maintained and tested as per the manufacturer's recommendations (N/E).

The latest records shall be readily accessible to the Division (N/E).

3110F.10 Pumps (N/E). Specification information for all MOT pumps providing oil and fire water service to wharf pipeline systems shall be retained. Information shall include, but not be limited to, pump make and model, motor make and model, flow rate, pressure rating and pump performance curves.

Hydrocarbon pumps that serve the oil transfer operations at the berthing system must be maintained per API 2610 [10.25]. Firewater pumps providing the wharf fire protection shall be maintained per NFPA 25 [10.30], as adopted and amended by the State Fire Marshal, or local enforcing agency requirements.

3110F.11 Critical systems seismic assessment (N/E). Critical mechanical and electrical equipment related to personnel safety, oil spill prevention or response, shall have a seismic assessment per Section 3104F.5.3. For equipment anchorages and supports, see Section 3110F.8.

3110F.12 References.

- [10.1] 2 CCR 2380(b), Title 2, California Code of Regulations, Section 2380(b), Loading Arms.
- [10.2] 33 CFR 154.510, Title 33 Code of Federal Regulations Section 154.510.
- [10.3] Oil Companies International Marine Forum (OCIMF), 1999, "Design and Construction Specification for Marine Loading Arms," 3rd ed., Witherby, London.
- [10.4] American Society of Mechanical Engineers (ASME), 2000, ASME B40.100-1998, "Pressure Gauges and Gauge Attachments," New York.
- [10.5] National Fluid Power Association (NFPA), 1996, ANSI/(NFPA) T3.6.7R2-1996, "Fluid Power Systems and Products—Square Head Industrial Cylinders - Mounting Dimensions," Milwaukee, WI.
- [10.6] National Fire Protection Association, 2002, NFPA 70, "National Electrical Code," Quincy, MA.
- [10.7] Underwriters Laboratory, Inc., 1997, "Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations," ANSI/UL Standard No. 913, 5th ed., Northbrook, IL.
- [10.8] 2 CCR 2370(e), Title 2 California Code of Regulations, Section 2370(e).
- [10.9] 47 CFR Part 15 Private Land Mobile Radio Services, Title 47 Code of Federal Regulations (CFR).
- [10.10] 2 CCR 2380(a), Title 2, California Code of Regulations, Section 2380(a).
- [10.11] 33 CFR 154.500 Hose Assemblies, Title 33 Code of Federal Regulations Section 154.500.
- [10.12] American Society of Mechanical Engineers, 1996, ASME/ANSI B16.5, "Pipe Flanges and Flanged Fittings," New York.
- [10.13] American Society for Testing and Materials, 2001, ASTM F-1122-87 (1998), "Standard Specification for Quick Disconnect Couplings," West Conshohocken, PA.
- [10.14] 29 CFR 1918, Subpart F, Title 29 Code of Federal Regulations Section 1918, Subpart F.
- [10.15] American Society of Mechanical Engineers, 1996, ASME B30.4 - 1996, "Portal Tower and Pedestal Cranes," New York.
- [10.16] American Society of Mechanical Engineers, 2002, ASME B30.7 - 2001, "Base Mounted Drum Hoists," New York.
- [10.17] American Society of Mechanical Engineers, 1999, ASME HST-4, "Performance Standard for Overhead Electric Wire-Rope Hoists," New York.
- [10.18] 29 CFR 1917.46, Title 29 Code of Federal Regulations Section 1917.46 Load Indicating Devices.
- [10.19] 29 CFR 1918.22, Title 29 Code of Federal Regulations Section 1918.22, Gangways.
- [10.20] US Army Corps of Engineers, 1996, "Safety and Health Requirements Manual, Sections 19(b) and 21(b)," EM 385-1-1, Washington, D.C.
- [10.21] Chapter 16.4, Ship/Shore Access, International Safety Guide for Oil Tankers and Terminals, 5th ed. 2006, Witherby, London.
- [10.22] 2 CCR 2380(f), Title 2, California Code of Regulations, Section 2380(f), Small Discharge Containment.
- [10.23] 33 CFR 154.530, Title 33, Code of Federal Regulations, Section 154.530 Small Discharge Containment.
- [10.24] 33 CFR 154.800 through 154.850, Title 33 Code of Federal Regulations, Sections 154.800 through 154.850.
- [10.25] American Petroleum Institute (API), 2005, API Standard 2610, "Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities," 2nd ed., Washington, D.C.
- [10.26] Federal Emergency Management Agency, 2003, "NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures (FEMA 450)," Part 1 — Provisions, Washington D.C.
- [10.27] CalARP Program Seismic Guidance Committee, September 2009, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.
- [10.28] Federal Emergency Management Agency, Nov. 2000, FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.

[10.29] American Society of Civil Engineers, 1997,
“Guidelines for Seismic Evaluation and Design of
Petrochemical Facilities,” New York, NY.

[10.30] National Fire Protection Association, 2011,
NFPA 25, Standard for the Inspection, Testing,
and Maintenance of Water-Based Fire Protection
Systems, Quincy, MA.

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public
Resources Code.

Division 11

SECTION 3111F ELECTRICAL SYSTEMS

3111F.1 General. This section provides minimum standards for electrical systems at marine oil terminals.

Electrical systems include the incoming electrical service and components, the electrical distribution system, branch circuit cables and the connections. Also included are:

1. Lighting, for operations, security and navigation
2. Controls for mechanical and electrical equipment
3. Supervision and instrumentation systems for mechanical and electrical equipment
4. Grounding and bonding
5. Corrosion protection through cathodic protection
6. Communications and data handling systems
7. Fire detection systems
8. Fire alarm systems
9. Emergency shutdown systems (ESD)

All electrical systems shall conform to API RP 540 [11.1] and the National Electrical Code (NEC) [11.2].

See Section 3101F.3 for definitions of "new" (N) and "existing" (E).

3111F.2 Hazardous area designations and plans (N/E). Area classifications shall be determined in accordance with API RP 500 [11.3], API RP 540 [11.1] and the NEC, Articles 500, 501, 504, 505 and 515 [11.2]. A marine oil terminal shall have a current set of scaled plan drawings, with clearly designated areas showing the hazard class, division and group. The plan view shall be supplemented with sections, elevations and details to clearly delineate the area classification at all elevations starting from low water level. The drawings shall be certified by a professional electrical engineer. The plans shall be reviewed, and revised when modifications to the structure, product or equipment change hazardous area identifications or boundaries.

3111F.3 Identification and tagging. All electrical equipment, cables and conductors shall be clearly identified by means of tags, plates, color coding or other effective means to facilitate troubleshooting and improve safety, and shall conform to the identification carried out for the adjacent on-shore facilities (N). Topics for such identification are found in the NEC Articles 110, 200, 210, 230, 384, 480 and 504 [11.2]. Existing electrical equipment (E) shall be tagged.

Where identification is necessary for the proper and safe operation of the equipment, the marking shall be clearly visible and illuminated (N/E). A coded identification system shall apply to all circuits, carrying low or high voltage power, control, supervisory or communication (N).

3111F.4 Purged or pressurized equipment in hazardous locations (N/E). Purged or pressurized enclosures shall be capable of preventing the entry of combustible gases into such spaces, in accordance with NFPA 496 [11.4]. Special emphasis shall

be placed on reliability and ease of operation. The pressurizing equipment shall be electrically monitored and alarms shall be provided to indicate failure of the pressurizing or purging systems.

3111F.5 Electrical service. Where critical circuits are used for spill prevention, fire control or life safety, an alternative service derived from a separate source and conduit system, shall be located at a safe distance from the main power service. A separate feeder from a double-ended substation or other source backed up by emergency generators will meet this requirement. An uninterrupted power service (UPS) shall be provided for control and supervisory circuits associated with ESD systems (N).

1. Electrical, instrument and control systems used to activate equipment needed to control a fire or mitigate its consequences shall be protected from fire and remain operable for 15 minutes in a 2000°F fire, unless designed to fail-safe during fire exposure. The temperature around these critical components shall not exceed 200°F during 15 minutes of fire exposure (N).
2. Wiring in fireproofed conduits shall be derated 15 percent to account for heat buildup during normal operation. Type MI (mineral insulated, metal sheathed [11.2]) cables may be used in lieu of fireproofing of wiring (N).
3. Emergency cables and conductors shall be located where they are protected from damage caused by traffic, corrosion or other sources (N).
4. Allowance shall be made for electrical faults, overvoltages and other abnormalities (N).

Where solid state motor controls are used for starting and speed control, corrective measures shall be incorporated for mitigating the possible generation of harmonic currents that may affect the ESD or other critical systems (N).

3111F.5.1 Emergency power systems. Emergency power systems shall be installed (N) and maintained (N/E) per NFPA-110 [11.6]. This does not include stored energy systems. Stored energy emergency power systems (SEEPS) shall be installed (N) when necessary to maintain continuous uninterruptable power to critical systems. SEEPS shall be installed (N) and maintained (N/E) per NFPA-111 [11.7].

3111F.6 Grounding and bonding (N/E).

1. All electrical equipment shall be effectively grounded as per NEC Article 250 [11.2]. All noncurrent carrying metallic equipment, structures, piping and other elements shall also be effectively grounded.
2. Grounding shall be considered in any active corrosion protection system for on-shore piping, submerged support structures or other systems. Insulation barriers, including flanges or nonconducting hoses shall be used to isolate cathodic protection systems from other electrical/static sources. None of these systems shall be compromised by grounding or bonding arrangements that may interconnect the corrosion protection systems or

interfere with them in any way that would reduce their effectiveness.

3. Bonding of vessels to the MOT structure is not permitted (2 CCR 2341 (f)) [11.5].
4. Whenever flanges of pipelines with cathodic protection are to be opened for repair or other work, the flanges shall be bonded prior to separation.
5. Direct wiring to ground shall be provided from all towers, loading arms or other high structures that are susceptible to lightning surges or strikes.

3111F.7 Equipment specifications (N). All electrical systems and components shall conform to National Electrical Manufacturers Association (NEMA) standards or be certified by a Nationally Recognized Testing Laboratory (NRTL).

3111F.8 Illumination (N/E). Lighting shall conform to 2 CCR 2365 [11.8] and 33 CFR 154.570 (d) [11.9].

3111F.9 Communications, control and monitoring systems.

3111F.9.1 Communication systems (N/E). Communications systems shall comply with 2 CCR 2370 [11.10], and conform to Section 6 of [11.11].

3111F.9.2 Overfill monitoring and controls (N/E). Overfill protection systems shall conform to Appendix C of API RP 2350 [11.12]. These systems shall be tested before each transfer operation or monthly, whichever is less frequent. Where vessel or barge overfill sensors and alarms are provided, they shall comply with 33 CFR 154.812 [11.13].

All sumps shall be provided with level sensing devices to initiate an alarm to alert the operator at the approach of a high level condition. A second alarm shall be initiated at a high-high level to alert the operator. Unless gravity drainage is provided, sumps must have an automatic pump, programmed to start at a predetermined safe level.

3111F.9.3 Monitoring systems (N/E). All monitoring systems and instrumentation such as, but not limited to: velocity monitoring systems, tension monitoring systems, anemometers, and current meters, shall be installed, maintained and calibrated per the manufacturer's recommendations. Specifications shall be retained. The latest records shall be readily accessible to the Division.

3111F.10 Corrosion protection.

3111F.10.1 Corrosion assessment (N/E). An assessment shall be performed to determine the existing and potential corrosion. This assessment shall include all steel or metallic components, including the structure, pipelines, supports or other ancillary equipment, with drawings and specifications for corrosion prevention/protection. The assessment shall be performed by a licensed professional engineer, using the methods and criteria prescribed in [11.14].

3111F.10.2 Inspection, testing and records (N/E). For sacrificial anode systems, periodic underwater inspections shall be performed and observations recorded. For impressed current systems, monthly rectifier readings and annual potential readings of the protected components shall be taken. If potential readings for steel structures are outside of acceptable limits (between -0.85 [11.15] and -1.10

Volts), corrective actions shall be taken. Voltage drops other than across the structure-to-electrolyte boundary must be considered for valid interpretations of potential measurement. Consideration is understood to mean the application of sound engineering practice in determining the significance of voltage drops by methods such as:

1. Measuring or calculating voltage drop(s)
2. Reviewing historical performance of the cathodic protection system (CPS)
3. Evaluating the physical and electrical characteristics of the structure and the environment
4. Determining whether or not there is physical evidence of corrosion

All isolating sections shall be tested immediately after installation or replacement, and, at a minimum, annually. Test results shall be recorded and documented. Electrical tests on insulating flanges shall make use of specialized insulator testers. The test instrument shall make use of RF signals, capacitive measurements or other means to clearly determine whether an insulating flange is shorted or open circuited without being affected by pipe-to-soil potentials, cathodic protection voltages or whether it is buried or exposed.

The cathodic protection inspection for buried or submerged pipelines shall conform to API 570 [11.16].

Insulating and isolating arrangements for protection against static, stray and impressed currents shall be tested in accordance with 2 CCR 2341(d) and 2380 [11.17].

3111F.11 Critical systems seismic assessment (N/E). Electrical power systems shall have a seismic assessment per Section 3104F.5.3. For equipment anchorages and supports, see Section 3110F.8.

3111F.12 References.

- [11.1] American Petroleum Institute, 1999, API Recommended Practice 540 (API RP 540), "Electrical Installations in Petroleum Processing Plants," 4th ed., Washington, D.C.
- [11.2] National Fire Protection Association, 2002, NFPA 70, "National Electrical Code (NEC)," Quincy, MA.
- [11.3] American Petroleum Institute, 1997, API Recommended Practice 500 (API RP 500), "Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2," 2nd ed., Washington, D.C.
- [11.4] National Fire Protection Association, 1998, NFPA 496, "Standard for Purgued and Pressurized Enclosures for Electrical Equipment," Quincy, MA.
- [11.5] 2 CCR 2341(f), Title 2, California Code of regulations, Section 2341(f).
- [11.6] National Fire Protection Association, 2010, NFPA 110, "Standard for Emergency and Standby Power Systems," Quincy, MA.

- [11.7] *National Fire Protection Association, 2011, NFPA 111, "Standard on Stored Electrical Energy Emergency and Standby Power Systems," Quincy, MA.*
- [11.8] *2 CCR 2365, Title 2 California Code of Regulations, Section 2365.*
- [11.9] *33 CFR 154.570(d), Title 33 Code of Federal Regulations Section 154.570(d).*
- [11.10] *2 CCR 2370, Title 2 California Code of Regulations, Section 2370.*
- [11.11] *Oil Companies International Marine Forum (OCIMF), 1987, "Guide on Marine Terminal Fire Protection and Emergency Evacuation," 1st ed., Witherby, London.*
- [11.12] *American Petroleum Institute, 1996, API Recommended Practice 2350 (API RP 2350), "Overfill Protection for Storage Tanks," 2nd ed., Washington, D.C.*
- [11.13] *33 CFR 154.812, Title 33, Code of Federal Regulations, Section 154.812 - Facility Requirements for Vessel Liquid Overfill Protection.*
- [11.14] *National Association of Corrosion Engineers (NACE), Standard Recommended Practice, 1994, RP01 76-1994 "Corrosion Control of Steel Fixed Offshore Platforms Associated with Petroleum Production," Houston, TX.*
- [11.15] *Department of Defense, 31 January 1990, Military Handbook, "Electrical Engineering Cathodic Protection," MIL-HDBK-1004/10, Washington, D.C.*
- [11.16] *American Petroleum Institute, 2002, API 570, "Piping Inspection Code," 2nd ed., October 1998 (February 2000 Addendum 1), Washington, D.C.*
- [11.17] *2 CCR 2341(d) and 2380, Title 2, California Code of Regulations, Sections 2341(d) and 2380.*

Authority: Sections 8755 and 8757, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 32 – ENCROACHMENT INTO PUBLIC RIGHT-OF-WAY

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.

See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | X | X | X | | | X | X | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 32

ENCROACHMENTS INTO THE PUBLIC RIGHT-OF-WAY

SECTION 3201 GENERAL

3201.1 Scope. The provisions of this chapter shall govern the encroachment of structures into the public right-of-way.

3201.2 Measurement. The projection of any structure or portion thereof shall be the distance measured horizontally from the lot line to the outermost point of the projection.

3201.3 Other laws. The provisions of this chapter shall not be construed to permit the violation of other laws or ordinances regulating the use and occupancy of public property.

3201.4 Drainage. Drainage water collected from a roof, awning, canopy or marquee, and condensate from mechanical equipment shall not flow over a public walking surface.

SECTION 3202 ENCROACHMENTS

3202.1 Encroachments below grade. Encroachments below grade shall comply with Sections 3202.1.1 through 3202.1.3.

3202.1.1 Structural support. A part of a building erected below grade that is necessary for structural support of the building or structure shall not project beyond the lot lines, except that the footings of street walls or their supports which are located not less than 8 feet (2438 mm) below grade shall not project more than 12 inches (305 mm) beyond the street lot line.

3202.1.2 Vaults and other enclosed spaces. The construction and utilization of vaults and other enclosed spaces below grade shall be subject to the terms and conditions of the applicable governing authority.

3202.1.3 Areaways. Areaways shall be protected by grates, guards or other approved means.

3202.2 Encroachments above grade and below 8 feet in height. Encroachments into the public right-of-way above grade and below 8 feet (2438 mm) in height shall be prohibited except as provided for in Sections 3202.2.1 through 3202.2.3. Doors and windows shall not open or project into the public right-of-way.

3202.2.1 Steps. Steps shall not project more than 12 inches (305 mm) and shall be guarded by approved devices not less than 3 feet (914 mm) in height, or shall be located between columns or pilasters.

3202.2.2 Architectural features. Columns or pilasters, including bases and moldings shall not project more than 12 inches (305 mm). Belt courses, lintels, sills, architraves, pediments and similar architectural features shall not project more than 4 inches (102 mm).

3202.2.3 Awnings. The vertical clearance from the public right-of-way to the lowest part of any awning, including valances, shall be not less than 7 feet (2134 mm).

3202.3 Encroachments 8 feet or more above grade. Encroachments 8 feet (2438 mm) or more above grade shall comply with Sections 3202.3.1 through 3202.3.4.

3202.3.1 Awnings, canopies, marquees and signs. Awnings, canopies, marquees and signs shall be constructed so as to support applicable loads as specified in Chapter 16. Awnings, canopies, marquees and signs with less than 15 feet (4572 mm) clearance above the sidewalk shall not extend into or occupy more than two-thirds the width of the sidewalk measured from the building. Stanchions or columns that support awnings, canopies, marquees and signs shall be located not less than 2 feet (610 mm) in front of the curb line.

3202.3.2 Windows, balconies, architectural features and mechanical equipment. Where the vertical clearance above grade to projecting windows, balconies, architectural features or mechanical equipment is more than 8 feet (2438 mm), 1 inch (25 mm) of encroachment is permitted for each additional 1 inch (25 mm) of clearance above 8 feet (2438 mm), but the maximum encroachment shall be 4 feet (1219 mm).

3202.3.3 Encroachments 15 feet or more above grade. Encroachments 15 feet (4572 mm) or more above grade shall not be limited.

3202.3.4 Pedestrian walkways. The installation of a pedestrian walkway over a public right-of-way shall be subject to the approval of the applicable governing authority. The vertical clearance from the public right-of-way to the lowest part of a pedestrian walkway shall be not less than 15 feet (4572 mm).

3202.4 Temporary encroachments. Where allowed by the applicable governing authority, vestibules and storm enclosures shall not be erected for a period of time exceeding seven months in any one year and shall not encroach more than 3 feet (914 mm) nor more than one-fourth of the width of the sidewalk beyond the street lot line. Temporary entrance awnings shall be erected with a clearance of not less than 7 feet (2134 mm) to the lowest portion of the hood or awning where supported on removable steel or other approved non-combustible support.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 33 – SAFEGUARDS DURING CONSTRUCTION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
 See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | X | | | | | X | X | X | X | X | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | X | X | | | X | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| 3303 | | | X | X | | | | | | | | | | | | | | | | |
| 3304 | | | X | X | | | | | | | | | | | | | | | | |
| 3305 | | | X | X | | | | | | | | | | | | | | | | |
| 3306 | | | X | X | | | | | | | | | | | | | | | | |
| 3306.2 | | | | | | | X | | | | | | | | | | | | | |
| 3307 | | | X | X | | | | | | | | | | | | | | | | |
| 3308 | | | X | X | | | | | | | | | | | | | | | | |
| 3310 | | | X | X | | | | | | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

CHAPTER 33

SAFEGUARDS DURING CONSTRUCTION

SECTION 3301 GENERAL

3301.1 Scope. The provisions of this chapter shall govern safety during construction and the protection of adjacent public and private properties.

3301.2 Storage and placement. Construction equipment and materials shall be stored and placed so as not to endanger the public, the workers or adjoining property for the duration of the construction project.

SECTION 3302 CONSTRUCTION SAFEGUARDS

3302.1 Alterations, repairs and additions. Required exits, existing structural elements, fire protection devices and sanitary safeguards shall be maintained at all times during alterations, repairs or additions to any building or structure.

Exceptions:

1. Where such required elements or devices are being altered or repaired, adequate substitute provisions shall be made.
2. Maintenance of such elements and devices is not required when the existing building is not occupied.

3302.2 Manner of removal. Waste materials shall be removed in a manner which prevents injury or damage to persons, adjoining properties and public rights-of-way.

3302.3 Fire safety during construction. Fire safety during construction shall comply with the applicable requirements of this code and the applicable provisions of Chapter 33 of the *California Fire Code*.

SECTION 3303 DEMOLITION

3303.1 Construction documents. Construction documents and a schedule for demolition shall be submitted where required by the building official. Where such information is required, no work shall be done until such construction documents or schedule, or both, are approved.

3303.2 Pedestrian protection. The work of demolishing any building shall not be commenced until pedestrian protection is in place as required by this chapter.

3303.3 Means of egress. A horizontal exit shall not be destroyed unless and until a substitute means of egress has been provided and approved.

3303.4 Vacant lot. Where a structure has been demolished or removed, the vacant lot shall be filled and maintained to the existing grade or in accordance with the ordinances of the jurisdiction having authority.

3303.5 Water accumulation. Provision shall be made to prevent the accumulation of water or damage to any foundations on the premises or the adjoining property.

3303.6 Utility connections. Service utility connections shall be discontinued and capped in accordance with the approved rules and the requirements of the applicable governing authority.

3303.7 Fire safety during demolition. Fire safety during demolition shall comply with the applicable requirements of this code and the applicable provisions of Chapter 56 of the *California Fire Code*.

SECTION 3304 SITE WORK

3304.1 Excavation and fill. Excavation and fill for buildings and structures shall be constructed or protected so as not to endanger life or property. Stumps and roots shall be removed from the soil to a depth of not less than 12 inches (305 mm) below the surface of the ground in the area to be occupied by the building. Wood forms which have been used in placing concrete, if within the ground or between foundation sills and the ground, shall be removed before a building is occupied or used for any purpose. Before completion, loose or casual wood shall be removed from direct contact with the ground under the building.

3304.1.1 Slope limits. Slopes for permanent fill shall be not steeper than one unit vertical in two units horizontal (50-percent slope). Cut slopes for permanent excavations shall be not steeper than one unit vertical in two units horizontal (50-percent slope). Deviation from the foregoing limitations for cut slopes shall be permitted only upon the presentation of a soil investigation report acceptable to the building official.

3304.1.2 Surcharge. No fill or other surcharge loads shall be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional loads caused by the fill or surcharge. Existing footings or foundations which can be affected by any excavation shall be underpinned adequately or otherwise protected against settlement and shall be protected against later movement.

3304.1.3 Footings on adjacent slopes. For footings on adjacent slopes, see Chapter 18.

3304.1.4 Fill supporting foundations. Fill to be used to support the foundations of any building or structure shall comply with Section 1804.5. Special inspections of compacted fill shall be in accordance with Section 1704.7.

3304.1.5 [HCD] Storm water drainage and retention during construction. Projects which disturb less than one acre of soil and are not part of a larger common plan of development which in total disturbs one acre or more,

shall manage storm water drainage during construction in accordance with the California Green Building Standards Code (CALGreen), Chapter 4, Division 4.1.

SECTION 3305 SANITARY

3305.1 Facilities required. Sanitary facilities shall be provided during construction, remodeling or demolition activities in accordance with the *California Plumbing Code*.

SECTION 3306 PROTECTION OF PEDESTRIANS

3306.1 Protection required. Pedestrians shall be protected during construction, remodeling and demolition activities as required by this chapter and Table 3306.1. Signs shall be provided to direct pedestrian traffic.

3306.2 Walkways. A walkway shall be provided for pedestrian travel in front of every construction and demolition site unless the applicable governing authority authorizes the sidewalk to be fenced or closed. Walkways shall be of sufficient width to accommodate the pedestrian traffic, but in no case shall they be less than 4 feet (1219 mm) in width. Walkways shall be provided with a durable walking surface. Walkways shall be accessible in accordance with *Chapter 11A or 11B as applicable*, and shall be designed to support all imposed loads and in no case shall the design live load be less than 150 pounds per square foot (psf) (7.2 kN/m²).

3306.3 Directional barricades. Pedestrian traffic shall be protected by a directional barricade where the walkway extends into the street. The directional barricade shall be of sufficient size and construction to direct vehicular traffic away from the pedestrian path.

3306.4 Construction railings. Construction railings shall be not less than 42 inches (1067 mm) in height and shall be sufficient to direct pedestrians around construction areas.

3306.5 Barriers. Barriers shall be not less than 8 feet (2438 mm) in height and shall be placed on the side of the walkway nearest the construction. Barriers shall extend the entire length of the construction site. Openings in such barriers shall be protected by doors which are normally kept closed.

3306.6 Barrier design. Barriers shall be designed to resist loads required in Chapter 16 unless constructed as follows:

1. Barriers shall be provided with 2-inch by 4-inch (51 mm by 102 mm) top and bottom plates.
2. The barrier material shall be boards not less than $\frac{3}{4}$ -inch (19.1 mm) thick or wood structural panels not less than $\frac{1}{4}$ -inch (6.4 mm) thick.
3. Wood structural use panels shall be bonded with an adhesive identical to that for exterior wood structural use panels.
4. Wood structural use panels $\frac{1}{4}$ inch (6.4 mm) or $\frac{5}{16}$ inch (23.8 mm) in thickness shall have studs spaced not more than 2 feet (610 mm) on center (o.c.).
5. Wood structural use panels $\frac{3}{8}$ inch (9.5 mm) or $\frac{1}{2}$ inch (12.7 mm) in thickness shall have studs spaced not more than 4 feet (1219 mm) on center provided a 2-inch by 4-inch (51 mm by 102 mm) stiffener is placed horizontally at midheight where the stud spacing is greater than 2 feet (610 mm) on center.
6. Wood structural use panels $\frac{5}{8}$ inch (15.9 mm) or thicker shall not span over 8 feet (2438 mm).

3306.7 Covered walkways. Covered walkways shall have a clear height of not less than 8 feet (2438 mm) as measured from the floor surface to the canopy overhead. Adequate lighting shall be provided at all times. Covered walkways shall be designed to support all imposed loads. In no case shall the design live load be less than 150 psf (7.2 kN/m²) for the entire structure.

Exception: Roofs and supporting structures of covered walkways for new, light-frame construction not exceeding two stories above grade plane are permitted to be designed for a live load of 75 psf (3.6kN/m²) or the loads imposed on them, whichever is greater. In lieu of such designs, the roof and supporting structure of a covered walkway are permitted to be constructed as follows:

1. Footings shall be continuous 2-inch by 6-inch (51 mm by 152 mm) members.
2. Posts not less than 4 inches by 6 inches (102 mm by 152 mm) shall be provided on both sides of the roof and spaced not more than 12 feet (3658 mm) on center.
3. Stringers not less than 4 inches by 12 inches (102 mm by 305 mm) shall be placed on edge upon the posts.

TABLE 3306.1
PROTECTION OF PEDESTRIANS

| HEIGHT OF CONSTRUCTION | DISTANCE FROM CONSTRUCTION TO LOT LINE | TYPE OF PROTECTION REQUIRED |
|------------------------|--|-----------------------------|
| 8 feet or less | Less than 5 feet | Construction railings |
| | 5 feet or more | None |
| More than 8 feet | Less than 5 feet | Barrier and covered walkway |
| | 5 feet or more, but not more than one-fourth the height of construction | Barrier and covered walkway |
| | 5 feet or more, but between one-fourth and one-half the height of construction | Barrier |
| | 5 feet or more, but exceeding one-half the height of construction | None |

For SI: 1 foot = 304.8 mm.

4. Joists resting on the stringers shall be not less than 2 inches by 8 inches (51 mm by 203 mm) and shall be spaced not more than 2 feet (610 mm) on center.
5. The deck shall be planks not less than 2 inches (51 mm) thick or wood structural panels with an exterior exposure durability classification not less than $\frac{23}{32}$ inch (18.3 mm) thick nailed to the joists.
6. Each post shall be knee braced to joists and stringers by members not less than 2-inch by 4-inch (51 mm by 102 mm); 4 feet (1219 mm) in length.
7. A curb which is not less than 2-inch by 4-inch (51 mm by 102 mm) shall be set on edge along the outside edge of the deck.

3306.8 Repair, maintenance and removal. Pedestrian protection required by this chapter shall be maintained in place and kept in good order for the entire length of time pedestrians are subject to being endangered. The owner or the owner's agent, upon the completion of the construction activity, shall immediately remove walkways, debris and other obstructions and leave such public property in as good a condition as it was before such work was commenced.

3306.9 Adjacent to excavations. Every excavation on a site located 5 feet (1524 mm) or less from the street lot line shall be enclosed with a barrier not less than 6 feet (1829 mm) in height. Where located more than 5 feet (1524 mm) from the street lot line, a barrier shall be erected where required by the building official. Barriers shall be of adequate strength to resist wind pressure as specified in Chapter 16.

SECTION 3307

PROTECTION OF ADJOINING PROPERTY

3307.1 Protection required. Adjoining public and private property shall be protected from damage during construction, remodeling and demolition work. Protection shall be provided for footings, foundations, party walls, chimneys, skylights and roofs. Provisions shall be made to control water runoff and erosion during construction or demolition activities. The person making or causing an excavation to be made shall provide written notice to the owners of adjoining buildings advising them that the excavation is to be made and that the adjoining buildings should be protected. Said notification shall be delivered not less than 10 days prior to the scheduled starting date of the excavation.

SECTION 3308

TEMPORARY USE OF STREETS, ALLEYS AND PUBLIC PROPERTY

3308.1 Storage and handling of materials. The temporary use of streets or public property for the storage or handling of materials or of equipment required for construction or demolition, and the protection provided to the public shall comply with the provisions of the applicable governing authority and this chapter.

3308.1.1 Obstructions. Construction materials and equipment shall not be placed or stored so as to obstruct access to fire hydrants, standpipes, fire or police alarm boxes,

catch basins or manholes, nor shall such material or equipment be located within 20 feet (6096 mm) of a street intersection, or placed so as to obstruct normal observations of traffic signals or to hinder the use of public transit loading platforms.

3308.2 Utility fixtures. Building materials, fences, sheds or any obstruction of any kind shall not be placed so as to obstruct free approach to any fire hydrant, fire department connection, utility pole, manhole, fire alarm box or catch basin, or so as to interfere with the passage of water in the gutter. Protection against damage shall be provided to such utility fixtures during the progress of the work, but sight of them shall not be obstructed.

SECTION 3309

FIRE EXTINGUISHERS

[F] 3309.1 Where required. All structures under construction, alteration or demolition shall be provided with no fewer than one approved portable fire extinguisher in accordance with Section 906 and sized for not less than ordinary hazard as follows:

1. At each stairway on all floor levels where combustible materials have accumulated.
2. In every storage and construction shed.
3. Additional portable fire extinguishers shall be provided where special hazards exist, such as the storage and use of flammable and combustible liquids.

[F] 3309.2 Fire hazards. The provisions of this code and the *California Fire Code* shall be strictly observed to safeguard against all fire hazards attendant upon construction operations.

SECTION 3310

MEANS OF EGRESS

3310.1 Stairways required. Where a building has been constructed to a building height of 50 feet (15 240 mm) or four stories, or where an existing building exceeding 50 feet (15 240 mm) in building height is altered, no fewer than one temporary lighted stairway shall be provided unless one or more of the permanent stairways are erected as the construction progresses.

3310.2 Maintenance of means of egress. Required means of egress shall be maintained at all times during construction, demolition, remodeling or alterations and additions to any building.

Exception: Existing means of egress need not be maintained where approved temporary means of egress systems and facilities are provided.

SECTION 3311

STANDPIPES

[F] 3311.1 Where required. In buildings required to have standpipes by Section 905.3.1, no fewer than one standpipe shall be provided for use during construction. Such stand-

pipes shall be installed when the progress of construction is not more than 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairs. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

[F] 3311.2 Buildings being demolished. Where a building is being demolished and a standpipe exists within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

[F] 3311.3 Detailed requirements. Standpipes shall be installed in accordance with the provisions of Chapter 9.

Exception: Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes conform to the requirements of Section 905 as to capacity, outlets and materials.

SECTION 3312

AUTOMATIC SPRINKLER SYSTEM

[F] 3312.1 Completion before occupancy. In buildings where an automatic sprinkler system is required by this code, it shall be unlawful to occupy any portion of a building or structure until the automatic sprinkler system installation has been tested and approved, except as provided in Section 111.3.

[F] 3312.2 Operation of valves. Operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by notification of duly designated parties. When the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service.

SECTION 3313

WATER SUPPLY FOR FIRE PROTECTION

[F] 3313.1 Where required. An approved water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible material arrives on the site.

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE CHAPTER 34 – EXISTING STRUCTURES

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | X | X | | | | | | | X | X | | | | | | | | |
| Adopt only those sections that are listed below | X | X | | | | | X | X | X | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |
| 3401 | | X | | | | | | | | | | | | | | | | | | |
| 3401.1 | | | X | X | | | | | X | X | | | | | | | | | | |
| 3401.1 (Last Paragraph only) | | | | | | | X | | | | | | | | | | | | | |
| 3401.1.1 | X | | | | | | | | | | | | | | | | | | | |
| 3401.1.1 | | X | | | | | | | | | | | | | | | | | | |
| 3401.2 | | X | | | | | | | | | | | | | | | | | | |
| 3401.3 | | X | X | X | | | | | | | | | | | | | | | | |
| 3401.1.2 | | | | | | | X | | | | | | | | | | | | | |
| 3401.1.3 | | | | | | | | X | | | | | | | | | | | | |
| 3401.3 | | | X | X | | | | | | | | | | | | | | | | |
| 3401.4 | | X | | | | | | | | | | | | | | | | | | |
| 3401.4.1 | | X | X | X | | | | | | | | | | | | | | | | |
| 3401.4.2 | | X | | | | | | | | | | | | | | | | | | |
| 3401.5 | | | | | | | | | | | X | | | | | | | | | |
| 3401.6 | | X | t | t | | | | | | | | | | | | | | | | |
| 3401.7 | X | | | | | | | | | | | X | X | | | | | | | |
| 3401.8 | X | | | | | | | | | | | | | | | | | | | |
| 3402 | X | X | | | | X | X | X | X | | | | | | | | | | | |
| 3402.1 | | | | | | | | | | | | X | X | | | | | | | |
| 3403 | X | | | | | | | | | | | | | | | | | | | |
| 3403.1 <i>Exception</i> | X | | | | | | | | | | | | | | | | | | | |
| 3403.2 <i>Equation</i> | X | | | | | | | | | | | | | | | | | | | |
| 3403.5 | | | t | t | | | | | | | | | | | | | | | | |
| 3404 | X | | | | | | | | | | | | | | | | | | | |
| 3404.1 <i>Exception #3</i> | X | | | | | | | | | | | | | | | | | | | |
| 3404.1.1 | | | X | X | | | | | | | | | | | | | | | | |
| 3404.6 | | X | t | t | | | | | | | | | | | | | | | | |
| 3405 | X | | | | | | | | | | | | | | | | | | | |
| 3405.1 <i>Exception</i> | X | | | | | | | | | | | | | | | | | | | |
| 3405.1.1 | | X | X | X | | | | | | | | | | | | | | | | |
| 3405.2 | | | t | t | | | | | | | | | | | | | | | | |
| 3405.3 | | | t | t | | | | | | | | | | | | | | | | |
| 3406 | X | X | t | t | | | | | | | | | | | | | | | | |
| 3407 | | | t | t | | | | | | | | | | | | | | | | |

(continued)

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE
CHAPTER 34 – EXISTING STRUCTURES—continued

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | X | X | | | | | | X | X | | | | | | | | | |
| Adopt only those sections that are listed below | X | X | | | | X | X | X | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |
| 3408 | X | X | | | | | | | | | | | | | | | | | | |
| 3409 | | | † | † | | | | | | | | | | | | | | | | |
| 3409 (1st Paragraph) | | | | | | X | | | | | | | | | | | | | | |
| 3409 | | | | | | | | | | | | | | | | | | | | |
| 3410.1 | | | X | X | | | | | | | | | | | | | | | | |
| 3410.2 | | | | | | | | | | | | | | | | | | | | |
| 3411 | | | † | † | | | | | | | | | | | | | | | | |
| 3412.2 | | | | | | | | | X | X | | | | | | | | | | |
| 3413 | | X | | | | | | | | | | | | | | | | | | |
| 3414 | | X | | | | | | | | | | | | | | | | | | |
| 3415 | | X | | | | | | | | | | | | | | | | | | |
| 3416 | | X | | | | | | | | | | | | | | | | | | |
| 3417 | X | | | | | X | X | | | | | | | | | | | | | |
| 3417.1.2 | | | | | | X | | | | | | | | | | | | | | |
| 3417.1.3 | | | | | | | X | | | | | | | | | | | | | |
| 3417.3.2 | | | | | | | X | | | | | | | | | | | | | |
| 3417.3.3 | | | | | | | | X | | | | | | | | | | | | |
| 3418 | X | | | | | X | X | | | | | | | | | | | | | |
| 3419 | X | | | | | X | X | | | | | | | | | | | | | |
| 3420 | | | | | | X | X | | | | | | | | | | | | | |
| 3421 | X | | | | | X | X | | | | | | | | | | | | | |
| 3422 | X | | | | | X | X | | | | | | | | | | | | | |
| 3423 | | | | | | X | X | | | | | | | | | | | | | |
| 3424 | | | | | | | | | X | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.

The state agency does not adopt sections identified with the following symbol: †

CHAPTER 34

EXISTING STRUCTURES

SECTION 3401 GENERAL

3401.1 Scope. The provisions of this chapter shall control the alteration, repair, addition and change of occupancy of existing structures, *including state-regulated structures in accordance with Sections 3401.1 and 3401.2.*

[**DSA-AC**] For applications listed in Section 1.9.1 regulated by the Division of the State Architect-Access Compliance for accessibility requirements, see Chapter 11B.

Exception: Existing bleachers, grandstands and folding and telescopic seating shall comply with ICC 300.

[**HCD 1**] In addition to the requirements in this chapter, maintenance, alteration, repair, addition, or change of occupancy to existing buildings and accessory structures under the authority of the Department of Housing and Community Development, as provided in Section 1.8.2.1.1, shall comply with California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1.

Exceptions:

1. Existing bleachers, grandstands and folding and telescopic seating shall comply with ICC 300-02.
2. [**HCD 2**] For moved buildings and maintenance, alteration, repair, addition, or change of occupancy to existing buildings and accessory structures in mobilehome parks or special occupancy parks as provided in Section 1.8.2.1.3. See California Code of Regulations, Title 25, Division 1, Chapters 2 and 2.2.
3. [**HCD 1**] Limited-density owner-built rural dwellings.

3401.1.1 Existing state-owned structures. The provisions of Sections 3417 through 3422 establish minimum standards for earthquake evaluation and design for retrofit of existing state-owned structures, including buildings owned by the University of California and the California State University.

The provisions of Sections 3417 through 3422 may be adopted by a local jurisdiction for earthquake evaluation and design for retrofit of existing buildings.

3401.1.2 Public school buildings. [DSA-SS] The provisions of Sections 3417 through 3423 establish minimum standards for earthquake evaluation and design for the rehabilitation of existing buildings for use as public school buildings under the jurisdiction of the Division of the State Architect-Structural Safety (DSA-SS, refer to Section 1.9.2.1) where required by Sections 4-307 and 4-309(c) of the California Administrative Code.

The provisions of Section 3417 through 3423 also establish minimum standards for earthquake evaluation and design for rehabilitation of existing public school buildings currently under the jurisdiction of DSA-SS.

3401.1.3 Community college buildings. [DSA-SS/CC] The provisions of Sections 3417 through 3423 establish minimum standards for earthquake evaluation and design for the rehabilitation of existing buildings for use as community college buildings under the jurisdiction of the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC, refer to Section 1.9.2.2) where required by Sections 4-307 and 4-309(c) of the California Administrative Code.

The provisions of Section 3417 through 3423 also establish minimum standards for earthquake evaluation and design for rehabilitation of existing community college buildings currently under the jurisdiction of DSA-SS/CC.

3401.2 Maintenance. Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices or safeguards which are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for the maintenance of buildings and structures. To determine compliance with this subsection, the building official shall have the authority to require a building or structure to be reinspected. The requirements of this chapter shall not provide the basis for removal or abrogation of fire protection and safety systems and devices in existing structures.

3401.3 Compliance. Alterations, repairs, additions and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in the California Fire Code, California Mechanical Code, California Plumbing Code, California Residential Code and California Electrical Code. Where provisions of the other codes conflict with provisions of this chapter, the provisions of this chapter shall take precedence.

3401.4 Building materials and systems. Building materials and systems shall comply with the requirements of this section.

3401.4.1 Existing materials. Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building code official to be unsafe per Section 116.

[**HCD 1**] Local ordinances or regulations shall permit the replacement, retention and extension of original materials, and the use of original methods of construction, for any building or accessory structure, provided such building or structure complied with the building code provisions in effect at the time of original construction and the building or accessory structure does not become or continue to be a substandard building. For additional information, see Health and Safety Code Sec-

tions 17912, 17920.3, 17922(d), 17922.3, 17958.8 and 17958.9.

3401.4.2 New and replacement materials. Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

3401.4.3 Existing seismic force-resisting systems. Where the existing seismic force-resisting system is a type that can be designated ordinary, values of R , Ω_0 , and C_d for the existing seismic force-resisting system shall be those specified by this code for an ordinary system unless it is demonstrated that the existing system will provide performance equivalent to that of a detailed, intermediate or special system.

3401.5 Dangerous conditions. The building official shall have the authority to require the elimination of conditions deemed dangerous.

3401.6 Alternative compliance. Work performed in accordance with the *International Existing Building Code* shall be deemed to comply with the provisions of this chapter.

Exception: [OSHPD 2] Section 3401.6 not permitted by OSHPD.

3401.7 Adoption of ASCE 41: [OSHPD 2 & 3] All additions, alterations, repairs and seismic retrofit to the existing structures or portions thereof may be designed in accordance with the provisions of ASCE 41, as modified herein. For load combinations which do not include seismic forces, the new building code provisions of this code shall be applicable.

3401.7.1 ASCE 41 Section 1.4 – Rehabilitation Objectives. Target building performance level shall be Life Safety (LS) Building Performance Level (3-C) as defined in Section 1.5.3.3 at Basic Safety Earthquake 1 (BSE-1) Seismic Hazard Level as defined in section 1.6.1.2 for Risk Category II Structures and Basic Safety Objective (BSO) Level as defined in Section 1.4.1 for Risk Category III Structures.

Risk Category IV structures shall satisfy Immediate Occupancy (IO) Building Performance Level of (1-B) as defined in Section 1.5.3.2 at Basic Safety Earthquake 1 (BSE-1) Seismic Hazard Level as defined in Section 1.6.1.2 and Collapse Prevention (CP) building performance level (5-E) per Section 1.5.3.4 at Basic Safety Earthquake 2 (BSE-2) Seismic Hazard Level as defined in Section 1.6.1.1.

3401.7.2 ASCE 41 Section 1.6 - Seismic Hazard. Response spectra and acceleration time histories shall be constructed in accordance with ASCE 7. The Basic Safety Earthquake 2 (BSE-2) in ASCE 41 shall be same as Maximum Considered Earthquake (MCE_R) in ASCE 7. The Basic Safety Earthquake 1 (BSE-1) shall be two-thirds of BSE-2.

3401.7.3 Analysis procedure. The selection of a particular analysis procedure from ASCE 41 may be subject to the approval of the enforcement agent.

3401.7.4 Structural design criteria. Prior to implementation of ASCE 41 nonlinear dynamic procedures—the

ground motion, analysis and design methods, material assumptions and acceptance criteria proposed by the engineer shall be reviewed by the enforcement agent.

3401.7.5 Structural observation, testing and inspections. Construction, testing, inspection and structural observation requirements shall be as required for new construction.

3401.8 Existing Group R Occupancies. [SFM] See the California Residential Code for existing Group R-3 occupancies or Chapter 46 of the California Fire Code for all other existing Group R occupancies.

3401.9 Dangerous conditions. [BSC] Regardless of the extent of structural or nonstructural damage, the building code official shall have the authority to require the elimination of conditions deemed dangerous.

SECTION 3402 DEFINITIONS

3402.1 Definitions. The following terms are defined in Chapter 2:

DANGEROUS.

EXISTING STRUCTURE.

PRIMARY FUNCTION.

SUBSTANTIAL STRUCTURAL DAMAGE.

TECHNICALLY INFEASIBLE.

SECTION 3403 ADDITIONS

3403.1 General. Additions to any building or structure shall comply with the requirements of this code for new construction. Alterations to the existing building or structure shall be made to ensure that the existing building or structure together with the addition are no less conforming with the provisions of this code than the existing building or structure was prior to the addition. An existing building together with its additions shall comply with the height and area provisions of Chapter 5.

Exception: For state-owned buildings, including those owned by the University of California and the California State University and the Judicial Council, the requirements of Sections 3403.3 and 3403.4 are replaced by the requirements of Sections 3417 through 3422.

3403.2 Flood hazard areas. For buildings and structures in flood hazard areas established in Section 1612.3, any addition that constitutes substantial improvement of the existing structure, as defined in Section 1612.2, shall comply with the flood design requirements for new construction, and all aspects of the existing structure shall be brought into compliance with the requirements for new construction for flood design.

For buildings and structures in flood hazard areas established in Section 1612.3, any additions that do not constitute substantial improvement of the existing structure, as defined in Section 1612.2, are not required to comply with the flood design requirements for new construction.

3403.3 Existing structural elements carrying gravity load. Any existing gravity load-carrying structural element for which an addition and its related alterations cause an increase in design gravity load of more than 5 percent shall be strengthened, supplemented, replaced or otherwise altered as needed to carry the increased gravity load required by this code for new structures. Any existing gravity load-carrying structural element whose gravity load-carrying capacity is decreased shall be considered an altered element subject to the requirements of Section 3404.3. Any existing element that will form part of the lateral load path for any part of the addition shall be considered an existing lateral load-carrying structural element subject to the requirements of Section 3403.4.

3403.3.1 Design live load. Where the addition does not result in increased design live load, existing gravity load-carrying structural elements shall be permitted to be evaluated and designed for live loads approved prior to the addition. If the approved live load is less than that required by Section 1607, the area designed for the nonconforming live load shall be posted with placards of approved design indicating the approved live load. Where the addition does result in increased design live load, the live load required by Section 1607 shall be used.

3403.4 Existing structural elements carrying lateral load. Where the addition is structurally independent of the existing structure, existing lateral load-carrying structural elements shall be permitted to remain unaltered. Where the addition is not structurally independent of the existing structure, the existing structure and its addition acting together as a single structure shall be shown to meet the requirements of Sections 1609 and 1613.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the addition considered is no more than 10 percent greater than its demand-capacity ratio with the addition ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with Sections 1609 and 1613. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction.

3403.5 Smoke alarms in existing portions of a building. Where an addition is made to a building or structure of a Group R or I-1 occupancy, the existing building shall be provided with smoke alarms in accordance with Section 1103.8 of the *California Fire Code*.

SECTION 3404 ALTERATIONS

3404.1 General. Except as provided by Section 3401.4 or this section, alterations to any building or structure shall comply with the requirements of the code for new construction. Alterations shall be such that the existing building or structure is no less complying with the provisions of this code than the existing building or structure was prior to the alteration.

Exceptions:

1. An existing stairway shall not be required to comply with the requirements of Section 1009 where the existing space and construction does not allow a reduction in pitch or slope.
2. Handrails otherwise required to comply with Section 1009.15 shall not be required to comply with the requirements of Section 1012.6 regarding full extension of the handrails where such extensions would be hazardous due to plan configuration.
3. For state-owned buildings, including those owned by the University of California and the California State University and the Judicial Council, the requirements of Sections 3404.3 through 3404.5 are replaced by the requirements of Sections 3417 through 3422.

3404.1.1 Replacement, retention and extension of original materials. [HCD 1] Local ordinances or regulations shall permit the replacement, retention and extension of original materials, and the use of original methods of construction, for any building or accessory structure, provided such building or structure complied with the building code provisions in effect at the time of original construction and the building or accessory structure does not become or continue to be a substandard building. For additional information, see Health and Safety Code Sections 17912, 17920.3, 17922(d), 17922.3, 17958.8 and 17958.9.

3404.2 Flood hazard areas. For buildings and structures in flood hazard areas established in Section 1612.3, any alteration that constitutes substantial improvement of the existing structure, as defined in Section 1612.2, shall comply with the flood design requirements for new construction, and all aspects of the existing structure shall be brought into compliance with the requirements for new construction for flood design.

For buildings and structures in flood hazard areas established in Section 1612.3, any alterations that do not constitute substantial improvement of the existing structure, as defined in Section 1612.2, are not required to comply with the flood design requirements for new construction.

3404.3 Existing structural elements carrying gravity load. Any existing gravity load-carrying structural element for which an alteration causes an increase in design gravity load of more than 5 percent shall be strengthened, supplemented, replaced or otherwise altered as needed to carry the increased gravity load required by this code for new structures. Any existing gravity load-carrying structural element whose gravity load-carrying capacity is decreased as part of the alteration shall be shown to have the capacity to resist the applicable design gravity loads required by this code for new structures.

3404.3.1 Design live load. Where the alteration does not result in increased design live load, existing gravity load-carrying structural elements shall be permitted to be evaluated and designed for live loads approved prior to the alteration. If the approved live load is less than that required by Section 1607, the area designed for the nonconforming live load shall be posted with placards of approved design indicating the approved live load. Where the alteration does

result in increased design live load, the live load required by Section 1607 shall be used.

3404.4 Existing structural elements carrying lateral load.

Except as permitted by Section 3404.5, where the alteration increases design lateral loads in accordance with Section 1609 or 1613, or where the alteration results in a structural irregularity as defined in ASCE 7, or where the alteration decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall be shown to meet the requirements of Sections 1609 and 1613.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the alteration considered is no more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces per Sections 1609 and 1613. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of additions and alterations since original construction.

3404.5 Voluntary seismic improvements. Alterations to existing structural elements or additions of new structural elements that are not otherwise required by this chapter and are initiated for the purpose of improving the performance of the seismic force-resisting system of an existing structure or the performance of seismic bracing or anchorage of existing nonstructural elements shall be permitted, provided that an engineering analysis is submitted demonstrating the following:

1. The altered structure and the altered nonstructural elements are no less conforming with the provisions of this code with respect to earthquake design than they were prior to the alteration.
2. New structural elements are detailed as required for new construction.
3. New or relocated nonstructural elements are detailed and connected to existing or new structural elements as required for new construction.
4. The alterations do not create a structural irregularity as defined in ASCE 7 or make an existing structural irregularity more severe.

3404.6 Smoke alarms. Individual sleeping units and individual dwelling units in Group R and I-1 occupancies shall be provided with smoke alarms in accordance with Section 1103.8 of the *California Fire Code*.

SECTION 3405 REPAIRS

3405.1 General. Buildings and structures, and parts thereof, shall be repaired in compliance with Section 3405 and 3401.2. Work on nondamaged components that is necessary for the required repair of damaged components shall be considered part of the repair and shall not be subject to the requirements for alterations in this chapter. Routine maintenance required by Section 3401.2, ordinary repairs exempt from permit in accor-

dance with Section 105.2, and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

Exception: For state-owned buildings, including those owned by the University of California and the California State University and the Judicial Council, the requirements of Sections 3405.2 through 3405.4 are replaced by the requirements of Sections 3417 through 3422.

3405.1.2 Replacement, retention and extension of original materials. [HCD 1] Local ordinances or regulations shall permit the replacement, retention and extension of original materials, and the use of original methods of construction, for any building or accessory structure, provided such building or structure complied with the building code provisions in effect at the time of original construction and the building or accessory structure does not become or continue to be a substandard building. For additional information, see Health and Safety Code Sections 17912, 17920.3, 17922(d), 17922.3, 17958.8 and 17958.9.

3405.2 Substantial structural damage to vertical elements of the lateral force-resisting system. A building that has sustained substantial structural damage to the vertical elements of its lateral force-resisting system shall be evaluated and repaired in accordance with the applicable provisions of Sections 3405.2.1 through 3405.2.3.

Exceptions:

1. Buildings assigned to Seismic Design Category A, B, or C whose substantial structural damage was not caused by earthquake need not be evaluated or rehabilitated for load combinations that include earthquake effects.
2. One- and two-family dwellings need not be evaluated or rehabilitated for load combinations that include earthquake effects.

3405.2.1 Evaluation. The building shall be evaluated by a registered design professional, and the evaluation findings shall be submitted to the building official. The evaluation shall establish whether the damaged building, if repaired to its pre-damage state, would comply with the provisions of this code for wind and earthquake loads.

Wind loads for this evaluation shall be those prescribed in Section 1609. Earthquake loads for this evaluation, if required, shall be permitted to be 75 percent of those prescribed in Section 1613.

3405.2.2 Extent of repair for compliant buildings. If the evaluation establishes compliance of the pre-damage building in accordance with Section 3405.2.1, then repairs shall be permitted that restore the building to its pre-damage state, based on material properties and design strengths applicable at the time of original construction.

3405.2.3 Extent of repair for noncompliant buildings. If the evaluation does not establish compliance of the pre-damage building in accordance with Section 3405.2.1, then the building shall be rehabilitated to comply with applicable provisions of this code for load combinations that include wind or seismic loads. The wind loads for the repair

shall be as required by the building code in effect at the time of original construction, unless the damage was caused by wind, in which case the wind loads shall be as required by this code. Earthquake loads for this rehabilitation design shall be those required for the design of the pre-damage building, but not less than 75 percent of those prescribed in Section 1613. New structural members and connections required by this rehabilitation design shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

3405.3 Substantial structural damage to gravity load-carrying components. Gravity load-carrying components that have sustained substantial structural damage shall be rehabilitated to comply with the applicable provisions of this code for dead and live loads. Snow loads shall be considered if the substantial structural damage was caused by or related to snow load effects. Existing gravity load-carrying structural elements shall be permitted to be designed for live loads approved prior to the damage. Nondamaged gravity load-carrying components that receive dead, live or snow loads from rehabilitated components shall also be rehabilitated or shown to have the capacity to carry the design loads of the rehabilitation design. New structural members and connections required by this rehabilitation design shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

3405.3.1 Lateral force-resisting elements. Regardless of the level of damage to vertical elements of the lateral force-resisting system, if substantial structural damage to gravity load-carrying components was caused primarily by wind or earthquake effects, then the building shall be evaluated in accordance with Section 3405.2.1 and, if noncompliant, rehabilitated in accordance with Section 3405.2.3.

Exceptions:

1. One- and two-family dwellings need not be evaluated or rehabilitated for load combinations that include earthquake effects.
2. Buildings assigned to Seismic Design Category A, B, or C whose substantial structural damage was not caused by earthquake need not be evaluated or rehabilitated for load combinations that include earthquake effects.

3405.4 Less than substantial structural damage. For damage less than substantial structural damage, repairs shall be allowed that restore the building to its pre-damage state, based on material properties and design strengths applicable at the time of original construction. New structural members and connections used for this repair shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

3405.5 Flood hazard areas. For buildings and structures in flood hazard areas established in Section 1612.3, any repair that constitutes substantial improvement of the existing structure, as defined in Section 1612.2, shall comply with the flood design requirements for new construction, and all aspects of the existing structure shall be brought into compliance with the requirements for new construction for flood design.

For buildings and structures in flood hazard areas established in Section 1612.3, any repairs that do not constitute substantial improvement or repair of substantial damage of the existing structure, as defined in Section 1612.2, are not required to comply with the flood design requirements for new construction.

SECTION 3406 FIRE ESCAPES

3406.1 Where permitted. Fire escapes shall be permitted only as provided for in Sections 3406.1.1 through 3406.1.4.

3406.1.1 New buildings. Fire escapes shall not constitute any part of the required means of egress in new buildings.

3406.1.2 Existing fire escapes. Existing fire escapes shall be continued to be accepted as a component in the means of egress in existing buildings only.

3406.1.3 New fire escapes. New fire escapes for existing buildings shall be permitted only where exterior stairs cannot be utilized due to lot lines limiting stair size or due to the sidewalks, alleys or roads at grade level. New fire escapes shall not incorporate ladders or access by windows.

3406.1.4 Limitations. Fire escapes shall comply with this section and shall not constitute more than 50 percent of the required number of exits nor more than 50 percent of the required exit capacity.

3406.2 Location. Where located on the front of the building and where projecting beyond the building line, the lowest landing shall not be less than 7 feet (2134 mm) or more than 12 feet (3658 mm) above grade, and shall be equipped with a counterbalanced stairway to the street. In alleyways and thoroughfares less than 30 feet (9144 mm) wide, the clearance under the lowest landing shall not be less than 12 feet (3658 mm).

3406.3 Construction. The fire escape shall be designed to support a live load of 100 pounds per square foot (4788 Pa) and shall be constructed of steel or other approved noncombustible materials. Fire escapes constructed of wood not less than nominal 2 inches (51 mm) thick are permitted on buildings of Type V construction. Walkways and railings located over or supported by combustible roofs in buildings of Type III and IV construction are permitted to be of wood not less than nominal 2 inches (51 mm) thick.

3406.4 Dimensions. Stairs shall be at least 22 inches (559 mm) wide with risers not more than, and treads not less than, 8 inches (203 mm) and landings at the foot of stairs not less than 40 inches (1016 mm) wide by 36 inches (914 mm) long, located not more than 8 inches (203 mm) below the door.

3406.5 Opening protectives. Doors and windows along the fire escape shall be protected with $\frac{3}{4}$ -hour opening protectives.

SECTION 3407 GLASS REPLACEMENT

3407.1 Conformance. The installation or replacement of glass shall be as required for new installations.

SECTION 3408 CHANGE OF OCCUPANCY

3408.1 Conformance. No change shall be made in the use or occupancy of any building that would place the building in a different division of the same group of occupancies or in a different group of occupancies, unless such building is made to comply with the requirements of this code for such division or group of occupancies. Subject to the approval of the building official, the use or occupancy of existing buildings shall be permitted to be changed and the building is allowed to be occupied for purposes in other groups without conforming to all the requirements of this code for those groups, provided the new or proposed use is less hazardous, based on life and fire risk, than the existing use.

3408.2 Certificate of occupancy. A certificate of occupancy shall be issued where it has been determined that the requirements for the new occupancy classification have been met.

3408.3 Stairways. Existing stairways in an existing structure shall not be required to comply with the requirements of a new stairway as outlined in Section 1009 where the existing space and construction will not allow a reduction in pitch or slope.

3408.4 Seismic. When a change of occupancy results in a structure being reclassified to a higher risk category, the structure shall conform to the seismic requirements for a new structure of the higher risk category.

Exceptions:

1. Specific seismic detailing requirements of Section 1613 for a new structure shall not be required to be met where the seismic performance is shown to be equivalent to that of a new structure. A demonstration of equivalence shall consider the regularity, overstrength, redundancy and ductility of the structure.
2. When a change of use results in a structure being reclassified from Risk Category I or II to Risk Category III and the structure is located where the seismic coefficient, S_{DS} , is less than 0.33, compliance with the seismic requirements of Section 1613 are not required.

SECTION 3409 HISTORIC BUILDINGS

[DSA-AC] For applications listed in Section 1.9.1 regulated by the Division of the State Architect-Access Compliance for Qualified Historical Buildings, see California Code of Regulations, Title 24, Part 8 (California Historical Building Code).

3409.1 Historic buildings. The provisions of this code relating to the construction, repair, alteration, addition, restoration and movement of structures, and change of occupancy shall not be mandatory for historic buildings where such buildings are judged by the building official to not constitute a distinct life safety hazard.

3409.2 Flood hazard areas. Within flood hazard areas established in accordance with Section 1612.3, where the work pro-

posed constitutes substantial improvement as defined in Section 1612.2, the building shall be brought into compliance with Section 1612.

Exception: Historic buildings that are:

1. Listed or preliminarily determined to be eligible for listing in the National Register of Historic Places;
2. Determined by the Secretary of the U.S. Department of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined to qualify as an historic district; or
3. Designated as historic under a state or local historic preservation program that is approved by the Department of Interior.

SECTION 3410 MOVED STRUCTURES

3410.1 Conformance. Structures moved into or within the jurisdiction shall comply with the provisions of this code for new structures.

Exception: [HCD 1 & HCD 2] After July 1, 1978, local ordinances or regulations for moved apartment houses and dwellings shall permit the retention of existing materials and methods of construction, provided the apartment house or dwelling complies with the building standards for foundations applicable to new construction and does not become or continue to be a substandard building. For additional information, see Health and Safety Code Section 17958.9.

SECTION 3411 ACCESSIBILITY FOR EXISTING BUILDINGS

3411.1 Scope. The provisions of Sections 3411.1 through 3411.9 apply to maintenance, change of occupancy, additions and alterations to existing buildings, including those identified as historic buildings.

3411.2 Maintenance of facilities. A facility that is constructed or altered to be accessible shall be maintained accessible during occupancy.

3411.3 Extent of application. An alteration of an existing facility shall not impose a requirement for greater accessibility than that which would be required for new construction. Alterations shall not reduce or have the effect of reducing accessibility of a facility or portion of a facility.

3411.4 Change of occupancy. Existing buildings that undergo a change of group or occupancy shall comply with this section.

Exception: Type B dwelling units or sleeping units required by Section 1107 of this code are not required to be provided in existing buildings and facilities undergoing a change of occupancy in conjunction with alterations where the work

area is 50 percent or less of the aggregate area of the building.

3411.4.1 Partial change in occupancy. Where a portion of the building is changed to a new occupancy classification, any alterations shall comply with Sections 3411.6, 3411.7 and 3411.8.

3411.4.2 Complete change of occupancy. Where an entire building undergoes a change of occupancy, it shall comply with Section 3411.4.1 and shall have all of the following accessible features:

1. At least one accessible building entrance.
2. At least one accessible route from an accessible building entrance to primary function areas.
3. Signage complying with *Chapter 11A or 11B as applicable*.
4. Accessible parking, where parking is being provided.
5. At least one accessible passenger loading zone, when loading zones are provided.
6. At least one accessible route connecting accessible parking and accessible passenger loading zones to an accessible entrance.

Where it is technically infeasible to comply with the new construction standards for any of these requirements for a change of group or occupancy, the above items shall conform to the requirements to the maximum extent technically feasible.

Exception: The accessible features listed in Items 1 through 6 are not required for an accessible route to Type B units.

3411.5 Additions. Provisions for new construction shall apply to additions. An addition that affects the accessibility to, or contains an area of, a primary function shall comply with the requirements in Section 3411.7.

3411.6 Alterations. A facility that is altered shall comply with the applicable provisions in *Chapter 11A or 11B as applicable* of this code and ICC A117.1, unless technically infeasible. Where compliance with this section is technically infeasible, the alteration shall provide access to the maximum extent technically feasible.

Exceptions:

1. The altered element or space is not required to be on an accessible route, unless required by Section 3411.7.
2. Accessible means of egress required by Chapter 10 are not required to be provided in existing buildings and facilities.
3. The alteration to Type A individually owned dwelling units within a Group R-2 occupancy shall meet the provision for a Type B dwelling unit and shall comply with the applicable provisions in *Chapter 11A or 11B as applicable*.
4. Type B dwelling or sleeping units required by Section 1107 of this code are not required to be provided in existing buildings and facilities undergoing a change

of occupancy in conjunction with alterations where the work area is 50 percent or less of the aggregate area of the building.

3411.7 Alterations affecting an area containing a primary function. Where an alteration affects the accessibility to, or contains an area of primary function, the route to the primary function area shall be accessible. The accessible route to the primary function area shall include toilet facilities or drinking fountains serving the area of primary function.

Exceptions:

1. The costs of providing the accessible route are not required to exceed 20 percent of the costs of the alterations affecting the area of primary function.
2. This provision does not apply to alterations limited solely to windows, hardware, operating controls, electrical outlets and signs.
3. This provision does not apply to alterations limited solely to mechanical systems, electrical systems, installation or alteration of fire protection systems and abatement of hazardous materials.
4. This provision does not apply to alterations undertaken for the primary purpose of increasing the accessibility of an existing building, facility or element.
5. This provision does not apply to altered areas limited to Type B dwelling and sleeping units.

3411.8 Scoping for alterations. The provisions of Sections 3411.8.1 through 3411.8.14 shall apply to alterations to existing buildings and facilities.

3411.8.1 Entrances. Accessible entrances shall be provided in accordance with *Chapter 11A or 11B as applicable*.

Exception: Where an alteration includes alterations to an entrance, and the building or facility has an accessible entrance, the altered entrance is not required to be accessible, unless required by Section 3411.7. Signs complying with *Chapter 11A or 11B as applicable* shall be provided.

3411.8.2 Elevators. Altered elements of existing elevators shall comply with *California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders* and ICC A117.1. Such elements shall also be altered in elevators programmed to respond to the same hall call control as the altered elevator.

3411.8.3 Platform lifts. Platform (wheelchair) lifts complying with ICC A117.1 and installed in accordance with ASME A18.1 shall be permitted as a component of an accessible route.

3411.8.4 Stairs and escalators in existing buildings. In alterations, change of occupancy or additions where an escalator or stair is added where none existed previously and major structural modifications are necessary for installation, an accessible route shall be provided between the levels served by the escalator or stairs in accordance with *Chapter 11A or 11B as applicable*.

3411.8.5 Ramps. Where slopes steeper than allowed by Section 1010.2 are necessitated by space limitations, the slope of ramps in or providing access to existing buildings or facilities shall comply with Table 3411.8.5.

TABLE 3411.8.5
RAMPS

| SLOPE | MAXIMUM RISE |
|---|--------------|
| Steeper than 1:10 but not steeper than 1:8 | 3 inches |
| Steeper than 1:12 but not steeper than 1:10 | 6 inches |

For SI: 1 inch = 25.4 mm.

3411.8.6 Performance areas. Where it is technically infeasible to alter performance areas to be on an accessible route, at least one of each type of performance area shall be made accessible.

3411.8.7 Accessible dwelling or sleeping units. Where Group I-1, I-2, I-3, R-1, R-2 or R-4 dwelling or sleeping units are being altered or added, the requirements of *Chapter 11A or 11B as applicable* for Accessible units apply only to the quantity of spaces being altered or added.

3411.8.8 Type A dwelling or sleeping units. Where more than 20 Group R-2 dwelling or sleeping units are being altered or added, the requirements of *Chapter 11A or 11B as applicable* for Type A units apply only to the quantity of the spaces being altered or added.

3411.8.9 Type B dwelling or sleeping units. Where four or more Group I-1, I-2, R-1, R-2, R-3 or R-4 dwelling or sleeping units are being added, the requirements of *Chapter 11A or 11B as applicable* for Type B units apply only to the quantity of the spaces being added. Where Group I-1, I-2, R-1, R-2, R-3 or R-4 dwelling or sleeping units are being altered and where the work area is greater than 50 percent of the aggregate area of the building, the requirements of Section 1107 for Type B units apply only to the quantity of the spaces being altered.

3411.8.10 Jury boxes and witness stands. In alterations, accessible wheelchair spaces are not required to be located within the defined area of raised jury boxes or witness stands and shall be permitted to be located outside these spaces where the ramp or lift access restricts or projects into the means of egress.

3411.8.11 Toilet rooms. Where it is technically infeasible to alter existing toilet and bathing rooms to be accessible, an accessible family or assisted-use toilet or bathing rooms constructed in accordance with *Chapter 11A or 11B as applicable* is permitted. The family or assisted-use toilet or bathing room shall be located on the same floor and in the same area as the existing toilet or bathing rooms.

3411.8.12 Dressing, fitting and locker rooms. Where it is technically infeasible to provide accessible dressing, fitting or locker rooms at the same location as similar types of rooms, one accessible room on the same level shall be provided. Where separate-sex facilities are provided, accessible rooms for each sex shall be provided. Separate-sex facilities are not required where only unisex rooms are provided.

3411.8.13 Fuel dispensers. Operable parts of replacement fuel dispensers shall be permitted to be 54 inches (1370 mm) maximum measured from the surface of the vehicular way where fuel dispensers are installed on existing curbs.

3411.8.14 Thresholds. The maximum height of thresholds at doorways shall be $\frac{3}{4}$ inch (19.1 mm). Such thresholds shall have beveled edges on each side.

3411.9 Historic buildings. These provisions shall apply to facilities designated as historic structures that undergo alterations or a change of occupancy, unless technically infeasible. Where compliance with the requirements for accessible routes, entrances or toilet rooms would threaten or destroy the historic significance of the facility, as determined by the applicable governing authority, the alternative requirements of Sections 3411.9.1 through 3411.9.4 for that element shall be permitted.

Exception: Type B dwelling or sleeping units required by Section 1107 are not required to be provided in historical buildings.

3411.9.1 Site arrival points. At least one accessible route from a site arrival point to an accessible entrance shall be provided.

3411.9.2 Multilevel buildings and facilities. An accessible route from an accessible entrance to public spaces on the level of the accessible entrance shall be provided.

3411.9.3 Entrances. At least one main entrance shall be accessible.

Exceptions:

1. If a main entrance cannot be made accessible, an accessible nonpublic entrance that is unlocked while the building is occupied shall be provided; or
2. If a main entrance cannot be made accessible, a locked accessible entrance with a notification system or remote monitoring shall be provided.

Signs complying with *Chapter 11A or 11B as applicable* shall be provided at the primary entrance and the accessible entrance.

3411.9.4 Toilet and bathing facilities. Where toilet rooms are provided, at least one accessible family or assisted-use toilet room complying with *Chapter 11A or 11B as applicable* shall be provided.

SECTION 3412 COMPLIANCE ALTERNATIVES

3412.1 Compliance. The provisions of this section are intended to maintain or increase the current degree of public safety, health and general welfare in existing buildings while permitting repair, alteration, addition and change of occupancy without requiring full compliance with Chapters 2 through 33, or Sections 3401.3, and 3403 through 3409, except where compliance with other provisions of this code is specifically required in this section.

3412.2 Applicability. Structures existing prior to January 1, 2014, in which there is work involving additions, alterations or changes of occupancy shall be made to comply with the

requirements of this section or the provisions of Sections 3403 through 3409. The provisions in Sections 3412.2.1 through 3412.2.5 shall apply to existing occupancies that will continue to be, or are proposed to be, in Groups A, B, E, F, M, R, S and U. These provisions shall not apply to buildings with occupancies in Group H or I.

3412.2.1 Change in occupancy. Where an existing building is changed to a new occupancy classification and this section is applicable, the provisions of this section for the new occupancy shall be used to determine compliance with this code.

3412.2.2 Partial change in occupancy. Where a portion of the building is changed to a new occupancy classification, and that portion is separated from the remainder of the building with fire barriers or horizontal assemblies having a fire-resistance rating as required by Table 508.4 for the separate occupancies, or with approved compliance alternatives, the portion changed shall be made to comply with the provisions of this section.

Where a portion of the building is changed to a new occupancy classification, and that portion is not separated from the remainder of the building with fire barriers or horizontal assemblies having a fire-resistance rating as required by Table 508.4 for the separate occupancies, or with approved compliance alternatives, the provisions of this section which apply to each occupancy shall apply to the entire building. Where there are conflicting provisions, those requirements which secure the greater public safety shall apply to the entire building or structure.

3412.2.3 Additions. Additions to existing buildings shall comply with the requirements of this code for new construction. The combined height and area of the existing building and the new addition shall not exceed the height and area allowed by Chapter 5. Where a fire wall that complies with Section 706 is provided between the addition and the existing building, the addition shall be considered a separate building.

3412.2.4 Alterations and repairs. An existing building or portion thereof, which does not comply with the requirements of this code for new construction, shall not be altered or repaired in such a manner that results in the building being less safe or sanitary than such building is currently. If, in the alteration or repair, the current level of safety or sanitation is to be reduced, the portion altered or repaired shall conform to the requirements of Chapters 2 through 12 and Chapters 14 through 33.

3412.2.4.1 Flood hazard areas. For existing buildings located in flood hazard areas established in Section 1612.3, if the alterations and repairs constitute substantial improvement of the existing building, the existing building shall be brought into compliance with the requirements for new construction for flood design.

3412.2.5 Accessibility requirements. All portions of the buildings proposed for change of occupancy shall conform to the accessibility provisions of Section 3411.

3412.3 Acceptance. For repairs, alterations, additions and changes of occupancy to existing buildings that are evaluated

in accordance with this section, compliance with this section shall be accepted by the building official.

3412.3.1 Hazards. Where the building official determines that an unsafe condition exists, as provided for in Section 116, such unsafe condition shall be abated in accordance with Section 116.

3412.3.2 Compliance with other codes. Buildings that are evaluated in accordance with this section shall comply with the *California Fire Code* and the *California Property Maintenance Code*.

3412.4 Investigation and evaluation. For proposed work covered by this section, the building owner shall cause the existing building to be investigated and evaluated in accordance with the provisions of this section.

3412.4.1 Structural analysis. The owner shall have a structural analysis of the existing building made to determine adequacy of structural systems for the proposed alteration, addition or change of occupancy. The analysis shall demonstrate that the building with the work completed is capable of resisting the loads specified in Chapter 16.

3412.4.2 Submittal. The results of the investigation and evaluation as required in Section 3412.4, along with proposed compliance alternatives, shall be submitted to the building official.

3412.4.3 Determination of compliance. The building official shall determine whether the existing building, with the proposed addition, alteration or change of occupancy, complies with the provisions of this section in accordance with the evaluation process in Sections 3412.5 through 3412.9.

3412.5 Evaluation. The evaluation shall be comprised of three categories: fire safety, means of egress and general safety, as defined in Sections 3412.5.1 through 3412.5.3.

3412.5.1 Fire safety. Included within the fire safety category are the structural fire resistance, automatic fire detection, fire alarm, automatic sprinkler system and fire suppression system features of the facility.

3412.5.2 Means of egress. Included within the means of egress category are the configuration, characteristics and support features for means of egress in the facility.

3412.5.3 General safety. Included within the general safety category are the fire safety parameters and the means of egress parameters.

3412.6 Evaluation process. The evaluation process specified herein shall be followed in its entirety to evaluate existing buildings. Table 3412.7 shall be utilized for tabulating the results of the evaluation. References to other sections of this code indicate that compliance with those sections is required in order to gain credit in the evaluation herein outlined. In applying this section to a building with mixed occupancies, where the separation between the mixed occupancies does not qualify for any category indicated in Section 3412.6.16, the score for each occupancy shall be determined and the lower score determined for each section of the evaluation process shall apply to the entire building.

Where the separation between mixed occupancies qualifies for any category indicated in Section 3412.6.16, the score for

each occupancy shall apply to each portion of the building based on the occupancy of the space.

3412.6.1 Building height. The value for building height shall be the lesser value determined by the formula in Section 3412.6.1.1. Chapter 5 shall be used to determine the allowable height of the building, including allowable increases due to automatic sprinklers as provided for in Section 504.2. Subtract the actual building height in feet from the allowable and divide by 12 1/2 feet. Enter the height value and its sign (positive or negative) in Table 3412.7 under Safety Parameter 3412.6.1, Building Height, for fire safety, means of egress and general safety. The maximum score for a building shall be 10.

3412.6.1.1 Height formula. The following formulas shall be used in computing the building height value.

$$\text{Height value, feet} = \frac{(AH) - (EBH)}{12.5} \times CF \quad (\text{Equation 34-1})$$

$$\text{Height value, stories} = (AS - EBS) \times CF \quad (\text{Equation 34-2})$$

where:

AH = Allowable height in feet from Table 503.

EBH = Existing building height in feet.

AS = Allowable height in stories from Table 503.

EBS = Existing building height in stories.

CF = 1 if $(AH) - (EBH)$ is positive.

CF = Construction-type factor shown in Table 3412.6.6(2) if $(AH) - (EBH)$ is negative.

Note: Where mixed occupancies are separated and individually evaluated as indicated in Section 3412.6, the values AH, AS, EBH and EBS shall be based on the height of the occupancy being evaluated.

3412.6.2 Building area. The value for building area shall be determined by the formula in Section 3412.6.2.2. Section 503 and the formula in Section 3412.6.2.1 shall be used to determine the allowable area of the building. This shall include any allowable increases due to frontage and automatic sprinklers as provided for in Section 506. Subtract the actual building area in square feet from the allowable area and divide by 1,200 square feet. Enter the area value and its sign (positive or negative) in Table 3412.7 under Safety Parameter 3412.6.2, Building Area, for fire safety, means of egress and general safety. In determining the area value, the maximum permitted positive value for area is 50 percent of the fire safety score as listed in Table 3412.8, Mandatory Safety Scores.

3412.6.2.1 Allowable area formula. The following formula shall be used in computing allowable area:

$$A_a = [A_t + (A_t \times I_f) + (A_t \times I_s)] \quad (\text{Equation 34-3})$$

where:

Aa = Allowable building area per story (square feet).

A_t = Tabular building area per story in accordance with Table 503 (square feet)

I_s = Area increase factor due to sprinkler protection as calculated in accordance with Section 506.3.

I_f = Area increase factor due to frontage as calculated in accordance with Section 506.2.

3412.6.2.2 Area formula. The following formula shall be used in computing the area value. Determine the area value for each occupancy floor area on a floor-by-floor basis. For each occupancy, choose the minimum area value of the set of values obtained for the particular occupancy.

$$\text{Area value } i = \frac{\text{Allowable area}_i}{1,200 \text{ square feet}} \left[1 \left(\frac{\text{Actual area}_i}{\text{Allowable area}_i} + \dots + \frac{\text{Actual area}_n}{\text{Allowable area}_n} \right) \right] \quad (\text{Equation 34-4})$$

where:

i = Value for an individual separated occupancy on a floor.

n = Number of separated occupancies on a floor.

3412.6.3 Compartmentation. Evaluate the compartments created by fire barriers or horizontal assemblies which comply with Sections 3412.6.3.1 and 3412.6.3.2 and which are exclusive of the wall elements considered under Sections 3412.6.4 and 3412.6.5. Conforming compartments shall be figured as the net area and do not include shafts, chases, stairways, walls or columns. Using Table 3412.6.3, determine the appropriate compartmentation value (*CV*) and enter that value into Table 3412.7 under Safety Parameter 3412.6.3, Compartmentation, for fire safety, means of egress and general safety.

3412.6.3.1 Wall construction. A wall used to create separate compartments shall be a fire barrier conforming to Section 707 with a fire-resistance rating of not less than 2 hours. Where the building is not divided into more than one compartment, the compartment size shall be taken as the total floor area on all floors. Where there is more than one compartment within a story, each compartmented area on such story shall be provided with a horizontal exit conforming to Section 1025. The fire door serving as the horizontal exit between compartments shall be so installed, fitted and gasketed that such fire door will provide a substantial barrier to the passage of smoke.

3412.6.3.2 Floor/ceiling construction. A floor/ceiling assembly used to create compartments shall conform to Section 712 and shall have a fire-resistance rating of not less than 2 hours.

**TABLE 3412.6.3
COMPARTMENTATION VALUES**

| OCCUPANCY | CATEGORIES ^a | | | | |
|----------------|---|---|--|--|--|
| | a Compartment size equal to or greater than 15,000 square feet | b Compartment size of 10,000 square feet | c Compartment size of 7,500 square feet | d Compartment size of 5,000 square feet | e Compartment size of 2,500 square feet or less |
| A-1, A-3 | 0 | 6 | 10 | 14 | 18 |
| A-2 | 0 | 4 | 10 | 14 | 18 |
| A-4, B, E, S-2 | 0 | 5 | 10 | 15 | 20 |
| F, M, R, S-1 | 0 | 4 | 10 | 16 | 22 |

For SI: 1 square foot = 0.093 m².

a. For areas between categories, the compartmentation value shall be obtained by linear interpolation.

3412.6.4 Tenant and dwelling unit separations. Evaluate the fire-resistance rating of floors and walls separating tenants, including dwelling units, and not evaluated under Sections 3412.6.3 and 3412.6.5. Under the categories and occupancies in Table 3412.6.4, determine the appropriate value and enter that value in Table 3412.7 under Safety Parameter 3412.6.4, Tenant and Dwelling Unit Separations, for fire safety, means of egress and general safety.

**TABLE 3412.6.4
SEPARATION VALUES**

| OCCUPANCY | CATEGORIES | | | | |
|---------------------------|------------|----|---|---|---|
| | a | b | c | d | e |
| A-1 | 0 | 0 | 0 | 0 | 1 |
| A-2 | -5 | -3 | 0 | 1 | 3 |
| A-3, A-4, B, E, F, M, S-1 | -4 | -3 | 0 | 2 | 4 |
| R | -4 | -2 | 0 | 2 | 4 |
| S-2 | -5 | -2 | 0 | 2 | 4 |

3412.6.4.1 Categories. The categories for tenant and dwelling unit separations are:

1. Category a—No fire partitions; incomplete fire partitions; no doors; doors not self-closing or automatic-closing.
2. Category b—Fire partitions or floor assemblies with less than a 1-hour fire-resistance rating or not constructed in accordance with Sections 708 or 711.
3. Category c—Fire partitions with a 1-hour or greater fire-resistance rating constructed in accordance with Section 708 and floor assemblies with a 1-hour but less than 2-hour fire-resistance rating constructed in accordance with Section 711, or with only one tenant within the floor area.
4. Category d—Fire barriers with a 1-hour but less than 2-hour fire-resistance rating constructed in accordance with Section 707 and floor assemblies with a 2-hour or greater fire-resistance rating constructed in accordance with Section 711.
5. Category e—Fire barriers and floor assemblies with a 2-hour or greater fire-resistance rating and constructed in accordance with Sections 707 and 711, respectively.

3412.6.5 Corridor walls. Evaluate the fire-resistance rating and degree of completeness of walls which create corridors serving the floor, and constructed in accordance with Section 1018. This evaluation shall not include the wall elements considered under Sections 3412.6.3 and 3412.6.4. Under the categories and groups in Table 3412.6.5, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.5, Corridor Walls, for fire safety, means of egress and general safety.

**TABLE 3412.6.5
CORRIDOR WALL VALUES**

| OCCUPANCY | CATEGORIES | | | |
|-------------------|------------|-----|----------------|----------------|
| | a | b | c ^a | d ^a |
| A-1 | -10 | -4 | 0 | 2 |
| A-2 | -30 | -12 | 0 | 2 |
| A-3, F, M, R, S-1 | -7 | -3 | 0 | 2 |
| A-4, B, E, S-2 | -5 | -2 | 0 | 5 |

a. Corridors not providing at least one half the travel distance for all occupants on a floor shall use Category b.

3412.6.5.1 Categories. The categories for Corridor Walls are:

1. Category a—No fire partitions; incomplete fire partitions; no doors; or doors not self-closing.
2. Category b—Less than 1-hour fire-resistance rating or not constructed in accordance with Section 708.4.
3. Category c—1-hour to less than 2-hour fire-resistance rating, with doors conforming to Section 716 or without corridors as permitted by Section 1018.
4. Category d—2-hour or greater fire-resistance rating, with doors conforming to Section 716.

3412.6.6 Vertical openings. Evaluate the fire-resistance rating of exit enclosures, hoistways, escalator openings and other shaft enclosures within the building, and openings between two or more floors. Table 3412.6.6(1) contains the appropriate protection values. Multiply that value by the construction type factor found in Table 3412.6.6(2). Enter the vertical opening value and its sign (positive or negative) in Table 3412.7 under Safety Parameter 3412.6.6, Vertical

Openings, for fire safety, means of egress, and general safety. If the structure is a one-story building or if all the unenclosed vertical openings within the building conform to the requirements of Section 708, enter a value of 2. The maximum positive value for this requirement shall be 2.

3412.6.6.1 Vertical opening formula. The following formula shall be used in computing vertical opening value.

$$VO = PV \times CF \quad (\text{Equation 34-5})$$

VO = Vertical opening value.

PV = Protection value [Table 3412.6.6(1)].

CF = Construction type factor [Table 3412.6.6(2)].

TABLE 3412.6.6(1)
VERTICAL OPENING PROTECTION VALUE

| PROTECTION | | VALUE | |
|----------------------------|--|----------------------------------|--|
| None (unprotected opening) | | -2 times number floors connected | |
| Less than 1 hour | | -1 times number floors connected | |
| 1 to less than 2 hours | | 1 | |
| 2 hours or more | | 2 | |

TABLE 3412.6.6(2)
CONSTRUCTION-TYPE FACTOR

| FACTOR | TYPE OF CONSTRUCTION | | | | | | | | |
|--------|----------------------|-----|-----|-----|------|------|-----|-----|----|
| | IA | IB | IIA | IIB | IIIA | IIIB | IV | VA | VB |
| | 1.2 | 1.5 | 2.2 | 3.5 | 2.5 | 3.5 | 2.3 | 3.3 | 7 |

3412.6.7 HVAC systems. Evaluate the ability of the HVAC system to resist the movement of smoke and fire beyond the point of origin. Under the categories in Section 3412.6.7.1, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.7, HVAC Systems, for fire safety, means of egress and general safety.

3412.6.7.1 Categories. The categories for HVAC systems are:

- Category a—Plenums not in accordance with Section 602 of the *California Mechanical Code*. -10 points.
- Category b—Air movement in egress elements not in accordance with Section 1018.5. -5 points.
- Category c—Both categories a and b are applicable. -15 points.
- Category d—Compliance of the HVAC system with Section 1018.5 and Section 602 of the *California Mechanical Code*. 0 points.
- Category e—Systems serving one story; or a central boiler/chiller system without ductwork connecting two or more stories. 5 points.

3412.6.8 Automatic fire detection. Evaluate the smoke detection capability based on the location and operation of automatic fire detectors in accordance with Section 907 and the *California Mechanical Code*. Under the categories and

occupancies in Table 3412.6.8, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.8, Automatic Fire Detection, for fire safety, means of egress and general safety.

TABLE 3412.6.8
AUTOMATIC FIRE DETECTION VALUES

| OCCUPANCY | CATEGORIES | | | | |
|------------------------|------------|----|---|---|---|
| | a | b | c | d | e |
| A-1, A-3, F, M, R, S-1 | -10 | -5 | 0 | 2 | 6 |
| A-2 | -25 | -5 | 0 | 5 | 9 |
| A-4, B, E, S-2 | -4 | -2 | 0 | 4 | 8 |

3412.6.8.1 Categories. The categories for automatic fire detection are:

- Category a—None.
- Category b—Existing smoke detectors in HVAC systems and maintained in accordance with the *California Fire Code*.
- Category c—Smoke detectors in HVAC systems. The detectors are installed in accordance with the requirements for new buildings in the *California Mechanical Code*.
- Category d—Smoke detectors throughout all floor areas other than individual sleeping units, tenant spaces and dwelling units.
- Category e—Smoke detectors installed throughout the floor area.

3412.6.9 Fire alarm systems. Evaluate the capability of the fire alarm system in accordance with Section 907. Under the categories and occupancies in Table 3412.6.9, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.9, Fire Alarm Systems, for fire safety, means of egress and general safety.

TABLE 3412.6.9
FIRE ALARM SYSTEM VALUES

| OCCUPANCY | CATEGORIES | | | |
|-----------------------------|------------|----------------|----|----|
| | a | b ^a | c | d |
| A-1, A-2, A-3, A-4, B, E, R | -10 | -5 | 0 | 5 |
| F, M, S | 0 | 5 | 10 | 15 |

a. For buildings equipped throughout with an automatic sprinkler system, add 2 points for activation by a sprinkler waterflow device.

3412.6.9.1 Categories. The categories for fire alarm systems are:

- Category a—None.
- Category b—Fire alarm system with manual fire alarm boxes in accordance with Section 907.4 and alarm notification appliances in accordance with Section 907.5.2.
- Category c—Fire alarm system in accordance with Section 907.
- Category d—Category c plus a required emergency voice/alarm communications system and a

fire command center that conforms to Section 403.4.5 and contains the emergency voice/alarm communications system controls, fire department communication system controls and any other controls specified in Section 911 where those systems are provided.

3412.6.10 Smoke control. Evaluate the ability of a natural or mechanical venting, exhaust or pressurization system to control the movement of smoke from a fire. Under the categories and occupancies in Table 3412.6.10, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.10, Smoke Control, for means of egress and general safety.

TABLE 3412.6.10
SMOKE CONTROL VALUES

| OCCUPANCY | CATEGORIES | | | | | |
|---------------|------------|----------------|----------------|----------------|----------------|----------------|
| | a | b | c | d | e | f |
| A-1, A-2, A-3 | 0 | 1 | 2 | 3 | 6 | 6 |
| A-4, E | 0 | 0 | 0 | 1 | 3 | 5 |
| B, M, R | 0 | 2 ^a | 3 ^a | 3 ^a | 3 ^a | 4 ^a |
| F, S | 0 | 2 ^a | 2 ^a | 3 ^a | 3 ^a | 3 ^a |

a. This value shall be 0 if compliance with Category d or e in Section 3412.6.8.1 has not been obtained.

3412.6.10.1 Categories. The categories for smoke control are:

- Category a—None.
- Category b—The building is equipped throughout with an automatic sprinkler system. Openings are provided in exterior walls at the rate of 20 square feet (1.86 m^2) per 50 linear feet (15 240 mm) of exterior wall in each story and distributed around the building perimeter at intervals not exceeding 50 feet (15 240 mm). Such openings shall be readily openable from the inside without a key or separate tool and shall be provided with ready access thereto. In lieu of operable openings, clearly and permanently marked tempered glass panels shall be used.
- Category c—One enclosed exit stairway, with ready access thereto, from each occupied floor of the building. The stairway has operable exterior windows and the building has openings in accordance with Category b.
- Category d—One smokeproof enclosure and the building has openings in accordance with Category b.
- Category e—The building is equipped throughout with an automatic sprinkler system. Each floor area is provided with a mechanical air-handling system designed to accomplish smoke containment. Return and exhaust air shall be moved directly to the outside without recirculation to other floor areas of the building under fire conditions. The system shall exhaust not less than six air changes per hour from the floor area. Supply air by mechanical means to the floor area is not required.

Containment of smoke shall be considered as confining smoke to the fire area involved without migration to other floor areas. Any other tested and approved design which will adequately accomplish smoke containment is permitted.

- Category f—Each stairway shall be one of the following: a smokeproof enclosure in accordance with Section 1022.9; pressurized in accordance with Section 909.20.5 or shall have operable exterior windows.

3412.6.11 Means of egress capacity and number. Evaluate the means of egress capacity and the number of exits available to the building occupants. In applying this section, the means of egress are required to conform to the following sections of this code: 1003.7, 1004, 1005, 1014.2, 1014.3, 1015.2, 1021, 1024.1, 1027.2, 1027.5, 1028.2, 1028.3, 1028.4 and 1029. The number of exits credited is the number that is available to each occupant of the area being evaluated. Existing fire escapes shall be accepted as a component in the means of egress when conforming to Section 3406.

Under the categories and occupancies in Table 3412.6.11, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.11, Means of Egress Capacity, for means of egress and general safety.

TABLE 3412.6.11
MEANS OF EGRESS VALUES

| OCCUPANCY | CATEGORIES | | | | |
|-----------------------|----------------|---|---|---|----|
| | a ^a | b | c | d | e |
| A-1, A-2, A-3, A-4, E | -10 | 0 | 2 | 8 | 10 |
| B, F, S | -1 | 0 | 0 | 0 | 0 |
| M | -3 | 0 | 1 | 2 | 4 |
| R | -3 | 0 | 0 | 0 | 0 |

a. The values indicated are for buildings six stories or less in height. For buildings over six stories above grade plane, add an additional 10 points.

3412.6.11.1 Categories. The categories for Means of Egress Capacity and number of exits are:

- Category a—Compliance with the minimum required means of egress capacity or number of exits is achieved through the use of a fire escape in accordance with Section 3406.
- Category b—Capacity of the means of egress complies with Section 1004 and the number of exits complies with the minimum number required by Section 1021.
- Category c—Capacity of the means of egress is equal to or exceeds 125 percent of the required means of egress capacity, the means of egress complies with the minimum required width dimensions specified in the code and the number of exits complies with the minimum number required by Section 1021.
- Category d—The number of exits provided exceeds the number of exits required by Section

1021. Exits shall be located a distance apart from each other equal to not less than that specified in Section 1015.2.

5. Category e—The area being evaluated meets both Categories c and d.

3412.6.12 Dead ends. In spaces required to be served by more than one means of egress, evaluate the length of the exit access travel path in which the building occupants are confined to a single path of travel. Under the categories and occupancies in Table 3412.6.12, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.12, Dead Ends, for means of egress and general safety.

TABLE 3412.6.12
DEAD-END VALUES

| OCCUPANCY | CATEGORIES ^a | | |
|---------------------------------|-------------------------|---|---|
| | a | b | c |
| A-1, A-3, A-4, B, E, F, M, R, S | -2 | 0 | 2 |
| A-2, E | -2 | 0 | 2 |

a. For dead end distances between categories, the dead end value shall be obtained by linear interpolation.

3412.6.12.1 Categories. The categories for dead ends are:

- Category a—Dead end of 35 feet (10 670 mm) in nonsprinklered buildings or 70 feet (21 340 mm) in sprinklered buildings.
- Category b—Dead end of 20 feet (6096 mm); or 50 feet (15 240 mm) in Group B in accordance with Section 1018.4, exception 2.
- Category c — No dead ends; or ratio of length to width (l/w) is less than 2.5:1.

3412.6.13 Maximum exit access travel distance. Evaluate the length of exit access travel to an approved exit. Determine the appropriate points in accordance with the following equation and enter that value into Table 3412.7 under Safety Parameter 3412.6.13, Maximum Exit Access Travel Distance, for means of egress and general safety. The maximum allowable exit access travel distance shall be determined in accordance with Section 1016.1.

$$\text{Points} = 20 \times \frac{\text{Maximum allowable travel distance}}{\text{Max. allowable travel distance}} - \frac{\text{Maximum actual travel distance}}{\text{Max. allowable travel distance}}$$

(Equation 34-6)

3412.6.14 Elevator control. Evaluate the passenger elevator equipment and controls that are available to the fire department to reach all occupied floors. Emergency recall and in-car operation of elevator recall controls shall be provided in accordance with the *California Fire Code*. Under the categories and occupancies in Table 3412.6.14, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.14, Elevator Control, for fire safety, means of egress and general safety. The values shall be zero for a single-story building.

TABLE 3412.6.14
ELEVATOR CONTROL VALUES

| ELEVATOR TRAVEL | CATEGORIES | | | |
|---|------------|----|---|----|
| | a | b | c | d |
| Less than 25 feet of travel above or below the primary level of elevator access for emergency fire-fighting or rescue personnel | -2 | 0 | 0 | +2 |
| Travel of 25 feet or more above or below the primary level of elevator access for emergency fire-fighting or rescue personnel | -4 | NP | 0 | +4 |

For SI: 1 foot = 304.8 mm.

NP = Not permitted.

3412.6.14.1 Categories. The categories for elevator controls are:

- Category a—No elevator.
- Category b—Any elevator without Phase I emergency recall operation and Phase II emergency in-car operation.
- Category c—All elevators with Phase I emergency recall operation and Phase II emergency in-car operation as required by the *California Fire Code*.
- Category d—All meet Category c; or Category b where permitted to be without Phase I emergency recall operation and Phase II emergency in-car operation; and at least one elevator that complies with new construction requirements serves all occupied floors.

3412.6.15 Means of egress emergency lighting. Evaluate the presence of and reliability of means of egress emergency lighting. Under the categories and occupancies in Table 3412.6.15, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.15, Means of Egress Emergency Lighting, for means of egress and general safety.

TABLE 3412.6.15
MEANS OF EGRESS EMERGENCY LIGHTING VALUES

| NUMBER OF EXITS REQUIRED BY SECTION 1015 | CATEGORIES | | |
|--|------------|---|---|
| | a | b | c |
| Two or more exits | NP | 0 | 4 |
| Minimum of one exit | 0 | 1 | 1 |

3412.6.15.1 Categories. The categories for means of egress emergency lighting are:

- Category a—Means of egress lighting and exit signs not provided with emergency power in accordance with Chapter 27.
- Category b—Means of egress lighting and exit signs provided with emergency power in accordance with Chapter 27.
- Category c—Emergency power provided to means of egress lighting and exit signs which pro-

vides protection in the event of power failure to the site or building.

3412.6.16 Mixed occupancies. Where a building has two or more occupancies that are not in the same occupancy classification, the separation between the mixed occupancies shall be evaluated in accordance with this section. Where there is no separation between the mixed occupancies or the separation between mixed occupancies does not qualify for any of the categories indicated in Section 3412.6.16.1, the building shall be evaluated as indicated in Section 3412.6 and the value for mixed occupancies shall be zero. Under the categories and occupancies in Table 3412.6.16, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.16, Mixed Occupancies, for fire safety and general safety. For buildings without mixed occupancies, the value shall be zero.

TABLE 3412.6.16
MIXED OCCUPANCY VALUES^a

| OCCUPANCY | CATEGORIES | | |
|-------------------------|------------|---|----|
| | a | b | c |
| A-1, A-2, R | -10 | 0 | 10 |
| A-3, A-4, B, E, F, M, S | -5 | 0 | 5 |

a. For fire resistance ratings between categories, the value shall be obtained by linear interpolation.

3412.6.16.1 Categories. The categories for mixed occupancies are:

- Category a—Occupancies separated by minimum 1-hour fire barriers or minimum 1-hour horizontal assemblies, or both.
- Category b—Separations between occupancies in accordance with Section 508.4.
- Category c—Separations between occupancies having a fire-resistance rating of not less than twice that required by Section 508.4.4.

3412.6.17 Automatic sprinklers. Evaluate the ability to suppress a fire based on the installation of an automatic sprinkler system in accordance with Section 903.3.1.1. “Required sprinklers” shall be based on the requirements of this code. Under the categories and occupancies in Table 3412.6.17, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.17, Automatic Sprinklers, for fire safety, means of egress divided by 2 and general safety.

TABLE 3412.6.17
SPRINKLER SYSTEM VALUES

| OCCUPANCY | CATEGORIES | | | | | |
|------------------------|------------|----|---|---|---|----|
| | a | b | c | d | e | f |
| A-1, A-3, F, M, R, S-1 | -6 | -3 | 0 | 2 | 4 | 6 |
| A-2 | -4 | -2 | 0 | 1 | 2 | 4 |
| A-4, B, E, S-2 | -12 | -6 | 0 | 3 | 6 | 12 |

3412.6.17.1 Categories. The categories for automatic sprinkler system protection are:

- Category a—Sprinklers are required throughout; sprinkler protection is not provided or the sprinkler system design is not adequate for the hazard protected in accordance with Section 903.
- Category b—Sprinklers are required in a portion of the building; sprinkler protection is not provided or the sprinkler system design is not adequate for the hazard protected in accordance with Section 903.
- Category c—Sprinklers are not required; none are provided.
- Category d—Sprinklers are required in a portion of the building; sprinklers are provided in such portion; the system is one which complied with the code at the time of installation and is maintained and supervised in accordance with Section 903.
- Category e—Sprinklers are required throughout; sprinklers are provided throughout in accordance with Chapter 9.
- Category f—Sprinklers are not required throughout; sprinklers are provided throughout in accordance with Chapter 9.

3412.6.18 Standpipes. Evaluate the ability to initiate attack on a fire by making a supply of water available readily through the installation of standpipes in accordance with Section 905. Required standpipes shall be based on the requirements of this code. Under the categories and occupancies in Table 3412.6.18, determine the appropriate value and enter that value into Table 3412.7 under Safety Parameter 3412.6.18, Standpipes, for fire safety, means of egress and general safety.

3412.6.18.1 Standpipe. The categories for standpipe systems are:

- Category a—Standpipes are required; standpipe is not provided or the standpipe system design is not in compliance with Section 905.3.
- Category b—Standpipes are not required; none are provided.
- Category c—Standpipes are required; standpipes are provided in accordance with Section 905.
- Category d—Standpipes are not required; standpipes are provided in accordance with Section 905.

3412.6.18
STANDPIPE SYSTEM VALUES

| OCCUPANCY | CATEGORIES | | | |
|------------------------|----------------|---|---|----|
| | a ^a | b | c | d |
| A-1, A-3, F, M, R, S-1 | -6 | 0 | 4 | 6 |
| A-2 | -4 | 0 | 2 | 4 |
| A-4, B, E, S-2 | -12 | 0 | 6 | 12 |

a. This option cannot be taken if Category a or b in Section 3412.6.17 is used.

3412.6.19 Incidental accessory occupancy. Evaluate the protection of incidental accessory occupancies in accordance with Section 508.2.5. Do not include those where this code requires suppression throughout the buildings, including covered mall buildings, high-rise buildings, public garages and unlimited area buildings. Assign the lowest score from Table 3412.6.19 for the building or floor area being evaluated and enter that value into Table 3412.7 under Safety Parameter 3412.6.19, Incidental Accessory Occupancy, for fire safety, means of egress and general safety. If there are no specific occupancy areas in the building or floor area being evaluated, the value shall be zero.

3412.7 Building score. After determining the appropriate data from Section 3412.6, enter those data in Table 3412.7 and total the building score.

3412.8 Safety scores. The values in Table 3412.8 are the required mandatory safety scores for the evaluation process listed in Section 3412.6.

3412.9 Evaluation of building safety. The mandatory safety score in Table 3412.8 shall be subtracted from the building score in Table 3412.7 for each category. Where the final score for any category equals zero or more, the building is in compliance with the requirements of this section for that category. Where the final score for any category is less than zero, the building is not in compliance with the requirements of this section.

3412.9.1 Mixed occupancies. For mixed occupancies, the following provisions shall apply:

- Where the separation between mixed occupancies does not qualify for any category indicated in Section 3412.6.16, the mandatory safety scores for the occupancy with the lowest general safety score in Table 3412.8 shall be utilized (see Section 3412.6.)
- Where the separation between mixed occupancies qualifies for any category indicated in Section 3412.6.16, the mandatory safety scores for each occupancy shall be placed against the evaluation scores for the appropriate occupancy.

**TABLE 3412.8
MANDATORY SAFETY SCORES^a**

| OCCUPANCY | FIRE SAFETY (MFS) | MEANS OF EGRESS (MME) | GENERAL SAFETY (MGS) |
|-----------|-------------------|-----------------------|----------------------|
| A-1 | 16 | 27 | 27 |
| A-2 | 19 | 30 | 30 |
| A-3 | 18 | 29 | 29 |
| A-4, E | 23 | 34 | 34 |
| B | 24 | 34 | 34 |
| F | 20 | 30 | 30 |
| M | 19 | 36 | 36 |
| R | 17 | 34 | 34 |
| S-1 | 15 | 25 | 25 |
| S-2 | 23 | 33 | 33 |

- a. MFS = Mandatory Fire Safety;
MME = Mandatory Means of Egress;
MGS = Mandatory General Safety.

**TABLE 3412.6.19
INCIDENTAL ACCESSORY OCCUPANCY AREA VALUES^a**

| PROTECTION REQUIRED BY TABLE 508.2.5 | PROTECTION PROVIDED | | | | | | |
|--------------------------------------|---------------------|--------|------|--------------|-----------------|---------|------------------|
| | None | 1 Hour | AFSS | AFSS with SP | 1 Hour and AFSS | 2 Hours | 2 Hours and AFSS |
| 2 Hours and AFSS | -4 | -3 | -2 | -2 | -1 | -2 | 0 |
| 2 Hours, or 1 Hour and AFSS | -3 | -2 | -1 | -1 | 0 | 0 | 0 |
| 1 Hour and AFSS | -3 | -2 | -1 | -1 | 0 | -1 | 0 |
| 1 Hour | -1 | 0 | -1 | 0 | 0 | 0 | 0 |
| 1 Hour, or AFSS with SP | -1 | 0 | -1 | 0 | 0 | 0 | 0 |
| AFSS with SP | -1 | -1 | -1 | 0 | 0 | -1 | 0 |
| 1 Hour or AFSS | -1 | 0 | 0 | 0 | 0 | 0 | 0 |

- a. AFSS = Automatic fire suppression system; SP = Smoke partitions (See Section 508.2.5).

Note: For Table 3412.7, see next page.

**TABLE 3412.7
SUMMARY SHEET — BUILDING CODE**

| Existing occupancy: | Proposed occupancy: | | |
|--|--|----------------------|---------------------|
| Year building was constructed: | Number of stories: _____ Height in feet: _____ | | |
| Type of construction: | Area per floor: _____ | | |
| Percentage of open perimeter increase: _____ % | | | |
| Completely suppressed: Yes _____ No _____ | Corridor wall rating: _____ | | |
| Compartmentation: Yes _____ No _____ | Required door closers: Yes _____ No _____ | | |
| Fire-resistance rating of vertical opening enclosures: _____ | | | |
| Type of HVAC system: _____, serving number of floors: _____ | | | |
| Automatic fire detection: Yes _____ No _____ | Type and location: _____ | | |
| Fire alarm system: Yes _____ No _____ | Type: _____ | | |
| Smoke control: Yes _____ No _____ | Type: _____ | | |
| Adequate exit routes: Yes _____ No _____ | Dead ends: _____ Yes _____ No _____ | | |
| Maximum exit access travel distance: _____ | Elevator controls: Yes _____ No _____ | | |
| Means of egress emergency lighting: Yes _____ No _____ | Mixed occupancies: Yes _____ No _____ | | |
| SAFETY PARAMETERS | FIRE SAFETY (FS) | MEANS OF EGRESS (ME) | GENERAL SAFETY (GS) |
| 3412.6.1 Building Height | | | |
| 3412.6.2 Building Area | | | |
| 3412.6.3 Compartmentation | | | |
| 3412.6.4 Tenant and Dwelling Unit Separations | | | |
| 3412.6.5 Corridor Walls | | | |
| 3412.6.6 Vertical Openings | | | |
| 3412.6.7 HVAC Systems | | | |
| 3412.6.8 Automatic Fire Detection | | | |
| 3412.6.9 Fire Alarm Systems | | | |
| 3412.6.10 Smoke Control | **** | | |
| 3412.6.11 Means of Egress Capacity | **** | | |
| 3412.6.12 Dead Ends | **** | | |
| 3412.6.13 Maximum Exit Access Travel Distance | **** | | |
| 3412.6.14 Elevator Control | | | |
| 3412.6.15 Means of Egress Emergency Lighting | **** | | |
| 3412.6.16 Mixed Occupancies | | **** | |
| 3412.6.17 Automatic Sprinklers | | ÷ 2 = | |
| 3412.6.18 Standpipes | | | |
| 3412.6.19 Incidental Accessory Occupancy | | | |
| Building score — total value | | | |

****No applicable value to be inserted.

**TABLE 3412.8
MANDATORY SAFETY SCORES^a**

| OCCUPANCY | FIRE SAFETY (MFS) | MEANS OF EGRESS (MME) | GENERAL SAFETY (MGS) |
|-----------|-------------------|-----------------------|----------------------|
| A-1 | 20 | 31 | 31 |
| A-2 | 21 | 32 | 32 |
| A-3 | 22 | 33 | 33 |
| A-4, E | 29 | 40 | 40 |
| B | 30 | 40 | 40 |
| F | 24 | 34 | 34 |
| M | 23 | 40 | 40 |
| R | 21 | 38 | 38 |
| S-1 | 19 | 29 | 29 |
| S-2 | 29 | 39 | 39 |

a. MFS = Mandatory Fire Safety

MME = Mandatory Means of Egress

MGS = Mandatory General Safety

**TABLE 3412.9
EVALUATION FORMULAS^a**

| FORMULA | T.3410.7 | T.3410.8 | SCORE | PASS | FAIL |
|------------|----------|----------------------------|-------|-------|-------|
| FS-MFS ≥ 0 | _____ | (FS) – _____ (MFS) = _____ | _____ | _____ | _____ |
| ME-MME ≥ 0 | _____ | (ME) – _____ (MME) = _____ | _____ | _____ | _____ |
| GS-MGS ≥ 0 | _____ | (GS) – _____ (MGS) = _____ | _____ | _____ | _____ |

a. FS = Fire Safety

ME = Means of Egress

GS = General Safety

MFS = Mandatory Fire Safety

MME = Mandatory Means of Egress

MGS = Mandatory General Safety

SECTION 3413 EXISTING GROUP R-1 AND GROUP R-2 OCCUPANCIES [SFM]

3413.1 Scope. The provisions of this section are intended to maintain or increase the current degree of public safety, health and general welfare in existing buildings classified as Group R Occupancies.

3413.1.1 Application. In accordance with Health and Safety Code Section 13143.2, the provisions of Sections 3413.2 through 3413.12 shall only apply to multiple-story structures existing on January 1, 1975, let for human habitation, including, and limited to, apartment houses, hotels, and motels wherein rooms used for sleeping are let above the ground floor.

3413.2 Number of exits. Every apartment and every other sleeping room shall have access to not less than two exits when the occupant load is 10 or more (exits need not be directly from the apartment or sleeping room). A fire escape as specified herein may be used as one required exit.

Subject to approval of the authority having jurisdiction, a ladder device as specified herein may be used in lieu of a fire escape when the construction feature or the location of the

building on the property cause the installation of a fire escape to be impractical.

3413.3 Stair construction. All stairs shall have a minimum run of 9 inches (229 mm) and a maximum rise of 8 inches (203 mm) and a minimum width exclusive of handrails of 30 inches (762 mm). Every stairway shall have at least one handrail. A landing having a minimum horizontal dimension of 30 inches (762 mm) shall be provided at each point of access to the stairway.

3413.4 Interior stairways. Every interior stairway shall be enclosed with walls of not less than one-hour fire-resistive construction. Where existing partitions form part of a stairwell enclosure, wood lath and plaster in good condition will be acceptable in lieu of one-hour fire-resistive construction. Doors to such enclosures shall be protected by a self-closing door equivalent to a solid wood door with a thickness of not less than 1³/₄ inches (44.5 mm).

Enclosures shall include all landings between flights and any corridors, passageways or public rooms necessary for continuous exit to the exterior of the buildings. The stairway need not be enclosed in a continuous shaft if cut off at each story by the fire-resistive construction required by this subsection for stairwell enclosures. Enclosures shall not be required if an automatic sprinkler system is provided for all portions of the

building except bedrooms, apartments and rooms accessory thereto. Interior stairs and vertical openings need not be enclosed in two-story buildings.

3413.5 Exterior stairways. *Exterior stairways shall be noncombustible or of wood of not less than 2-inch (51 mm) nominal thickness with solid treads and risers.*

3413.6 Fire escapes, exit ladder devices. *Fire escapes may be used as one means of egress if the pitch does not exceed 60 degrees, the width is not less than 18 inches (457 mm), the treads are not less than 4 inches (102 mm) wide, and they extend to the ground or are provided with counterbalanced stairs reaching to the ground. Access shall be by an opening having a minimum dimension of 29 inches (737 mm) when open. The sill shall not be more than 30 inches (762 mm) above the floor and landing.*

A ladder device, when used in lieu of a fire escape, shall conform to Section 3413.6.1 and the following:

Serves an occupant load of nine people or less or a single dwelling unit or hotel room.

The building does not exceed three stories in height.

The access is adjacent to an opening as specified for emergency egress or rescue or from a balcony.

The device does not pass in front of any building opening below the unit being served.

The availability of activating the ladder device is accessible only to the opening or balcony served.

The device as installed will not cause a person using it to be within 12 feet (3658 mm) of exposed energized high-voltage conductors.

3413.6.1 Exit ladder devices.

3413.6.1.1 Scope. *This standard for exit ladder devices is applicable where such devices are permitted by the building official for installation on existing apartment houses and hotels in conformance with the California Building Code.*

3413.6.1.2 Instructions. *Installation shall be in accordance with the manufacturer's instructions. Instructions shall be illustrated and shall include directions and information adequate for attaining proper and safe installation of the product. Where exit ladder devices are intended for mounting on different support surfaces, specific installation instructions shall be provided for each surface.*

3413.6.1.3 General design. *All load-bearing surfaces and supporting hardware shall be of noncombustible materials. Exit ladder devices shall have a minimum width of 12 inches (305 mm) when in the position intended for use. The design load shall not be less than 400 pounds (1780N) for 16-foot (4877 mm) length and 600 pounds (2699N) for 25-foot (7620 mm) length.*

3413.6.1.4 Performance.

3413.6.1.4.1 *Exit ladder devices shall be capable of withstanding an applied load of four times the design load when installed in the manner intended for use. Test loads shall be applied for a period of one hour.*

3413.6.1.4.2 *Exit ladder devices of the retractable type shall, in addition to the static load requirements of Section 413.6.1.4.1, be capable of withstanding the following tests:*

- 1. Rung strength**
- 2. Rung-to-side-rail shear strength**
- 3. Release mechanism**
- 4. Low temperature**

3413.6.1.5 Rung-strength test. *Rungs of retractable exit ladder devices shall be capable of withstanding a load of 1,000 pounds (4448N) when applied to a 3½-inch-wide (89 mm) block resting at the center of the rung. The test load shall be applied for a period of one hour. The ladder shall remain operational following this test.*

3413.6.1.6 Rung-to-side-rail shear test. *Rungs of retractable exit ladder devices shall be capable of withstanding 1,000 (4448N) when applied to a 3½-inch-wide (89 mm) block resting on the center rung as near the side rail as possible. The test load shall be applied for a period of one hour. Upon removal of the test load the fasteners attaching the rung to the side rail shall show no evidence of failure. The ladder shall remain operational following the test.*

3413.6.1.7 Release mechanism test. *The release mechanism of retractable exit ladder devices shall operate with an average applied force of not more than 5 pounds (22.2N) for hand-operated releasing mechanisms and an average applied force of not more than 25 pounds (111N) for foot-pedal types of releasing mechanisms. For these tests, a force gauge shall be applied to the release mechanism, and the average of three consecutive readings shall be computed.*

3413.6.1.8 Low temperature operation test. *Representative samples of the exit ladder devices shall be subjected to a temperature of -40°C in an environmental chamber for a period of 24 hours. The release mechanism shall be operated immediately upon removal from the chamber. The ladder device shall function as intended without any restriction of operation.*

3413.7 Doors and openings. *Exit doors and openings shall meet the requirements of Sections 1008.1.2, 1008.8.1.8, 1008.1.9 and 708.6. Doors shall not reduce the required width of stairway more than 6 inches (152 mm) when open. Transoms and openings other than doors from corridors to rooms shall be fixed closed and shall be covered with a minimum of ¾-inch (19 mm) plywood or ½-inch (13 mm) gypsum wallboard or equivalent material.*

Exceptions:

- 1. Existing solid-bonded wood-core doors 1¾ inches thick (34.9 mm), or their equivalent may be continued in use.**
- 2. Where the existing frame will not accommodate a door complying with Section 708.6, a 1¾-inch-thick (35 mm) solid-bonded wood-core door may be used.**

3413.8 Exit signs. Every exit doorway or change of direction of a corridor shall be marked with a well-lighted exit sign having letters at least 5 inches (127 mm) high.

3413.9 Enclosure of vertical openings. Elevators, shafts, ducts and other vertical openings shall be enclosed as required for stairways in Section 3413.5 or by wired glass set in metal frames. Doors shall be noncombustible or as regulated in Section 3413.5.

3413.10 Separation of occupancies. Occupancy separations shall be provided as specified in Section 508. Lobbies and public dining rooms, not including cocktail lounges, shall not require a separation if the kitchen is so separated from the dining room. Every room containing a boiler or central heating plant shall be separated from the rest of the building by not less than a one-hour fire-resistive occupancy separation.

Exception: A separation shall not be required for such rooms with equipment serving only one dwelling unit.

3413.11 Equivalent protection. In lieu of the separation of occupancies required by Section 3413.10, equivalent protection may be permitted when approved by the enforcement agency.

Exception: The provisions of Sections 3413.3 through 3413.11 above shall not apply to any existing apartment house, hotel or motel having floors (as measured from the top of the floor surface) used for human occupancy located more than 75 feet (22 860 mm) above the lowest floor level having building access which is subject to the provisions of Section 33414, California Building Code, relating to existing high-rise buildings.

Note: In accordance with Health and Safety Code Section 17920.7, the provisions of Sections 3413.3 through 3413.11 above shall apply only to multiple-story structures existing on January 1, 1975, let for human habitation including, and limited to, apartments, houses, hotels and motels wherein rooms used for sleeping are let above the ground floor.

3413.12 Fire alarms.

3413.12.1 General. Every apartment house three or more stories in height or containing more than 15 apartments, every hotel three or more stories in height or containing 20 or more guest rooms, shall have installed therein an automatic or manually operated fire alarm system. Such fire alarm systems shall be so designed that all occupants of the building may be warned simultaneously and shall be in accordance with the California Fire Code. See Section 3414.14 for special requirements in buildings over 75 feet (22 860 mm) in height.

Exception: A fire alarm system need not be installed provided such apartment house or hotel is separated by an unpierced wall of not less than four-hour fire resistance in buildings of Type IA, Type IIB, Type III or Type IV construction and two-hour fire resistance in buildings of all other types of construction provided:

1. Areas do not exceed the number of apartments or guest rooms stipulated.

2. The fire-resistive wall conforms to the requirements of Section 706.6.

3. The wall complies with all other applicable provisions of the California Building Code.

4. The wall extends to all outer edges of horizontal projecting elements, such as balconies, roof overhangs, canopies, marquees or architectural projections.

5. No openings are permitted for air ducts or similar penetrations, except that openings for pipes, conduits and electrical outlets of copper, sheet steel or ferrous material shall be permitted through such wall and need not be protected, provided they do not unduly impair the required fire resistance of the assembly.

6. Tolerances around such penetrations shall be filled with approved noncombustible materials..

3413.12.2 Installation. The installation of all fire alarm equipment shall be in accordance with the California Fire Code.

3413.13 Existing Group R Occupancy high-rise buildings.

3413.13.1 General. Regardless of other provisions of these regulations relating to existing high-rise buildings, requirements relative to existing Group R-1 or Group R-2 Occupancies shall not be less restrictive than those established pursuant to Health and Safety Code Section 13143.2.

3413.13.2 Corridor openings. Openings in corridor walls and ceilings shall be protected by not less than 1 $\frac{3}{4}$ -inch (44.5 mm) solid-bonded wood-core doors, $\frac{1}{4}$ -inch-thick (6 mm) wired glass conforming to Section 715.1, by approved fire dampers or by equivalent protection in lieu of any of these items. Transoms shall be fixed closed with material having a fire-resistive rating equal to $\frac{1}{2}$ -inch (12.7 mm) Type X gypsum wallboard or equivalent material installed on both sides of the opening.

3413.13.3 Fire alarm systems. Notwithstanding the provisions of Section 403, every existing high-rise building used for the housing of a Group R-1 or Group R-2 Occupancies shall have installed therein a fire alarm system conforming to this subsection.

3413.13.3.1 General. Every apartment house and every hotel shall have installed therein an automatic or manually operated fire alarm system. Such fire alarm systems shall be so designed that all occupants of the building may be warned simultaneously.

3413.13.3.2 Installation. The installation of all fire alarm equipment shall be in accordance with the California Fire Code.

3413.13.3.3 Fire-extinguishing systems. Automatic fire-extinguishing systems installed in any structure subject to these regulations shall have an approved flow indicator electrically interconnected to the required fire alarm system.

SECTION 3414 EXISTING HIGH-RISE BUILDINGS [SFM]

3414.1 Scope and definition. The provisions of Sections 3414.1 through 3414.27 shall apply to every existing high-rise building of any type of construction or occupancy having floors (as measured from the top of the floor surface) used for human occupancy located more than 75 feet (22 860 mm) above the lowest floor level having building access.

Exceptions:

1. Hospitals, as defined in Section 1250 of the Health and Safety Code.
2. The following structures, while classified as high-rise buildings, shall not be subject to the provisions of Sections 3414.1 through 3414.27, but shall conform to all applicable provisions of these regulations.
 - 2.1 Building used exclusively as open parking garages.
 - 2.2 Buildings where all floors above the 75 foot (22 860 mm) level are used exclusively as open parking garages.
 - 2.3 Floors of buildings used exclusively as open parking garages and located above all other floors used for human occupancy.
 - 2.4 Buildings such as power plants, look-out towers, steeples, grain houses, and similar structures, when so determined by the enforcing agency.
 - 2.5 Buildings used exclusively for jails and prisons.

For the purposes of this section, "building access" shall mean an exterior door opening conforming to all of the following:

1. Suitable and available for fire department use.
2. Located not more than 2 feet (610 mm) above the adjacent ground level.
3. Leading to a space, room or area having foot traffic communication capabilities with the remainder of the building.
4. Designed to permit penetration through the use of fire department forcible-entry tools and equipment unless other approved arrangements have been made with the fire authority having jurisdiction.

"Existing high-rise structure" means a high-rise structure, the construction of which is commenced or completed prior to July 1, 1974.

For the purpose of this section, construction shall be deemed to have commenced when plans and specifications are more than 50 percent complete and have been presented to the local jurisdiction prior to July 1, 1974. Actual construction of such buildings shall commence on or before January 1, 1976, unless all provisions for new buildings have been met.

Note: It is the intent of this section that, in determining the level from which the highest occupied floor is to be

measured, the enforcing agency should exercise reasonable judgment, including consideration of overall accessibility to the building by fire department personnel and vehicular equipment. When a building is situated on sloping terrain and there is building access on more than one level, the enforcing agency may select the level which provides the most logical and adequate fire department access.

3414.2 Compliance data. Except as may be otherwise specified, existing high-rise building shall conform to the applicable requirements of these regulations by April 26, 1979.

Exception: The period of compliance may be extended upon showing of good cause for such extension if a systematic and progressive plan of correction is submitted to, and approved by, the enforcing agency. Such extension shall not exceed two years from the date of approval of such plan. Any plan of correction submitted pursuant to this exception shall be submitted and approved on or before April 26, 1979.

3414.3 Continued use. Existing high-rise building may have their use continued if they conform, or are made to conform, to the intent of the provisions of Sections 3414.5 through 3414.27 to provide for the safety of the occupants of the high-rise buildings and person involved in fire-suppression activities.

3414.4 Alternate protection. Alternate means of egress, fire walls or fire barriers, smoke barriers, automatic fire detection or fire-extinguishing systems, or other fire-protection devices, equipment or installations may be approved by the enforcing agency to provide reasonable and adequate life safety as intended by Sections 3414.5 through 3414.27 for existing high-rise buildings.

3414.5 Basic provisions. The provisions outlined in Sections 3414.1 through 3414.27 are applicable to every existing high-rise building.

3414.6 Minimum construction. Existing wood lath and plaster, existing $\frac{1}{2}$ -inch (12.7 mm) gypsum wallboard, existing installations of $\frac{1}{2}$ -inch thick (12.7 mm) wired glass which are or are rendered inoperative and fixed in a closed position, or other existing materials having similar fire-resistive capabilities shall be acceptable. All such assemblies shall be in good repair, free of any condition which would diminish their original fire-resistive characteristics.

Where $1\frac{3}{4}$ -inch (44.5 mm) solid-bonded wood-core doors are specified in these regulations for existing high-rise buildings, new or existing $1\frac{5}{8}$ -inch (34.9 mm) doors shall be acceptable where existing framing will not accommodate a $1\frac{3}{4}$ -inch (44.5 mm) door.

Note: It is the intent of this provisions that existing wood frames may have their use continued.

3414.7 New construction. All new construction shall be composed of materials and assemblies of materials conforming to the fire-resistive provisions of these regulations. In no case shall enclosure walls be required to be of more than one-hour fire-resistive construction.

Exception: When approved by the enforcing agency, materials specified in Section 3414.6 may be used for new con-

struction when necessary to maintain continuity of design and measurement of existing construction.

3414.8 Exits. Every floor from an existing high-rise building shall have access to two separate means of egress, one of which, when approved by the enforcing agency, may be an existing exterior fire escape.

New installations of smoke-proof enclosures shall not be required.

Note: In determining the adequacy of exits and their design, Chapter 10 may be used as a guide. It is the intent of this section that every existing high-rise building need not mandatorily conform or be made to conform with the requirements for new high-rise buildings. Reasonable judgment in the application of requirements must be exercised by the enforcing agency.

3414.9 Fire escapes. An existing fire escape in good structural condition may be acceptable as one of the required means of egress from each floor. Access to such fire escapes may be by any one of the following:

Through a room between the corridor and the fire escape if the door to the room is operable from the corridor side without the use of any key, special knowledge or effort.

By a door operable to a fire escape from the interior without the use of any key, special knowledge or effort.

By a window operable from the interior. Such window shall have a minimum dimension of 29 inches (737 mm) when open. The sill shall not be more than 30 inches (762 mm) above the floor and landing.

3414.10 Protection of exterior openings. When an existing fire escape is accepted as one of the require means of egress, openings onto the fire escape landing and openings within 5 feet (1524 mm) horizontally of the landings shall be protected in a manner acceptable to the enforcing agency.

3414.11 Locking of stairway doors. When exit doors from corridors to exit stairways are locked to prohibit access from the stairway side, the locking mechanisms shall be retracted to the unlocked position upon failure of electrical power and a telephone or other two-way communication system connected to an approved emergency service that operates continuously shall be provided at not less than every fifth floor in each required stairway. In lieu thereof, master keys which will unlock all such doors from the stairway side shall be provided in such numbers and locations as approved by the enforcing agency.

3414.12 Enclosures. Interior vertical shafts, including but not limited to, elevators, stairway and utility, shall be enclosed with construction as set forth in Section 3414.6.

3414.13 Opening protection. Doors in other than elevators, which shall be of a type acceptable to the enforcing agency, shall be approved one-hour, fire-rated, tight-fitting or gasketed doors or equivalent protection, and shall be of the normally closed type, self-closing or a type which will close automatically in accordance with Section 715.

Exception: In lieu of stairway enclosures, smoke barriers may be provided in such a manner that fire and smoke will not spread to other floors or otherwise impair exit facilities.

In these instances, smoke barriers shall not be less than one-hour fire resistive with openings protected by not less than approved one-third-hour, fire-rated, tight-fitting or gasketed doors. Such doors shall be of the self-closing type or of a type which will close automatically in the manner specified in Section 715.

Doors crossing corridors shall be provided with wired-glass vision panels set in approved steel frames.

Doors for elevators shall not be of the open-grille type.

3414.14 Fire alarm system. Every existing high-rise building shall be provided with an approved fire alarm system. In department stores, retail sales stores and similar occupancies where the general public is admitted, such systems shall be of a type capable of alerting staff and employees. In office buildings and all other high-rise buildings, such systems shall be of a type capable of alerting all occupants simultaneously.

Exceptions:

1. In areas of public assemblage, the type and location of audible appliances shall be as determined by the enforcing agency.
2. When acceptable to the enforcing agency, the occupant voice notification system required by Section 3414.17 may be used in lieu of the fire alarm system required by Section 3414.14.

3414.15 Existing systems. Existing fire systems, when acceptable to the enforcing agency, shall be deemed as conforming to the provisions of these regulations. For requirements for existing Group R-1 Occupancies, see Section 3412.13.

3414.16 Annunciation. When a new fire alarm system is installed, it shall be connected to an annunciation panel installed in a location approved by the enforcing agency.

For purposes of annunciation, zoning shall be in accordance with Section 907.6.3.

3414.17 Monitoring. Shall be in accordance with Section 907.6.5.

3414.18 Systems interconnection. When an automatic fire detection system or automatic extinguishing system is installed, activation of such system shall cause the sounding of the fire alarm notification appliances at locations designated by the enforcing agency.

3414.19 Manual fire alarm boxes. A manual fire alarm box shall be provided in the locations designated by the enforcing agency. Such locations shall be where boxes are readily accessible and visible and in normal paths of daily travel by occupants of the building.

3414.20 Emergency voice/alarm communication system. An approved emergency voice/alarm system shall be provided in every existing high-rise building which exceeds 150 feet (45 720 mm) in height measured in the manner set forth in Section 3412.1. Such system shall provide communication from a location available to and designated by the enforcing agency to not less than all public areas.

The emergency voice/alarm system may be combined with a fire alarm system provide the combined system has been approved and listed by the State Fire Marshal. The sounding of

a fire alarm signal in any given area or floor shall not prohibit voice communication to other areas of floors. Combination systems shall be designed to permit voice transmission to override the fire alarm signal, but the fire alarm signal shall not terminate in less than three minutes.

3414.21 Fire department system. When it is determined by test that portable fire department communication equipment is ineffective, a communication system acceptable to the enforcing agency shall be installed within the building to permit emergency communication between fire-suppression personnel.

3414.22 Interior wall and ceiling finish. Interior wall and ceiling finish of exitways shall conform to the provisions of Chapter 8. Where the materials used in such finishes do not conform to the provisions of Chapter 8, such finishes may be surfaced with an approved fire-retardant coating.

3414.23 Ventilation. Natural or mechanical ventilation for the removal of products of combustion shall be provided in every story of an existing high-rise building. Such ventilation shall be any one or combination of the following:

Panels or windows in the exterior wall which can be opened. Such venting facilities shall be provided at the rate of at least 20 square feet (1.86 m^2) of opening per 50 lineal feet (15 240 lineal mm) of exterior wall in each story, distributed around the perimeter at not more than 50-foot (15 240 mm) intervals on at least two sides of the building.

Approved fixed tempered glass may be used in lieu of openable panels or windows. When only selected panels or windows are of tempered glass, they shall be clearly identified as required by the enforcing agency. Any other design which will produce equivalent results.

3414.24 Smoke control systems. Existing air-circulation systems shall be provided with an override switch in a location approved by the enforcing agency which will allow for the manual control of shutdown of the systems.

Exception: Systems which serve only a single floor, or portion thereof, without any penetration by ducts or other means into adjacent floors.

3414.25 Elevator recall smoke detection. Smoke detectors for emergency operation of elevators shall be provided as required by Section 3003.

3414.26 Exitsigns and illumination. Exits and stairways shall be provided with exit signs and illumination as required by Sections 1011.1 and 1011.2.

3414.27 Automatic sprinkler system—Existing high-rise buildings. Regardless of any other provisions of these regulations, every existing high-rise building of Type II-B, Type III-B or Type V-B construction shall be provided with an approved automatic sprinkler system conforming to NFPA 13.

SECTION 3415 EXISTING GROUP I OCCUPANCIES [SFM]

3415.1 General. Existing buildings housing existing protective social-care homes or facilities established prior to March 4, 1972 may have their use continued if they conform, or are made to conform, to the following provisions:

3415.2 Use of floors. The use of floor levels in buildings of Type III, IV or V nonfire-rated construction may be as follows:

Nonambulatory—first floor only;

Ambulatory—not higher than the third-floor level, provided walls and partitions are constructed of materials equal in fireresistive quality to that of wood lath and plaster in good repair and all walls are firestopped at each floor level.

3415.3 Enclosure of exits and vertical openings. Except for two-story structures housing ambulatory guests, all interior stairs shall be enclosed in accordance with Chapter 10. In lieu of stairway enclosures, floor separations or smoke barriers may be provided in such a manner that fire and smoke will not spread rapidly to floors above or otherwise impair exit facilities. In these instances, floor separations or smoke barriers shall have a fire resistance equal to not less than $\frac{1}{2}$ -inch (13 mm) gypsum wall board on each side of wood studs with openings protected by not less than a $1\frac{3}{4}$ -inch (44.5 mm) solid bonded wood-core door of the self-closing type. All other vertical openings shall be enclosed in accordance with the provisions of Section 3414.6 and 3414.13.

3415.4 Exit access. Each floor or portion thereof of buildings used for the housing of existing protective social-care homes or facilities shall have access to not less than two exits in such a manner as to furnish egress from the building or structure in the event of an emergency substantially equivalent to the provisions of Chapter 10.

3415.5 Corridor openings. Openings from rooms to interior corridors shall be protected by not less than $1\frac{3}{4}$ -inch (44.5 mm) solid-bonded wood-core doors. Transoms and other similar openings shall be sealed with materials equivalent to existing corridor wall construction.

3415.6 Interior finishes. Interior wall and ceiling finishes shall conform to the requirements for a Group R-1 Occupancy as specified in Chapter 8.

3415.7 Automatic fire sprinklers. Automatic sprinkler systems shall be installed in existing protective social-care occupancies in accordance with the provisions of Section 903.2.6.

3415.8 Fire alarm systems. Automatic fire alarm systems shall be installed in existing protective social-care homes or facilities in accordance with the provisions of Section 907.2.6.

Exception: When an approved automatic sprinkler system conforming to Section 903.2.6 is installed, a separate fire alarm system as specified in this section need not be provided.

SECTION 3416 EXISTING GROUP L OCCUPANCIES [SFM]

3416 Existing Group L Occupancies.

3416.1 Repairs general. Additions, alterations or repairs may be made to any building or structure without requiring the existing building or structure to comply with all the requirements of this code section, provided the addition, alteration, or repair conforms to the requirements of this section.

3416.2 Unsafe condition. Additions, repairs or alterations shall not be made to an existing building or structure that will cause the existing building or structure to be in violation of any of the provisions of this code, nor shall such additions or alterations cause the existing building or structure to become unsafe, or to be in violation of any of the provisions of this code. An unsafe condition shall be deemed to have been created if an addition or alteration will cause the existing building or structure to become structurally unsafe or overloaded; will not provide adequate egress in compliance with the provisions of this code or will obstruct existing exits; will create a fire hazard; will reduce required fire resistance or will otherwise create conditions dangerous to human life.

3416.3 Changes in use or occupancy. Any buildings that have alterations or additions, which involves a change in use or occupancy, shall not exceed the height, number of stories and area permitted for new buildings

3416.4 Buildings not in compliance with code. Additions or alterations shall not be made to an existing building or structure when such existing building or structure is not in full compliance with the provisions of this code except when such addition or alteration will result in the existing building or structure being no more hazardous, based on life safety, fire safety and sanitation, than before such additions or alterations are undertaken.

3416.5 Maintenance of structural and fire resistive integrity. Alterations or repairs to an existing building or structure that are nonstructural and do not adversely affect any structural member of any part of the building or structure having required fire resistance may be made with the same materials of which the building or structure is constructed. The installation or replacement of glass shall be as required for new installations.

3416.6 Continuation of existing use. Buildings in existence at the time of the adoption of this code may have their existing use or occupancy continued if such use or occupancy was legal at the time of the adoption of this code, provided such continued use is not dangerous to life.

3416.7 Maximum allowable quantities. Laboratory suites approved prior to January 1, 2008 shall not exceed the maximum allowable quantities listed in Tables 3416.1 and 3416.2.

SECTION 3417

EARTHQUAKE EVALUATION AND DESIGN FOR RETROFIT OF EXISTING BUILDINGS

3417.1 Purpose.

3417.1.1 Existing state-owned structures. The provisions of Sections 3417 through 3423 establish minimum standards for earthquake evaluation and design for retrofit of existing state-owned structures, including buildings owned by the University of California and the California State University.

The provisions of Sections 3417 through 3423 may be adopted by a local jurisdiction for earthquake evaluation and design for retrofit of existing buildings.

3417.1.2 Public school buildings. The provisions of Sections 3417 through 3423 establish minimum standards for

earthquake evaluation and design for the rehabilitation of existing buildings for use as public school buildings under the jurisdiction of the Division of the State Architect-Structural Safety (DSA-SS), refer to Section 1.9.2.1.

The provisions of Section 3417 through 3423 also establish minimum standards for earthquake evaluation and design for rehabilitation of existing public buildings currently under the jurisdiction of DSA-SS.

3417.1.2.1 Reference to other chapters. For public schools, where reference within this chapter is made to sections in Chapters 16, 17, 18, 19, 21 or 22, the provisions in Chapters 16A, 17A, 18A, 19A, 21A and 22A respectively shall apply instead.

3417.1.3 Community college buildings. The provisions of Sections 3417 through 3423 establish minimum standards for earthquake evaluation and design for the rehabilitation of existing buildings for use as community college buildings under the jurisdiction of the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC), refer to Section 1.9.2.2.

The provisions of Section 3417 through 3423 also establish minimum standards for earthquake evaluation and design for rehabilitation of existing community college buildings currently under the jurisdiction of DSA-SS/CC.

3417.1.3.1 Reference to other chapters. For community colleges, where reference within this chapter is made to sections in Chapters 17 or 18, the provisions in Chapters 17A and 18A respectively shall apply instead.

3417.2 Scope. All modifications, structurally connected additions and/or repairs to existing structures or portions thereof shall, at a minimum, be designed and constructed to resist the effects of seismic ground motions as provided in this section. The structural system shall be evaluated by a registered design professional and, if not meeting or exceeding the minimum seismic design performance requirements of this section, shall be retrofitted in compliance with these requirements.

Exception: Those structures for which Section 3417.3 determines that assessment is not required, or for which Section 3417.4 determines that retrofit is not needed, then only the requirements of Section 3417.11 apply.

3417.3 Applicability.

3417.3.1 Existing state-owned buildings. For existing state-owned structures including all buildings owned by the University of California and the California State University, the requirements of Section 3417 apply whenever the structure is to be retrofitted, repaired or modified and any of the following apply:

1. Total construction cost, not including cost of furnishings, fixtures and equipment, or normal maintenance, for the building exceeds 25 percent of the construction cost for the replacement of the existing building.

The changes are cumulative for past modifications to the building that occurred after adoption of the 1995 California Building Code and did not require seismic retrofit.

2. There are changes in risk category.

3. The modification to the structural components increases the seismic forces in or strength requirements of any structural component of the existing structure by more than 10 percent cumulative since the original construction, unless the component has the capacity to resist the increased forces determined in accordance with Section 3419. If the building's seismic base shear capacity has been increased since the original construc-

tion, the percent change in base shear may be calculated relative to the increased value.

4. Structural elements need repair where the damage has reduced the lateral-load-resisting capacity of the structural system by more than 10 percent.
5. Changes in live or dead load increase story shear by more than 10 percent.

TABLE 3416.7(1)
EXEMPT AMOUNTS OF HAZARDOUS MATERIALS, LIQUIDS AND CHEMICALS
PRESENTING A PHYSICAL HAZARD BASIC QUANTITIES PER LABORATORY SUITE¹
When two units are given, values within parentheses are in cubic feet (cu. ft) or pounds (lb)

| CONDITION | | STORAGE | | | USE CLOSED SYSTEMS | | | USE OPEN SYSTEMS | | |
|---|-------|-----------------------|----------------------|--------------------|-----------------------|---------------------|--------------------|-----------------------|---------------------|--------------|
| MATERIAL | CLASS | Solid Pounds (cu. ft) | Liquid Gallons (lb) | Gas (cu. ft) | Solid Pounds (cu. ft) | Liquid Gallons (lb) | Gas (cu. ft) | Solid Pounds (cu. ft) | Liquid Gallons (lb) | Gas (cu. ft) |
| 1.1 Combustible liquid | II | — | 120 ² | — | — | 120 | — | — | 30 | — |
| | III A | — | 330 ² | — | — | 330 | — | — | 80 | — |
| | III B | — | 13,200 ² | — | — | 13,200 | — | — | 3,300 | — |
| 1.2 Combustible dust lbs./1000 cu. ft. | I | — | — | 1 | — | — | — | 1 | — | — |
| 1.3 Combustible fiber (loose) (baled) | | (100) (1,000) | — | — | (100) (1,000) | — | — | (20) (200) | — | — |
| 1.4 Cryogenic, flammable or oxidizing | | | 45 | — | — | 45 | — | — | 10 | — |
| 2.1 Explosives | | 12 | (1) ² | — | 1/4 | (1/4) | — | 1/4 | (1/4) | — |
| 3.1 Flammable solid | | 125 ² | — | — | 25 | — | — | 25 | — | — |
| 3.2. Flammable gas (gaseous) (liquefied) | | — | — | 750 ² | — | — | 750 ² | — | — | — |
| 3.3 Flammable liquid Combination I A, I B, I C | I A | — | 30 ² | — | — | 30 | — | — | 10 | — |
| | I B | — | 60 ² | — | — | 60 | — | — | 15 | — |
| | I-C | — | 90 ² | — | — | 90 | — | — | 20 | — |
| | | — | 120 ² | — | — | 120 | — | — | 30 | — |
| 4.1 Organic peroxide, unclassified detonatable | | I ² | (1) ² | — | 1/4 | (1/4) | — | 1/4 | (1/4) | — |
| 4.2 Organic peroxide | I | 5 ² | (5) ² | — | (1) | (1) | — | 1 | 1 | — |
| | II | 50 ² | (50) ² | — | 50 | (50) | — | 10 | (10) | — |
| | III | 125 ² | (125) ² | — | 125 | (125) | — | 25 | (25) | — |
| | IV | 500 | (500) | — | 500 | (500) | — | 100 | (100) | — |
| | V | N.L. | N.L. | — | N.L. | N.L. | — | N.L. | N.L. | — |
| 4.3 Oxidizer | 4 | I ² | (1) ² | — | 1/4 ² | (1/4) | — | 1/4 | (1/4) | — |
| | 3 | 10 ² | (10) ² | — | 2 | (2) | — | 2 | (2) | — |
| | 2 | 250 ² | (250) ² | — | 50 | (250) | — | 50 | (50) | — |
| | 1 | 1,000 ² | (1,000) ² | — | 1,000 | (1,000) | — | 200 | (200) | — |
| 4.4 Oxidizer:Gas (gaseous) (liquefied) | | — | 15 ² | 1,500 ² | — | — | 1,500 ² | — | — | — |
| 5.1 Pyrophoric | | 4 ² | (4) ² | 50 ² | 1 | (1) | 10 ² | 0 | 0 | 0 |
| 6.1 Unstable (reactive) | 4 | I ² | (1) ² | 10 ² | 1/4 | (1/4) | 2 ² | 1/4 | (1/4) | 0 |
| | 3 | 5 ² | (5) ² | 50 ² | 1 | (1) | 10 ² | 1 | (1) | 0 |
| | 2 | 50 ² | (50) ² | 250 ² | 50 | (50) | 250 ² | 10 | (10) | 0 |
| | 1 | 125 ² | (125) ² | 750 ² | 125 | (125) | 750 ² | 25 | (25) | 0 |
| 7.1 Water (reactive) | 3 | 5 ² | (5) ² | — | 5 | (5) | — | 1 | (1) | — |
| | 2 | 50 ² | (50) ² | — | 50 | (50) | — | 10 | (10) | — |
| | 1 | 125 ² | (125) ² | — | 125 | (125) ² | — | 25 | (25) | — |

1. A laboratory suite is a space up to 10,000 square feet (929 m²) bounded by not less than a one hour fire resistive occupancy separation within which the exempt amounts of hazardous materials may be stored, dispensed, handled or used. Up through the third floor and down through the first basement floor, the quantity in this table shall apply. Fourth, fifth and sixth floors and the second and third basement floor level quantity shall be reduced to 75 percent of this table. The seventh through 10th floor and below the third basement floor level quantity shall be reduced to 50 percent of this table.

2. Quantities may be increased 100 percent when stored in approved exhausted gas cabinets, exhausted enclosures or fume hoods.

TABLE 3416.7(2)
EXEMPT AMOUNTS OF HAZARDOUS MATERIALS, LIQUIDS AND CHEMICALS
PRESENTING A HEALTH HAZARD MAXIMUM QUANTITIES FOR LABORATORY SUITE¹
When two units are given, values within parentheses are in pounds (lbs.).

| MATERIAL | STORAGE | | | USE CLOSED SYSTEMS | | | USE OPEN SYSTEMS | |
|--------------------------------|-----------------|----------------------------|-------------------|---------------------------|----------------------------|-------------------|-------------------------|----------------------------|
| | Solid lb | Liquid Gallons (lb) | Gas cu. ft | Solid lb | Liquid Gallons (lb) | Gas cu. ft | Solid lb | Liquid Gallons (lb) |
| 1. Corrosives | 5,000 | 500 | 650 ² | 5,000 | 500 | 650 | 1,000 | 100 |
| 2a. Highly toxics ² | 40 | 10 | 65 | 5 | 1 | 65 | 2 | 1/4 |
| 2b. Toxics | 500 | 50 | 650 ² | 500 | 50 | 650 | 5 | 1/2 |
| 3. Irritants | 5,000 | 500 | 650 | 5,000 | 500 | 650 | 1,000 | 100 |
| 4. Sensitizers | 5,000 | 500 | 650 | 5,000 | 500 | 650 | 1,000 | 100 |
| 5. Other health hazards | 5,000 | 500 | 650 | 5,000 | 500 | 650 | 1,000 | 100 |

1. A laboratory suite is a space up to 10,000 square feet (929 m^2) bounded by not less than a one hour fire resistive occupancy separation within which the exempt amounts of hazardous materials may be stored, dispensed, handled or used. Up through the third floor and down through the first basement floor, the quantity in this table shall apply. Fourth, fifth and sixth floors and the second and third basement floor level quantity shall be reduced to 75 percent of this table. The seventh through 10th floor and below the third basement floor level quantity shall be reduced to 50 percent of this table.
2. Permitted only when stored or used in approved exhausted gas cabinets, exhausted enclosures or fume hoods. Quantities of high toxics in use in open systems need not be reduced above the third floor or below the first basement floor level. Individual container size shall be limited to 2 pounds (0.91 kg) for solids and 1/4 gallon (0.95 L) for liquids.

3417.3.2 Public school buildings. For public schools, the provisions of Section 3417 apply when required in accordance with Sections 4-307 and 4-309(c), Title 24, Part 1.

3417.3.3 Community college buildings. For community colleges, the provisions of Section 3417 apply when required in accordance with Sections 4-307 and 4-309(c), Title 24, Part 1.

3417.4 Evaluation required. If the criteria in Section 3417.3 apply to the project under consideration, the design professional of record shall provide an evaluation in accordance with Section 3417 to determine the seismic performance of the building in its current configuration and condition. If the structure's seismic performance as required by Section 3417.5 is evaluated as satisfactory and the peer reviewer(s), when Method B of Section 3421 is used, concur, then no structural retrofit is required.

3417.5 Minimum seismic design performance levels for structural and nonstructural components. Following the notations of ASCE 41, the seismic requirements for design and assessment are based upon a prescribed Earthquake Hazard Level (BSE-1, BSE-2, BSE-R or BSE-C), a specified structural performance level (S-1 through S-5) and a non-structural performance level (N-A through N-E). The minimum seismic performance criteria are given in Table 3417.5 according to the Building Regulatory Authority and the Risk Category as determined in Chapter 16 or by the regulatory authority. The building shall be evaluated at both the Level 1 and Level 2 performance levels, and the more restrictive requirements shall apply.

Basic Safety Earthquake 2 (BSE-2) in ASCE 41 shall be same as Risk-Targeted Maximum Considered Earthquake (MCE_R) in ASCE 7. Probabilistic response spectra defining other Earthquake Hazard Levels shall be developed using site-specific ground motions in accordance with ASCE 7 Section 21.2 utilizing the Next Generation Attenuation (NGA) relations used for

the 2008 USGS seismic hazards maps for Western United States (WUS). When supported by data and analysis, other NGA relations, that were not used for the 2008 USGS maps, shall be permitted as additions or substitutions. No fewer than three NGA relations shall be utilized. Response spectra shall incorporate the risk coefficient C_R per ASCE 7 Section 21.2.1.1

Ground-motion response history analysis shall be as set forth in ASCE 7 Chapter 16, Section 17.3 or Section 18.2.3.

Exception: If the floor area of an addition is greater than the larger of 50 per cent of the floor area of the original building or 1,000 square feet (93 m^2), then the Table 3417.5 entries for BSE-R and BSE-C are replaced by BSE-1 and BSE-2, respectively.

3417.6 Retrofit required. Where the evaluation indicates the building does not meet the required performance objectives of this section, the owner shall take appropriate steps to ensure that the building's structural system is retrofitted in accordance with the provisions of Section 3417. Appropriate steps are either: 1) undertake the seismic retrofit as part of the additions, modifications and/or repairs of the structure; or 2) provide a plan, acceptable to the building official, to complete the seismic retrofit in a timely manner. The relocation or moving of an existing building is considered to be an alteration requiring filing of the plans and specifications approved by the building official.

3417.7 The additions, modification or repair to any existing building are permitted to be prepared in accordance with the requirements for a new building, Chapter 16, Part 2, Title 24, C.C.R., 2013 edition, applied to the entire building.

3417.8 The requirements of ASCE 41 Chapter 9 are to apply to the use of seismic isolation or passive energy systems for the repair, modification or retrofit of an existing structure. When seismic isolation or passive energy dissipation is used, the project must have project peer review as prescribed in Section 3422.

TABLE 3417.5
SEISMIC PERFORMANCE REQUIREMENTS BY BUILDING REGULATORY AUTHORITY AND RISK CATEGORY.
ALL BUILDINGS NOT REGULATED BY DSA ARE ASSIGNED AS "STATE-OWNED."

| | | PERFORMANCE CRITERIA | |
|--|-------------------|------------------------|------------------------|
| Building Regulatory Authority | Risk Category | Level 1 | Level 2 |
| <i>State Owned</i> | <i>I, II, III</i> | <i>BSE R, S 3, N D</i> | <i>BSE C, S 5, N E</i> |
| <i>State Owned</i> | <i>IV</i> | <i>BSE R, S 2, N B</i> | <i>BSE C, S 4, N C</i> |
| <i>Division of the State Architect</i> Public schools | <i>I</i> | <i>BSE 1, S 3, N C</i> | <i>BSE 2, S 5, N E</i> |
| <i>Division of the State Architect</i> Public schools | <i>II, III</i> | <i>BSE 1, S 2, N C</i> | <i>BSE 2, S 4, N D</i> |
| <i>Division of the State Architect</i> Public schools | <i>IV</i> | <i>BSE 1, S 2, N C</i> | <i>BSE 2, S 4, N C</i> |
| <i>Division of the State Architect</i> Community college | <i>I, II, III</i> | <i>BSE R, S 3, N D</i> | <i>BSE 2, S 5, N E</i> |
| <i>Division of the State Architect</i> Community college | <i>IV</i> | <i>BSE R, S 2, N B</i> | <i>BSE 2, S 4, N C</i> |

1. ASCE 41 provides acceptance criteria (e.g. m, rotation) for Immediate Occupancy (S1), Life Safety (S3), and Collapse Prevention (S5), and specifies that values for S 2 and S 4 are to be determined by interpolation between the adjacent performance level values.

The required method of interpolation is as follows:

For level S 2, the acceptance value is $\frac{1}{3}$ of the sum of the tabulated value for Immediate Occupancy (IO level) and twice the tabulated value for the Life Safety (LS level).

For level S 4, the acceptance value is one half the sum of the value for the LS level and the value for the Collapse Prevention (CP) level.

For nonstructural components, N A corresponds to the IO level, N C to the LS level, and N D to the Hazards Reduced (HR level).

For evaluation procedures, N B shall be the same as for N A. Where numerical values are used, the values for N B are one half the sum of the appropriate IO and LS values. Where IO or CP values are not given by ASCE 41, then the LS values are permitted to be substituted.

2. Buildings evaluated and retrofitted to meet the requirements for a new building, Chapter 16, Part 2, Title 24, in accordance with the exception in Section 3419.1, are deemed to meet the seismic performance requirements of this section.

3417.9 Any construction required by this chapter shall include structural observation by the registered design professional who is responsible for the structural design in accordance with Section 3419.10.

3417.10 Where Method B of Section 3421 is used or is required by Section 3419.7, the proposed method of building evaluation and design procedures must be accepted by the building official prior to the commencement of the work.

3417.11 Voluntary lateral-force-resisting system modifications. Where the exception of Section 3417.2 applies, modifications of existing structural components and additions of new structural components that are initiated for the purpose of improving the seismic performance of an existing structure and that are not required by other portions of this chapter are permitted under the requirements of Section 3419.12.

SECTION 3418 DEFINITIONS

3418.1. In addition to the definitions given in Section 3402, for the purposes of Sections 3417 through 3423, certain terms are defined as follows:

ADDITION means any work that increases the floor or roof area or the volume of enclosed space of an existing building, and is structurally attached to the existing building by connections that are required for transmitting vertical or horizontal loads between the addition and the existing structure.

ALTERATION means any change within or to an existing building, which does not increase and may decrease the floor or roof area or the volume of enclosed space.

BSE-C RESPONSE ACCELERATION PARAMETERS are the parameters (S_{xs} and S_{xi}) taken from 5-percent/50-year

maximum direction spectral response acceleration curves or by a Site Specific Response Spectrum developed in accordance with Section 3417.5. Values for BSE-C need not be greater than those for BSE-2.

BSE-R RESPONSE ACCELERATION PARAMETERS are the parameters (S_{xs} and S_{xi}) taken from 20-percent/50-year maximum direction spectral response acceleration curves or by a Site Specific Response Spectrum developed in accordance with Section 3417.5. Values for BSE-R need not be greater than those for BSE-1.

BUILDING OFFICIAL is that individual within the agency or organization charged with responsibility for compliance with the requirements of this code. For some agencies this person is termed the "enforcement agent."

DESIGN is the procedure that includes both the evaluation and retrofit design of an existing component, element or structural system, and design of a new component, element or structural system.

ENFORCEMENT AGENCY (Authority Having Jurisdiction in ASCE 41) is the agency or organization charged with responsibility for agency or organization compliance with the requirements of this code.

METHOD A refers to the procedures prescribed in Section 3420.

METHOD B refers to the procedures allowed in Section 3421.

MODIFICATIONS. For this chapter, modification is taken to include repairs to structures that have been damaged.

N-A, N-B, N-C, N-D, N-E are seismic nonstructural component performance measures as defined in ASCE 41. N-A corresponds to the highest performance level, and N-D the lowest, while N-E is not considered.

PEER REVIEW refers to the procedures contained in Section 3422.

REPAIR as used in this chapter means the design and construction work undertaken to restore or enhance the structural and nonstructural load-resisting system participating in the lateral response and stability of a structure that has experienced damage from earthquakes or other destructive events.

S-1, S-2, S-3, S-4, S-5, S-6 are seismic structural performance measures as defined in ASCE 41. S-1 corresponds to the highest performance level, and S-5 the lowest, while S-6 is not considered.

SPECIFIC PROCEDURES are the procedures listed in Section 3419.1.1.

STRUCTURAL REPAIRS are any changes affecting existing or requiring new structural components primarily intended to correct the effects of damage, deterioration or impending or actual failure, regardless of cause.

SECTION 3419 SEISMIC CRITERIA SELECTION FOR EXISTING BUILDINGS

3419.1 Basis for evaluation and design. This section determines what technical approach is to be used for the seismic evaluation and design for existing buildings. For those buildings or portions of buildings for which Section 3417 requires action, the procedures and limitations for the evaluation of existing buildings and design of retrofit systems and/or repair thereof shall be implemented in accordance with this section.

One of the following approaches must be used:

1. Method A of Section 3420;
2. Method B of Section 3421, with independent review of a peer reviewer as required in Section 3422; or
3. For state-owned buildings only, the use of one of the specific procedures listed in Section 3419.1.1.

When Method B is chosen it must be approved by the building official, and, where applicable, by the peer reviewer. All referenced standards in ASCE 41 shall be replaced by referenced standards listed in Chapter 35 of this code.

Exception: [DSA-SS & DSA-SS/CC] For public schools and community colleges constructed to the requirements of California Building Code, 2007 or later edition, that code is permitted to be used in place of those specific in Section 3419.1 provided the building complies with Seismic Design Category D or higher.

3419.1.1 Specific procedures. For state-owned buildings, the following specific procedures taken from the International Existing Building Code (IEBC) Appendix A may be used, without peer review, for their respective types of construction to comply with the seismic performance requirements for Risk Category I, II or III buildings:

1. Seismic Strengthening Provisions for Unreinforced Masonry Bearing Wall Buildings (Chapter A1 of the IEBC).

2. Prescriptive Provisions for Seismic Strengthening of Cripple Walls and Sill Plate Anchorage of Light Wood-Frame, Residential Buildings (Chapter A3 of the IEBC) ||
3. Earthquake Hazard Reduction in Existing Reinforced Concrete and Reinforced Masonry Wall Buildings with Flexible Diaphragms (Chapter A2 of the IEBC).

3419.1.2 When a design project is begun under Method B the selection of the peer reviewer is subject to the approval of the building official. Following approval by the peer reviewer, the seismic criteria for the project and the planned evaluation provisions must be approved by the building official. The approved seismic criteria and evaluation provisions shall apply. Upon approval of the building official these are permitted to be modified.

3419.1.3 For state-owned and community college buildings, where unreinforced masonry is not bearing, it may be used only to resist applied lateral loads. Where unreinforced masonry walls are part of the structure they must be assessed for stability under the applicable nonstructural evaluation procedure.

3419.1.4 Public schools. For public schools, unreinforced masonry shall not be used to resist in-plane or out-of-plane seismic forces or superimposed gravity loads.

3419.1.5 Public schools. For public schools of light-frame construction, horizontal diaphragms and vertical shear walls shall consist of either diagonal lumber sheathing or structural panel sheathing. Braced horizontal diaphragms may be acceptable when approved by DSA. Straight lumber sheathing may be used in combination with diagonal or structural panel sheathing as diaphragms or shear walls. Let-in bracing, plaster (stucco), hollow claytile, gypsum wallboard and particleboard sheathing shall not be assumed to resist seismic forces.

3419.2 Existing conditions. The existing condition and properties of the entire structure must be determined and documented by thorough inspection of the structure and site, review of all available related construction documents, review of geotechnical and engineering geologic reports, and performance of necessary testing and investigation. Where samples from the existing structure are taken or in situ tests are performed, they shall be selected and interpreted in a statistically appropriate manner to ensure that the properties determined and used in the evaluation or design are representative of the conditions and structural circumstances likely to be encountered in the structure as a whole. Adjacent structures or site features that may affect the retrofit design shall be identified.

The entire load path of the seismic-force-resisting system shall be determined, documented and evaluated. The load path includes all the horizontal and vertical elements participating in the structural response: such as diaphragms, diaphragm chords, diaphragm collectors, vertical elements such as walls, frames, braces; foundations and the connections between the components and elements of the load path. Repaired or retrofitted elements and the standards under which the work was constructed shall be identified.

Data collection in accordance with ASCE 41 Section 2.2 shall meet the following minimum levels:

1. For state-owned buildings, the requirements shall be met following the data collection requirements of ASCE 41, Section 2.2.
2. For public schools and community college buildings constructed in conformance with the Field Act, the "Usual" level as defined in ASCE 41, Section 2.2.6.2.
3. For public schools and community college buildings not constructed in conformance with the Field Act, the "Comprehensive" level as defined in ASCE 41, Section 2.2.6.3.

Concrete material requirements and testing for public school and community college buildings shall also comply with Sections 1914A and 1913.5, respectively.

Qualified test data from the original construction may be accepted, in part or in whole, by the enforcement agency to fulfill the data collection requirements.

Exceptions:

1. The number of samples for data collection may be adjusted with approval of the enforcement agency when it has been determined that adequate information has been obtained or additional information is required.
2. Welded steel moment frame connections of buildings that may have experienced potentially damaging ground motions shall be inspected in accordance with Chapters 3 and 4, FEMA 352, Recommended Post Earthquake Evaluation and Repair Criteria for Welded Moment-Frame Construction for Seismic Applications (July 2000).

Where original building plans and specifications are not available, "as-built" plans shall be prepared that depict the existing vertical and lateral structural systems, exterior elements, foundations and nonstructural systems in sufficient detail to complete the design.

Data collection shall be directed and observed by the project structural engineer or design professional in charge of the design.

3419.3 Site geology and soil characteristics. Soil profile shall be assigned in accordance with the requirements of Chapter 18.

3419.4 Risk categories. For purposes of earthquake-resistant design, each structure shall be placed in one of the risk categories in accordance with the requirements of this code.

3419.5 Configuration requirements. Each structure shall be designated structurally regular or irregular in accordance with the requirements of ASCE 41, Sections 2.4.1.1.1 to 2.4.1.1.4.

3419.6 General selection of the design method. The requirements of Method B (Section 3421) may be used for any existing building.

3419.7 Prescriptive selection of the design method. The requirements of Method A (Section 3420) or the specific procedures for applicable building types given in Section 3419.1.1

are permitted to be used except under the following conditions, where the requirements of Method B (Section 3421) must be used.

3419.7.1 When the building contains prestressed or post-tensioned structural components (beams, columns, walls or slabs) or contains precast structural components (beams, columns, walls or flooring systems).

3419.7.2 When the building is classified as irregular in vertical or horizontal plan by application of ASCE/SEI 7, Section 12.3 and/or ASCE 41, Sections 2.4.1.1.1 to 2.4.1.1.4, unless the irregularity is demonstrated not to affect the seismic performance of the building.

Exception: If the retrofit design removes the configurational attributes that caused the building to be classified as irregular, then Section 3419.7.2 does not apply and Method A may be used.

3419.7.3 For any building that is assigned to Risk Category IV.

3419.7.4 For any building using undefined or hybrid structural systems.

3419.7.5 When seismic isolation or energy dissipation systems are used in the retrofit or repair, either as part of the existing structure or as part of the modifications.

3419.7.6 When the height of the structure exceeds 240 feet (73 152 mm).

3419.8 Strength requirements. All components of the lateral-force-resisting system must have the strength to meet the acceptance criteria prescribed in ASCE 41, Chapter 3, or as prescribed in the applicable Appendix A chapter of the IEBC if a specific procedure in Section 3419.1.1 is used. Any component not having this strength shall have its capacity increased by modifying or supplementing its strength so that it exceeds the demand, or the demand is reduced to less than the existing strength by making other modifications to the structural system.

Exception: A component's strength is permitted to be less than that required by the specified seismic load combinations if it can be demonstrated that the associated reduction in seismic performance of the component or its removal due to the failure does not result in a structural system that does not comply with the required performance objectives of Section 3417. If this exception is taken for a component, then it cannot be considered part of the primary lateral-load-resisting system.

3419.9 Nonstructural component requirements. Where the nonstructural performance levels required by Section 3417, Table 3417.5 are N-D or higher, mechanical, electrical and plumbing components shall comply with the provisions of ASCE 41, Chapter 11, Section 11.2.

Exception: Modifications to the procedures and criteria may be made subject to approval by the building official, and concurrence of the peer reviewer if applicable. All reports and correspondence shall also be forwarded to the building official.

3419.10 Structural observation, testing and inspection. Structural, geotechnical and construction observation, testing and inspection as used in this section shall mean meeting the requirements of Chapter 17, with a minimum allowable level of investigation corresponding to seismic design category (SDC) D. At a minimum the project site will be visited by the responsible design professional to observe existing conditions and to review the construction work for general compliance with approved plans, specifications and applicable structural regulations. Such visits shall occur at significant construction stages and at the completion of the structural retrofit. Structural observation shall be provided for all structures. The plan for testing and inspection shall be submitted to the building official for review and approval with the application for permit.

Additional requirements: For public schools and community colleges, construction material testing, inspection and observation during construction shall also comply with Section 4-333, Part 1, Title 24.

3419.10.1 The registered design professional, or their designee, responsible for the structural design shall be retained to perform structural observation and independently report to the owner of observations and findings as they relate to adherence to the permitted plans and good workmanship.

3419.10.2 At the conclusion of construction, the structural observer shall submit to the enforcement agency and the owner a final written statement that the required site visits have been made, that the work, to the best of the structural observers knowledge and belief, is or is not in general conformity to the approved plans and that the observed structural deficiencies have been resolved and/or listing those that, to the best of the structural observers knowledge and belief, have not been satisfactorily corrected.

3419.10.2.1 The requirement for structural observation shall be noted and prominently displayed on the front sheet of the approved plans and incorporated into the general notes on the approved plans.

3419.10.2.2 Preconstruction meeting. A preconstruction meeting is mandatory for all projects which require structural observation. The meeting shall include, but is not limited to, the registered design professional, structural observer, general contractor, affected subcontractors, the project inspector and a representative of the enforcement agency (designated alternates may attend if approved by the structural observer). The structural observer shall schedule and coordinate this meeting. The purpose of the meeting is to identify and clarify all essential structural components and connections that affect the lateral and vertical load systems and to review scheduling of the required observations for the project's structural system retrofit.

3419.11 Temporary actions. When compatible with the building use, and the time phasing for both use and the retrofit program, temporary shoring or other structural support is permitted to be considered. Temporary bracing, shoring and prevention of falling hazards are permitted to be used to qualify for Exception 1 in Section 3419.12 that allows inadequate

capability in some existing components, as long as the required performance levels given in Section 3417 can be provided by the permanent structure. The consideration for such temporary actions shall be noted in the design documents.

3419.12 Voluntary modifications to the lateral-force resisting system. Where modifications of existing structural components and additions of new structural components are initiated for the purpose of improving the lateral-force resisting strength or stiffness of an existing structure and they are not required by other sections of this code, then they are permitted to be designed to meet an approved seismic performance criteria provided that an engineering analysis is submitted that follows:

1. The capacity of existing structural components required to resist forces is not reduced, unless it can be demonstrated that reduced capacity meets the requirements of Section 3419.8.
2. The lateral loading to or strength requirement of existing structural components is not increased beyond their capacity.
3. New structural components are detailed and connected to the existing structural components as required by this code for new construction.
4. New or relocated nonstructural components are detailed and connected to existing or new structural components as required by this code for new construction.
5. A dangerous condition is not created.

3419.12.1 State-owned buildings. Voluntary modifications to lateral-force-resisting systems conducted in accordance with Appendix A of the IEBC and the referenced standards of this code shall be permitted.

3419.12.1.1 Design documents. When Section 3419.12 is the basis for structural modifications, the approved design documents must clearly state the scope of the seismic modifications and the accepted criteria for the design. The approved design documents must clearly have the phrase "The seismic requirements of Chapter 34 for existing buildings have not been checked to determine if these structural modifications meet CBC requirements: the modifications proposed are to a different seismic performance standard than would be required in Section 3419 if they were not voluntary as allowed in Section 3419.12."

3419.12.2 Public schools and community colleges. When Section 3419.12 is the basis for structural modifications, the approved design documents must clearly indicate the scope of modifications and the acceptance criteria for the design.

SECTION 3420 METHOD A

3420.1 General. The retrofit design shall employ the Linear Static or Linear Dynamic Procedures of ASCE 41, Section 3.3.1 or 3.3.2, and comply with the applicable general requirements of ASCE 41, Chapters 2 and 3. The earthquake hazard level and performance level given specified in Section 3417.5 for the building's risk category shall be used. Structures shall

be designed for seismic forces coming from any horizontal direction.

Exception: The ASCE 41 Simplified Rehabilitation Method of Chapter 10 may be used if the Level 1 seismic performance level is S-3 or lower; the building's structural system is one of the primary building types described in ASCE 41, Table 10-2, and ASCE 41, Table 10-1 permits its use for the building height.

SECTION 3421 METHOD B

3421.1 The existing or retrofitted structure shall be demonstrated to have the capability to sustain the deformation response due to the specified earthquake ground motions and meet the seismic performance requirements of Section 3417. The registered design professional shall provide an evaluation of the response of the existing structure in its modified configuration and condition to the ground motions specified. If the building's seismic performance is evaluated as satisfactory and the peer reviewer(s) and the enforcement agency concur, then no further structural modifications of the lateral-load-resisting system are required.

When the evaluation indicates the building does not meet the required performance levels given in Table 3417.5 for the risk category, then a retrofit and/or repair design shall be prepared that provides a structure that meets these performance objectives and reflects the appropriate consideration of existing conditions. Any approach to analysis and design is permitted to be used, provided that the approach shall be rational, shall be consistent with the established principals of mechanics and shall use the known performance characteristics of materials and assemblages under reversing loads typical of severe earthquake ground motions.

Exception: Further consideration of the structure's seismic performance may be waived by the enforcement agency if both the registered design professional and peer reviewer(s) conclude that the structural system can be expected to perform at least as well as required by the provisions of this section without completing an analysis of the structure's compliance with these requirements. A detailed report shall be submitted to the responsible building official that presents the reasons and basis for this conclusion. This report shall be prepared by the registered design professional. The peer reviewer(s) shall concur in this conclusion and affirm to it in writing. The building official shall either approve this decision or require completion of the indicated work specified in this section prior to approval.

3421.2 The approach, models, analysis procedures, assumptions on material and system behavior and conclusions shall be peer reviewed in accordance with the requirements of Section 3422 and accepted by the peer reviewer(s).

Exceptions:

1. The enforcement agency may perform the work of peer review when qualified staff is available within the jurisdiction.

2. The enforcement agency may modify or waive the requirements for peer review when appropriate.

3421.2.1 The approach used in the development of the design shall be acceptable to the peer reviewer and the enforcement agency and shall be the same method as used in the evaluation of the building. Approaches that are specifically tailored to the type of building, construction materials and specific building characteristics may be used, if they are acceptable to the independent peer reviewer. The use of Method A allowed procedures may also be used under Method B.

3421.2.2 Any method of analysis may be used, subject to acceptance by the peer reviewer(s) and the building official. The general requirements given in ASCE 41, Chapter 2, shall be complied with unless exceptions are accepted by the peer reviewer(s) and building official. Use of other than ASCE 41 procedures in Method B requires building official concurrence before implementation.

3421.2.3 Prior to implementation, the procedures, methods, material assumptions and acceptance/rejection criteria proposed by the registered design professional will be peer reviewed as provided in Section 3422. Where nonlinear procedures are used, prior to any analysis, the representation of the seismic ground motion shall be reviewed and approved by the peer reviewer(s) and the building official.

3421.2.4 The conclusions and design decisions shall be reviewed and accepted by the peer reviewer(s) and the building official.

SECTION 3422 PEER REVIEW REQUIREMENTS

3422.1 General. Independent peer review is an objective, technical review by knowledgeable reviewer(s) experienced in the structural design, analysis and performance issues involved. The reviewer(s) shall examine the available information on the condition of the building, the basic engineering concepts employed and the recommendations for action.

3422.2 Timing of independent review. The independent reviewer(s) shall be selected prior to initiation of substantial portions of the design and/or analysis work that is to be reviewed, and review shall start as soon as practical after Method B is adopted and sufficient information defining the project is available.

3422.3 Qualifications and terms of employment. The reviewer(s) shall be independent from the design and construction team.

3422.3.1 The reviewer(s) shall have no other involvement in the project before, during or after the review, except in a review capacity.

3422.3.2 The reviewer(s) shall be selected and paid by the owner and shall have technical expertise in the evaluation and retrofit of buildings similar to the one being reviewed, as determined by the enforcement agency.

3422.3.3 The reviewer (or in the case of review teams, the chair) shall be a California-licensed structural engineer

who is familiar with the technical issues and regulations governing the work to be reviewed.

Exception: Other individuals with acceptable qualifications and experience may be a peer reviewer(s) with the approval of the building official.

3422.3.4 The reviewer shall serve through completion of the project and shall not be terminated except for failure to perform the duties specified herein. Such termination shall be in writing with copies to the enforcement agency, owner and the registered design professional. When a reviewer is terminated or resigns, a qualified replacement shall be appointed within 10 working days, and the reviewer shall submit copies of all reports, notes and correspondence to the responsible building official, the owner and the registered design professional within 10 working days of such termination.

3422.3.5 The peer reviewer shall have access in a timely manner to all documents, materials and information deemed necessary by the peer reviewer to complete the peer review.

3422.4 Scope of review. Review activities shall include, where appropriate, available construction documents, design criteria and representative observations of the condition of the structure, all inspection and testing reports, including methods of sampling, analytical models and analyses prepared by the registered design professional and consultants, and the retrofit or repair design. Review shall include consideration of the proposed design approach, methods, materials, details and constructability.

Changes observed during construction that affect the seismic-resisting system shall be reported to the reviewer in writing for review and recommendation.

3422.5 Reports. The reviewer(s) shall prepare a written report to the owner and building official that covers all aspects of the review performed, including conclusions reached by the reviewer(s). Reports shall be issued after the schematic phase, during design development, and at the completion of construction documents but prior to submittal of the project plans to the enforcement agency for plan review. When acceptable to the building official, the requirement for a report during a specific phase of the project development may be waived.

Such reports should include, at the minimum, statements of the following:

1. Scope of engineering design peer review with limitations defined.
2. The status of the project documents at each review stage.
3. Ability of selected materials and framing systems to meet performance criteria with given loads and configuration.
4. Degree of structural system redundancy and the deformation compatibility among structural and nonstructural components.
5. Basic constructability of the retrofit or repair system.
6. Other recommendations that would be appropriate to the specific project.

7. Presentation of the conclusions of the reviewer identifying any areas that need further review, investigation and/or clarification.

8. Recommendations.

The last report prepared prior to submittal of permit documents to the enforcement agency shall include a statement indicating that the design is in conformance with the approved evaluation and design criteria.

3422.6 Response and resolutions. The registered design professional shall review the report from the reviewer(s) and shall develop corrective actions and responses as appropriate. Changes observed during construction that affect the seismic-resisting system shall be reported to the reviewer in writing for review and recommendations. All reports, responses and resolutions prepared pursuant to this section shall be submitted to the responsible enforcement agency and the owner along with other plans, specifications and calculations required. If the reviewer resigns or is terminated prior to completion of the project, then the reviewer shall submit copies of all reports, notes and correspondence to the responsible building official, the owner and the registered design professional within 10 working days of such termination.

3422.7 Resolution of conflicts. When the conclusions and recommendations of the peer reviewer conflict with the registered design professional's proposed design, the enforcement agency shall make the final determination of the requirement for the design.

SECTION 3423 ADDITIONAL REQUIREMENTS FOR PUBLIC SCHOOLS AND COMMUNITY COLLEGES

The requirements of Section 3423 apply only to public schools under the jurisdiction of the Division of the State Architect-Structural Safety (DSA-SS, refer to Section 1.9.2.1) and community colleges under the jurisdiction of the Division of the State Architect-Structural Safety/Community Colleges (DSA-SS/CC). Refer to Section 1.9.2.2.

3423.1 Evaluation and design criteria report. During the schematic phase of the project, the owner or the registered design professional in charge of the design shall prepare and sign an Evaluation and Design Criteria Report in accordance with Part 1, Title 24, C. C. R., Section 4-307(a). The report shall be submitted to the DSA for review and approval prior to proceeding with design development of the rehabilitation.

The Evaluation and Design Criteria Report shall:

1. Identify the building(s) structural and nonstructural systems, potential deficiencies in the elements or systems and the proposed method for retrofit.
2. Identify geological and site-related hazards.
3. Propose the methodology for evaluation and retrofit design.
4. Propose the complete program for data collection (Section 3419.2).

5. Include existing or "as-built" building plans, reports and associated documents of the existing construction.

3423.2 Rehabilitation involving only portions of structures. Where only a portion(s) of a structure is to be rehabilitated, the public school or community college portion of the structure shall:

1. Be seismically separated from the unrehabilitated portion in accordance with Chapter 16 of Part 2, Title 24, or the entire structure shall be rehabilitated in accordance with this Section. For structures in which the unrehabilitated portion is above or below the school or community college portion, the entire structure shall be rehabilitated in accordance with this division.
2. Be retrofitted as necessary to protect the occupants from falling hazards of the unrehabilitated portion of the building, and;
3. Be retrofitted as necessary to protect required exitways being blocked by collapse or falling hazards of the unrehabilitated portion.

SECTION 3424 ADDITIONAL REQUIREMENTS FOR SKILLED NURSING FACILITIES AND INTERMEDIATE CARE FACILITIES [OSHPD 2]

3424.1 Services/systems and utilities. Services/systems and utilities that are necessary to the operation of a skilled nursing facility or intermediate care facility shall meet the requirements of this section. Examples of services/systems and utilities include but are not limited to normal power; emergency power; nurse call; fire alarm; communication and data systems; space-heating systems; process load systems; cooling systems; domestic hot and cold water systems; means of egress systems; fire-suppression systems; building drain and sewer systems; and medical gas systems that support licensed services.

Exception: Remodel projects that use available existing services/systems and utilities are exempted from the requirements of this section. The enforcing agency may exempt minor addition, minor alteration, and minor remodel projects and projects to upgrade existing services/systems and utilities from the requirements of this section.

3424.1.1 Services/systems and utilities for skilled nursing facilities and intermediate care facilities.

3424.1.1.1 New buildings and additions. Services/systems and utilities for new buildings and additions shall not originate in or pass through or under nonconforming structures. The structures must be under the jurisdiction of OSHPD.

Exception: As an alternate to this section, skilled nursing and intermediate care facilities may meet the requirements in Section 3416A.1.1.1 for hospital buildings.

3424.1.1.2 Alterations and remodels. Services/systems and utilities for alterations or remodels of existing buildings may pass through nonconforming structures provided that the structure is under the jurisdiction of OSHPD, and the new services/systems and utilities passing through the buildings are anchored and braced for seismic forces in accordance with these regulations for new buildings and are free of adverse seismic interactions caused by potential failure of overhead or adjacent components.

3424.2 Means of egress for single-story light frame skilled nursing facilities and intermediate care facilities. Means of egress for single-story light frame skilled nursing facilities and intermediate care facilities shall comply with the requirements of Sections 3424.2.1 and 3424.2.2.

3424.2.1 New facilities or additions to existing facilities. Means of egress for new skilled nursing facilities or intermediate care facilities, or additions to existing skilled nursing facilities or intermediate care facilities shall only pass through conforming buildings.

Exception: As an alternate, the nursing facilities and intermediate care facilities may meet the egress requirements in Sections 3417A.1.1.1 through 3417A.1.1.5 for hospital buildings.

3424.2.2 Jurisdiction. Means of egress for skilled nursing facilities and intermediate care facilities shall only pass through buildings that are under the jurisdiction of the Office of Statewide Health Planning and Development (OSHPD).

CALIFORNIA BUILDING CODE-MATRIX ADOPTION TABLE CHAPTER 34A – EXISTING STRUCTURES

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | CSA | DPH | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|-----|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | | | | | | | X | | | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | | |



CHAPTER 34A

EXISTING STRUCTURES

SECTION 3401A GENERAL

3401A.1 Scope. The provisions of this chapter shall control the alteration, repair, addition and change of occupancy of existing structures for applications listed in Sections 1.10.1 (OSHPD 1) and 1.10.4 (OSHPD 4) regulated by the Office of Statewide Health Planning and Development (OSHPD).

These applications include hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers. For SFM and DSA-AC requirements enforced by the Office of Statewide Health Planning and Development (OSHPD) refer to Chapter 34.

Exception: [OSHPD 2] Single-story Type V skilled nursing or intermediate care facilities utilizing wood-frame or light-steel-frame construction as defined in Health and Safety Code Section 129725, which shall comply with Chapter 34 and any applicable amendments therein.

[DSA-AC] For applications listed in Section 1.9.1 regulated by the Division of the State Architect-Access Compliance for accessibility requirements, see Chapter 11B, Section 1134B.

3401A.2 Maintenance. Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices or safeguards which are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for the maintenance of buildings and structures. To determine compliance with this subsection, the building official shall have the authority to require a building or structure to be reinspected. The requirements of this chapter shall not provide the basis for removal or abrogation of fire protection and safety systems and devices in existing structures.

3401A.3 Compliance. Alterations, repairs, additions and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in the California Energy Code, California Fire Code, California Mechanical Code, California Plumbing Code and California Electrical Code, California Residential Code and NFPA 70. Where provisions of the other codes conflict with provisions of this chapter, the provisions of this chapter shall take precedence.

3401A.4 Building materials and systems. Building materials and systems shall comply with the requirements of this section.

3401A.4.1 Existing materials. Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 116.

3401A.4.2 New and replacement materials. Except as otherwise required or permitted by this code, materials per-

mitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

3401A.4.3 Existing seismic force-resisting systems. Where the existing seismic force-resisting system is a type that can be designated ordinary or is a welded steel moment frame constructed under a permit issued prior to October 25, 1994, values of R , Ω_0 , and C_d for the existing seismic force-resisting system shall be those specified by this code for an ordinary system unless it is demonstrated that the existing system will provide performance equivalent to that of a detailed, intermediate or special system.

3401.5 Dangerous conditions. The building official shall have the authority to require the elimination of conditions deemed dangerous.

SECTION 3402A DEFINITIONS

3402A.1 Definitions. The following terms are defined in Chapter 2.

DANGEROUS.

PRIMARY FUNCTION.

SUBSTANTIAL STRUCTURAL DAMAGE.

TECHNICALLY INFEASIBLE.

3402A.2 Definitions for this chapter. The following words and terms shall, for the purposes of this chapter and as used elsewhere in the code, have the meanings shown herein. Definitions provided in Section 1613A.2, ASCE 7 Section 11.2 and ASCE 41 shall apply when appropriate in addition to terms defined in this section:

ASSOCIATED STRUCTURAL ALTERATIONS means any change affecting existing structural elements or requiring new structural elements for vertical or lateral support of an otherwise nonstructural alteration.

EXISTING STRUCTURE. A structure that has a valid certificate of occupancy issued by the building official.

GENERAL ACUTE CARE HOSPITAL. See Section 1224.3.

NONSTRUCTURAL ALTERATION is any alteration which neither affects existing structural elements nor requires new structural elements for vertical or lateral support and which does not increase the lateral shear force in any story by more than 5 percent.

PEER REVIEW refers to procedure contained in Section 3414A.

REPAIR as used in this chapter means all the design and construction work affecting existing or requiring new structural elements undertaken to restore or enhance the structural and nonstructural load resisting system participating in vertical or lateral response of a structure primarily intended to correct the effects of deterioration or impending or actual failure, regardless of cause.

VOLUNTARY STRUCTURAL ALTERATION is any alteration of existing structural element or provision of new structural elements which is not necessary for vertical or lateral support of other work and is initiated by the applicant primarily for the purpose of increasing the vertical or lateral load-carrying strength or stiffness of an existing building.

SECTION 3403A ADDITIONS

3403A.1 General. Additions to any building or structure shall comply with the requirements of this code for new construction. Alterations to the existing building or structure shall be made to ensure that the existing building or structure together with the addition are no less conforming with the provisions of this code than the existing building or structure was prior to the addition. An existing building together with its additions shall comply with the height and area provisions of Chapter 5.

3403A.2 Flood hazard areas. For buildings and structures in flood hazard areas established in Section 1612A.3, any addition that constitutes substantial improvement of the existing structure, as defined in Section 1612A.2, shall comply with the flood design requirements for new construction, and all aspects of the existing structure shall be brought into compliance with the requirements for new construction for flood design.

For buildings and structures in flood hazard areas established in Section 1612A.3, any additions that do not constitute substantial improvement of the existing structure, as defined in Section 1612A.2, are not required to comply with the flood design requirements for new construction.

3403A.3 Existing structural elements carrying gravity load. Any existing gravity load-carrying structural element for which an addition and its related alterations cause an increase in design gravity load of more than 5 percent shall be strengthened, supplemented, replaced or otherwise altered as needed to carry the increased load required by this code for new structures. Any existing gravity load-carrying structural element whose gravity load-carrying capacity is decreased shall be considered an altered element subject to the requirements of Section 3404A.3. Any existing element that will form part of the lateral load path for any part of the addition shall be considered an existing lateral load-carrying structural element subject to the requirements of Section 3403A.4.

3403A.3.1 Design live load. Where the addition does not result in increased design live load, existing gravity load-carrying structural elements shall be permitted to be evaluated and designed for live loads approved prior to the addition. If the approved live load is less than that required by Section 1607A, the area designed for the nonconforming live load shall be posted with placards of approved design indicating the approved live load. Where the addition does

result in increased design live load, the live load required by Section 1607A shall be used.

3403A.4 Existing structural elements carrying lateral load.

Where the addition is structurally independent of the existing structure, existing lateral load-carrying structural elements shall be permitted to remain unaltered. Where the addition is not structurally independent of the existing structure, the existing structure and its addition acting together as a single structure shall be shown to meet the requirements of Sections 1609A and 1613A.

Exceptions:

1. Any existing lateral load-carrying structural element whose demand-capacity ratio with the addition considered is no more than 10 percent greater than its demand-capacity ratio with the addition ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with Sections 1609A and 1613A. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction.
2. For incidental alterations, drift limits based on original design code shall be permitted to be used in lieu of the drift limits required by ASCE 7.

3403A.5 Smoke alarms in existing portions of a building.

Where an addition is made to a building or structure of a Group R or I-1 occupancy, the existing building shall be provided with smoke alarms in accordance with Section 1103A.8 of the California Fire Code.

SECTION 3404A ALTERATIONS

3404A.1 General. Except as provided by this section, alterations to any building or structure shall comply with the requirements of the code for new construction. Alterations shall be such that the existing building or structure is no less complying with the provisions of this code than the existing building or structure was prior to the alteration.

Exceptions:

1. An existing stairway shall not be required to comply with the requirements of Section 1009 where the existing space and construction does not allow a reduction in pitch or slope.
2. Handrails otherwise required to comply with Section 1009.15 shall not be required to comply with the requirements of Section 1012.6 regarding full extension of the handrails where such extensions would be hazardous due to plan configuration.

3404A.2 Flood hazard areas. For buildings and structures in flood hazard areas established in Section 1612A.3, any alteration that constitutes substantial improvement of the existing structure, as defined in Section 1612A.2, shall comply with the flood design requirements for new construction, and all aspects

of the existing structure shall be brought into compliance with the requirements for new construction for flood design.

For buildings and structures in flood hazard areas established in Section 1612A.3, any alterations that do not constitute substantial improvement of the existing structure, as defined in Section 1612A.2, are not required to comply with the flood design requirements for new construction.

3404A.3 Existing structural elements carrying gravity load. Any existing gravity load-carrying structural element for which an alteration causes an increase in design gravity load of more than 5 percent shall be strengthened, supplemented, replaced or otherwise altered as needed to carry the increased gravity load required by this code for new structures. Any existing gravity load-carrying structural element whose gravity load-carrying capacity is decreased as part of the alteration shall be shown to have the capacity to resist the applicable design gravity loads required by this code for new structures.

3404A.3.1 Design live load. Where the alteration does not result in increased design live load, existing gravity load-carrying structural elements shall be permitted to be evaluated and designed for live loads approved prior to the alteration. If the approved live load is less than that required by Section 1607A, the area designed for the nonconforming live load shall be posted with placards of approved design indicating the approved live load. Where the alteration does result in increased design live load, the live load required by Section 1607A shall be used.

3404A.4 Existing structural elements carrying lateral load. Except as permitted by Section 3404A.5, where the alteration increases design lateral loads in accordance with Section 1609A or 1613A, or where the alteration results in a structural irregularity as defined in ASCE 7, or where the alteration decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall be shown to meet the requirements of Sections 1609A and 1613A.

Exceptions:

1. Any existing lateral load-carrying structural element whose demand-capacity ratio with the alteration considered is no more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces per Sections 1609A and 1613A. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of additions and alterations since original construction.
2. For incidental alterations, drift limits based on original design code shall be permitted to be used in lieu of the drift limits required by ASCE 7.

3404A.5 Voluntary seismic improvements. Alterations to existing structural elements or additions of new structural elements that are not otherwise required by this chapter and are initiated for the purpose of improving the performance of the seismic force-resisting system of an existing structure or the performance of seismic bracing or anchorage of existing nonstructural elements shall be permitted, provided that an engineering analysis is submitted demonstrating the following:

1. The altered structure, and the altered structural and nonstructural elements are no less in compliance with the provisions of this code with respect to earthquake design than they were prior to the alteration.
2. New structural elements are designed, detailed and connected to the existing structural elements as required by Chapter 16A. *Alterations of existing structural elements shall be based on design demand required by Chapter 16A but need not exceed the maximum load effect that can be transferred to the elements by the system.*
3. Exception: Seismic design in accordance with Sections 3411A and 3412A shall be permitted.
4. New, relocated or altered nonstructural elements are designed, detailed and connected to existing or new structural elements as required by Chapter 16A.
5. The alterations do not create a structural irregularity as defined in ASCE 7 or make an existing structural irregularity more severe.

3404A.6 Smoke alarms. Individual sleeping units and individual dwelling units in Group R and I-1 occupancies shall be provided with smoke alarms in accordance with Section 1103A.8 of the *California Fire Code*.

SECTION 3405A REPAIRS

3405A.1 General. Buildings and structures, and parts thereof, shall be repaired in compliance with Section 3405A and 3401A.2. Work on nondamaged components that is necessary for the required repair of damaged components shall be considered part of the repair and shall not be subject to the requirements for alterations in this chapter. Routine maintenance required by Section 3401A.2, ordinary repairs exempt from permit in accordance with Section 105.2, and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

3405A.2 Substantial structural damage to vertical elements of the lateral force-resisting system. A building that has sustained substantial structural damage to the vertical elements of its lateral force-resisting system shall be evaluated and repaired in accordance with the applicable provisions of Sections 3405A.2.1 through 3405A.2.3.

3405A.2.1 Evaluation. The building shall be evaluated by a registered design professional, and the evaluation findings shall be submitted to the building official. The evaluation shall establish whether the damaged building, if repaired to its pre-damage state, would comply with the provisions of this code for wind and earthquake loads.

Windloads for this evaluation shall be those prescribed in Section 1609A. Earthquake loads for this evaluation, if required, shall be permitted to be 75 percent of those prescribed in Section 1613A.

3405A.2.2 Extent of repair for compliant buildings. If the evaluation establishes compliance of the pre-damage building in accordance with Section 3405A.2.1, then repairs shall be permitted that restore the building to its pre-damage state, based on material properties and design strengths applicable at the time of original construction.

3405A.2.3 Extent of repair for noncompliant buildings. If the evaluation does not establish compliance of the predamage building in accordance with Section 3405A.2.1, then the building shall be rehabilitated to comply with applicable provisions of this code for load combinations, including wind or seismic loads. The wind loads for the repair shall be as required by the building code in effect at the time of original construction, unless the damage was caused by wind, in which case the wind loads shall be as required by the code in effect at the time of original construction or as required by this code. Earthquake loads for this rehabilitation design shall be those required for the design of the predamage building, but not less than *ninety* percent of those prescribed in Section 1613A. New structural members and connections required by this rehabilitation design shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

3405A.3 Substantial structural damage to gravity load-carrying components. Gravity load-carrying components that have sustained substantial structural damage shall be rehabilitated to comply with the applicable provisions of this code for dead and live loads. Snow loads shall be considered if the substantial structural damage was caused by or related to snow load effects. Existing gravity load-carrying structural elements shall be permitted to be designed for live loads approved prior to the damage. Nondamaged gravity load-carrying components that receive dead, live or snow loads from rehabilitated components shall also be rehabilitated or shown to have the capacity to carry the design loads of the rehabilitation design. New structural members and connections required by this rehabilitation design shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

3405A.3.1 Lateral force-resisting elements. Regardless of the level of damage to vertical elements of the lateral force-resisting system, if substantial structural damage to gravity load-carrying components was caused primarily by

wind or earthquake effects, then the building shall be evaluated in accordance with Section 3405A.2.1 and, if noncompliant, rehabilitated in accordance with Section 3405A.2.3.

3405A.4 Less than substantial structural damage. For damage less than substantial structural damage, repairs shall be allowed that restore the building to its pre-damage state, based on material properties and design strengths applicable at the time of original construction. New structural members and connections used for this repair shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

3405A.5 Flood hazard areas. For buildings and structures in flood hazard areas established in Section 1612A.3, any repair that constitutes substantial improvement of the existing structure, as defined in Section 1612A.2, shall comply with the flood design requirements for new construction, and all aspects of the existing structure shall be brought into compliance with the requirements for new construction for flood design.

For buildings and structures in flood hazard areas established in Section 1612A.3, any repairs that do not constitute substantial improvement or repair of substantial damage of the existing structure, as defined in Section 1612A.2, are not required to comply with the flood design requirements for new construction.

SECTION 3406A FIRE ESCAPES

3406A.1 Where permitted. Fire escapes shall be permitted only as provided for in Sections 3406A.1.1 through 3406A.1.4.

3406A.1.1 New buildings. Fire escapes shall not constitute any part of the required means of egress in new buildings.

3406A.1.2 Existing fire escapes. Existing fire escapes shall be continued to be accepted as a component in the means of egress in existing buildings only.

3406A.1.3 New fire escapes. New fire escapes for existing buildings shall be permitted only where exterior stairs cannot be utilized due to lot lines limiting stair size or due to the sidewalks, alleys or roads at grade level. New fire escapes shall not incorporate ladders or access by windows.

3406A.1.4 Limitations. Fire escapes shall comply with this section and shall not constitute more than 50 percent of the required number of exits nor more than 50 percent of the required exit capacity.

3406A.2 Location. Where located on the front of the building and where projecting beyond the building line, the lowest landing shall not be less than 7 feet (2134 mm) or more than 12 feet (3658 mm) above grade, and shall be equipped with a counterbalanced stairway to the street. In alleyways and thoroughfares less than 30 feet (9144 mm) wide, the clearance under the lowest landing shall not be less than 12 feet (3658 mm).

3406A.3 Construction. The fire escape shall be designed to support a live load of 100 pounds per square foot (4788 Pa) and shall be constructed of steel or other approved noncombustible materials. Fire escapes constructed of wood not less than nominal 2 inches (51 mm) thick are permitted on buildings of Type V construction. Walkways and railings located over or supported by combustible roofs in buildings of Type III and IV construction are permitted to be of wood not less than nominal 2 inches (51 mm) thick.

3406A.4 Dimensions. Stairs shall be at least 22 inches (559 mm) wide with risers not more than, and treads not less than, 8 inches (203 mm) and landings at the foot of stairs not less than 40 inches (1016 mm) wide by 36 inches (914 mm) long, located not more than 8 inches (203 mm) below the door.

3406A.5 Opening protectives. Doors and windows along the fire escape shall be protected with $\frac{3}{4}$ -hour opening protectives.

SECTION 3407A GLASS REPLACEMENT

3407A.1 Conformance. The installation or replacement of glass shall be as required for new installations.

SECTION 3408A CHANGE OF OCCUPANCY

3408A.1 Conformance. No change shall be made in the use or occupancy of any building that would place the building in a different division of the same group of occupancies or in a different group of occupancies, unless such building is made to comply with the requirements of this code for such division or group of occupancies. Subject to the approval of the building official, the use or occupancy of existing buildings shall be permitted to be changed and the building is allowed to be occupied for purposes in other groups without conforming to all the requirements of this code for those groups, provided the new or proposed use is less hazardous, based on life and fire risk, than the existing use.

3408A.2 Certificate of occupancy. A certificate of occupancy shall be issued where it has been determined that the requirements for the new occupancy classification have been met.

3408A.3 Stairways. An existing stairway shall not be required to comply with the requirements of Section 1009 where the existing space and construction does not allow a reduction in pitch or slope.

3408A.4 Seismic. When a change of occupancy results in a structure being reclassified to a higher risk category, the structure shall conform to the seismic requirements for a new structure of the higher risk category.

Exception: Specific seismic detailing requirements of Section 1613A for a new structure shall not be required to be met where the seismic performance is shown to be equivalent to that of a new structure. A demonstration of equivalence shall consider the regularity, overstrength, redundancy and ductility of the structure.

SECTION 3409A HISTORIC BUILDINGS

3409A.1 Historic buildings. The provisions of this code relating to the construction, repair, alteration, addition, restoration

and movement of structures, and change of occupancy shall not be mandatory for historic buildings where such buildings are judged by the building official to not constitute a distinct life safety hazard.

3409A.2 Flood hazard areas. Within flood hazard areas established in accordance with Section 1612A.3, where the work proposed constitutes substantial improvement as defined in Section 1612A.2, the building shall be brought into compliance with Section 1612A.

Exception: Historic buildings that are:

1. Listed or preliminarily determined to be eligible for listing in the National Register of Historic Places;
2. Determined by the Secretary of the U.S. Department of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined to qualify as an historic district; or
3. Designated as historic under a state or local historic preservation program that is approved by the Department of Interior.

SECTION 3410A MOVED STRUCTURES

3410A.1 Conformance. Structures moved into or within the jurisdiction shall comply with the provisions of this code for new structures.

SECTION 3411A ADDITIONS, ALTERATIONS, REPAIRS AND SEISMIC RETROFIT TO EXISTING BUILDINGS OR STRUCTURES DESIGNED IN ACCORDANCE WITH PRE-1973 BUILDING CODE

3411A.1 General. Provisions of this section shall apply to hospital buildings which were originally designed to pre-1973 building code and not designated as SPC 3 or higher in accordance with Chapter 6 of the California Administrative Code.

3411A.1.1 Incidental and minor structural alterations, additions or repairs. Incidental and minor structural additions shall be permitted provided the additions meet this code for new construction using importance factor, I_e , equal to or greater than 1.0. Alterations or repairs to the existing affected lateral load-resisting systems shall be made to conform to the requirements of Sections 3404A or 3405A respectively using importance factor, I_e , equal to or greater than 1.0.

3411A.1.1.1 Nonstructural components. Component importance factor, I_p , shall be permitted to be 1.0.

Exception: Components required for life-safety purposes after an earthquake, including emergency and standby power systems, fire protection sprinkler systems, fire alarm control panels, and egress stairways shall have a component importance factor (I_p) of 1.5.

3411A.1.2 Major structural alteration, additions or repairs. Major structural alterations, additions or repairs shall be in accordance with Section 3403A, 3404A or 3405A respectively.

SECTION 3412A

COMPLIANCE ALTERNATIVES FOR ADDITIONS, ALTERATIONS, REPAIRS AND SEISMIC RETROFIT TO EXISTING STRUCTURES

3412A.1 Adoption of ASCE 41. Except for the modifications as set forth in Sections 3412A and 3413A all additions, alterations, repairs and seismic retrofit to existing structures or portions thereof shall be permitted to be designed in accordance with the provisions of ASCE 41. For load combinations which do not include seismic forces, the new building code provisions of this code shall be applicable.

3412A.1.1 ASCE 41 Section 1.4 – Rehabilitation Objectives. Target building performance level shall be as follows:

- a. **For general acute care hospitals along with all structures required for their continuous operation or access/egress – Immediate Occupancy (IO) Structural Performance Level (S-1) as defined in Section 1.5.1.1 at Basic Safety Earthquake 1 (BSE-1) Seismic Hazard Level as defined in Section 1.6.1.2 and Collapse Prevention (CP) Structural performance level (S-5) per Section 1.5.1.5 at Basic Safety Earthquake 2 (BSE-2) Seismic Hazard Level as defined in Section 1.6.1.1. The nonstructural performance level shall satisfy the requirements of this code for new hospital buildings.**

Exceptions: Buildings satisfying requirements of Sections 3411A or 3412A.2.

- b. **For pre-1973 buildings which will not be used for general acute care services after January 1, 2030 – Basic Safety Objective (BSO) Level as defined in Section 1.4.1. BSO level includes Life Safety Building Performance (3-C) Level as defined in Section 1.5.3.3 at the Basic Safety Earthquake 1 (BSE-1) Seismic Hazard Level as defined in section 1.6.1.2 and Collapse Prevention (CP) building performance level (5-E) per Section 1.5.3.4 at the Basic Safety Earthquake 2 (BSE-2) Seismic Hazard Level as defined in Section 1.6.1.1.**

Exceptions: Buildings satisfying requirements of Sections 3411A or 3412A.2.

- c. **All others – Immediate Occupancy (IO) Building Performance Level of (1-B) as defined in Section 1.5.3.2 at Basic Safety Earthquake 1 (BSE-1) Seismic Hazard Level as defined in Section 1.6.1.2 and Collapse Prevention (CP) building performance level (5-E) per Section 1.5.3.4 at Basic Safety Earthquake 2 (BSE-2) Seismic Hazard Level as defined in Section 1.6.1.1.**

3412A.1.2 Material testing required. Use of material properties based on historical information as default values shall not be permitted.

3412A.1.3 Analysis procedure. The selection of a particular analysis procedure from ASCE 41 shall be subject to the approval of the enforcement agent.

3412A.1.4 Structural design criteria. Prior to implementation of ASCE 41 Nonlinear Dynamic Procedure, the ground motion, analysis and design methods, material assumptions and acceptance criteria proposed by the engineer shall be reviewed by the enforcement agent.

3412A.1.5 Structural observation, testing and inspections. Construction, testing, inspection and structural observation requirements shall be as required for new construction.

3412A.2 Seismic evaluation and retrofit of general acute care hospitals. Not notwithstanding any other requirements of this code, existing general acute care hospitals shall comply with the seismic evaluation requirements specified in Chapter 6, of the California Administrative Code, when applicable. Seismic retrofit to comply with requirements specified in Chapter 6 of the California Administrative Code shall be permitted to be in accordance with this section. For load combinations that do not include seismic forces, the new building provisions of this code shall be applicable.

3412A.2.1 SPC 5 and NPC 4/NPC 5. Structures and nonstructural components and systems satisfying the requirements of this code for new buildings for Risk Category IV shall be considered to satisfy the requirements of SPC 5 and NPC 4. NPC 4 buildings satisfying operational requirements for NPC 5 of Table 11.1, Chapter 6, of the California Administrative Code, shall be placed in nonstructural performance category NPC 5.

New general acute care hospitals and new building(s), larger than 4000 sq ft, required for general acute care services designed to requirements of this code shall be considered to satisfy the requirements of SPC 5 and NPC 5.

3412A.2.2 SPC 5 using ASCE 41. Structures satisfying the requirements of immediate occupancy structural performance level (S-1) in accordance with Section 1.5.1.1 of ASCE 41 at BSE-1, Collapse prevention performance level S-5 in accordance with Section 1.5.1.5 of ASCE 41 at BSE-2 and items identified in Chapter 6, Article 10 of the California Administrative Code, satisfying the requirements of Immediate Occupancy Nonstructural performance level (N-B) per Section 1.5.2.2 of ASCE 41 at BSE-1 shall be considered to comply with SPC 5 requirements of Table 2.5.3, Chapter 6, of the California Administrative Code.

3412A.2.3 SPC 2 using ASCE 41. Structures satisfying the requirements of life safety structural performance level (S-3) per Section 1.5.1.3 of ASCE 41 at BSE-1 and items identified in Chapter 6, Article 10, of the California Administrative Code satisfying the requirements of life safety nonstructural performance level (N-C) per Section 1.5.2.3 of ASCE 41 at BSE-1, shall be considered to comply with SPC 2 requirements of Table 2.5.3, Chapter 6, of the California Administrative Code.

3412A.2.4 NPC. Nonstructural components for immediate occupancy nonstructural performance level (N-B) in Section 1.5.2.2 shall meet the requirements of this code for new buildings. Nonstructural components for operational nonstructural performance level (NPC-5) in Section 1.5.2.1 shall meet performance level N-B and Section 3413A.1.30. Building satisfying the requirements of nonstructural performance level NPC and N-B as described in this section shall be considered to satisfy the requirements of NPC 5 & NPC 4 of Table 11.1, Chapter 6, of the California Administrative Code, respectively.

Immediate occupancy nonstructural performance level (N-B) in Section 1.5.2.2 and life safety nonstructural performance level (N-C) in Section 1.5.2.3 of ASCE 41 at BSE-1 shall be considered equivalent to NPC 3/NPC 2 and NPC 3R requirements respectively of Table 11.1, Chapter 6, of the California Administrative Code. For NPC 3/NPC 3R/NPC 2, only components listed in Table 11.1, Chapter 6, of the California Administrative Code for NPC 3/NPC 3R/NPC 2 need to satisfy the requirements specified above.

Exceptions:

- 1) Evaluation procedure in Article 11, Chapter 6, of the California Administrative Code shall be used for seismic evaluation of NPC 2, NPC 3/NPC 3R, NPC 4 and NPC 5, where specific procedure is not outlined in ASCE 41. Administrative and permitting provisions outlined in Article 11, Chapter 6, of the California Administrative Code shall apply.
- 2) Anchorage and bracing of nonstructural components in buildings in seismic performance categories SPC 1 and SPC 2 with a performance level of NPC 3R shall be permitted to comply with the provisions of Section 1630A of the 1995 California Building Code using an importance factor $I_p = 1.0$. The capacity of welds, anchors and fasteners shall be determined in accordance with requirements of this code.
- 3) Anchorage and bracing of nonstructural components in buildings in seismic performance categories SPC 1 or SPC 2 with a performance level of NPC 3 or higher, and SPC 3 or SPC 4, shall be permitted to comply with the provisions of Section 1630B of the 1998 California Building Code using an importance factor $I_p = 1.5$. The capacity of welds, anchors and fasteners shall be determined in accordance with requirements of this code.

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 loads where they control the design of the elements or their connections. Increases in F_p due to anchorage conditions (for example shallow anchors) need not be considered. For NPC 3R, the adequacy of load path for nonstructural elements need only be verified when the total reaction at the point of support (including the application of F_p) exceeds the following limits:

1. 250 pounds for components or equipment attached to light frame walls. For the purposes of this require-

ment, the sum of the absolute value of all reactions due to component loads on a single stud shall not exceed 250 pounds.

2. 1,000 pounds for components or equipment attached to roofs, or walls of reinforced concrete or masonry construction.
3. 2,000 pounds for components or equipment attached to floors or slabs-on-grade.

Exception: If the anchorage or bracing is configured in a manner that results in significant torsion on a supporting structural element, the effects of the nonstructural reaction force on the structural element shall be considered in the anchorage design.

SECTION 3413A MODIFICATIONS TO ASCE 41

3413A.1 General. The text of ASCE 41 shall be modified as indicated in Sections 3413A.1.1 through 3413A.1.32.

3413A.1.1 ASCE 41 Section 1.1. Modify ASCE 41 Section 1.1 with the following:

Seismic evaluations shall be performed using procedure and criteria of ASCE 41 except for general acute care hospitals, which shall be evaluated per Chapter 6, of the California Administrative Code. when required per provisions of that chapter.

3413A.1.2 ASCE 41 Section 1.6 Seismic Hazard. Modify ASCE 41 Section 1.6 with the following:

Response spectra and acceleration time histories shall be constructed in accordance with Sections 1613A, 1616A, and 1803A.6. Basic Safety Earthquake 2 (BSE-2) in ASCE 41 shall be same as Maximum Considered Earthquake (MCE) in ASCE 7. Basic Safety Earthquake 1 (BSE-1) shall be two-thirds of BSE-2.

3413A.1.3 ASCE 41 Section 2.2.6. Modify ASCE 41 Section 2.2.6 with the following:

Data collection requirements. The extent of data collection shall be at Comprehensive level for all structures except that data collection at Usual level shall be permitted for structures with BSO or lower target performance objective. Materials properties testing program shall be pre-approved by the enforcement agent.

Tension testing of reinforcing bars shall be in accordance with ASTM A 370 Annex A9. All test specimens shall be the full section of the bar as rolled (8-in. gage length) and shall not be reduced.

Structural members, slabs and walls shall be repaired equivalent to their original condition at test sample locations.

For buildings, built under an OSHPD permit based on the 1976 or later edition of the CBC, where materials properties are shown on design drawings and original materials test data are available, no materials testing shall be required when approved by the enforcement agent.

3413A.1.4 ASCE 41 Section 2.4.1.1. Modify ASCE 41 Section 2.4.1.1 with the following:

1. If one or more component DCRs exceed 1.5 for the Immediate Occupancy Structural Performance Level (S-1) or 2.0 for the Life Safety Structural Performance level (S-3) and any irregularity described in Section 2.4.1.1.1 through 2.4.1.1.4 is present, then linear procedures are not applicable and shall not be used.
2. Linear procedures are not applicable to moment resisting frames where plastic hinges do not form in either the beam at the face of column or in the column panel zone.

3413A.1.5 ASCE 41 Section 2.4.2.1. Modify ASCE 41 Section 2.4.2.1 with the following:

Nonlinear static procedure. If higher mode effects are significant and building is taller than 75 feet above the base, the Nonlinear Dynamic Procedure shall be used.

3413A.1.6 ASCE 41 Section 2.4.4.5. Modify ASCE 41 Section 2.4.4.5 by the following:

Material properties. Expected material properties are not permitted to be determined by multiplying lower bound values by the assumed factors specified in Chapters 5 through 8.

3413A.1.7 ASCE 41 Section 3.2.10.1. Modify ASCE 41 Section 3.2.10.1 with the following:

Linear procedures. Equation 3-5 is not permitted by OSHPD.

3413A.1.8 ASCE 41 Section 3.3.1.3.5. Replace ASCE 41 Section 3.3.1.3.5 as follows:

Unreinforced masonry buildings. Unreinforced Masonry not permitted by OSHPD.

3413A.1.9 ASCE 41 Section 3.3.3.2.2. Modify ASCE 41 Section 3.3.3.2.2 with the following:

Simplified NSP Analysis. Not permitted by OSHPD.

3413A.1.10 ASCE 41 Section 3.4.2.2. Modify ASCE 41 Section 3.4.2.2 with the following:

Acceptance criteria for linear procedures – drift limitations. The interstory drift ratio shall not exceed the drift limits for Risk Category IV buildings in ASCE 7 Table 12.12-1 due to forces corresponding to BSE-1, except that buildings designed to BSO or lower performance levels are permitted to meet the drift limits for Risk Category II buildings. For dual systems, the least interstory drift ratio shall control.

Exception: Larger interstory drift ratios shall be permitted where justified by rational analysis that both structural and nonstructural elements can tolerate such drift and approved by the enforcement agent.

3413A.1.11 ASCE 41 Section 3.4.3.2.1. Modify ASCE 41 Section 3.4.3.2.1 with the following:

Deformation-controlled actions. For any building required to meet the Operational Building Performance level, 1-A or Immediate Occupancy Building Perfor-

mance Level, 1-B, primary components shall be within the acceptance criteria for primary components and secondary components shall be within the acceptance criteria for secondary components.

3413A.1.12 ASCE 41 Section 4.4. Modify ASCE 41 Section 4.4 with the following:

Foundation strength and stiffness. Foundation and soil strength shall be used to evaluate potential overturning, uplift and sliding for fixed base assumptions, and stiffness for flexible base assumptions, including deformations associated with those actions.

3413A.1.13 ASCE 41 Section 4.4.1.1. Replace ASCE 41 Section 4.4.1.1 as follows:

Presumptive capacities. Not permitted by OSHPD.

3413A.1.14 ASCE 41 Section 4.4.1.2. Replace ASCE 41 Section 4.4.1.2 as follows:

Prescriptive expected capacities. Not permitted by OSHPD.

3413A.1.15 ASCE 41 Section 4.4.3.2.2. Modify ASCE 41 Section 4.4.3.2.2 with the following:

Flexible base assumption. The soil strength shall be evaluated.

3413A.1.16 ASCE 41 Section 4.5. Modify ASCE 41 Section 4.5 with the following:

Seismic earth pressure. Where the grade difference from one side of the building to another exceeds one-half story height, the seismic increment of earth pressure shall be added to the gravity lateral earth pressure to evaluate the building overturning and sliding stability and the lateral force resisting system below grade in combination with the building seismic forces.

3413A.1.17 ASCE 41 Table 5.6. Modify ASCE 41 Table 5.6 with the following:

Acceptance criteria for nonlinear procedures—structural steel components. For fully and partially restrained moment connections designed to 1989 or prior edition of the California Building Code shall be verified for the presence of welds using E70T-4 electrodes or other electrodes with equivalent aluminum content. Where E70T-4 or equivalent electrodes are present, the plastic rotation angles and residual strength ratios used shall be substantiated by the statistical analysis of three or more applicable cyclic test results subject to the approval of the enforcement agent.

3413A.1.18 ASCE 41 Section 6.7.1.1. Modify ASCE 41 Section 6.7.1.1 with the following:

Monolithic reinforced concrete shear walls and wall segments. For nonlinear procedures, shear walls or wall segments with axial loads greater than $0.35 P_o$ shall be included in the model as primary elements with appropriate strength and stiffness degrading properties assigned to those components subject to the approval of the enforcement agent. For linear procedures, the effects of deformation compatibility shall be investigated using moment-curvature section analyses and cyclic testing

results of similar components to determine whether strengthening is necessary to maintain the gravity load carrying capacity of that component.

Horizontal wall segments or spandrels reinforced similar to vertical wall segments or piers shall be classified as wall segments, not shear wall coupling beams, in Tables 6-18 through 6-21.

3413A.1.19 ASCE 41 Section 7.3.2. Replace ASCE 41 Section 7.3.2 as follows:

Unreinforced masonry walls and piers in-plane. Not permitted by OSHPD.

3413A.1.20 ASCE 41 Section 7.3.3. Replace ASCE 41 Section 7.3.3 as follows:

Unreinforced masonry walls out-of-plane. Not permitted by OSHPD.

3413A.1.21 ASCE 41 7.3.4.2.2 Shear strength of walls and piers. Modify ASCE 41 Section 7.3.4.2.2 with the following:

The spacing of shear reinforcing, S , shall be less than or equal to the wall pier clear height divided by 2 or the story height divided by 2, whichever is smaller.

3413A.1.22 ASCE 41 Section 9.2.4. Modify ASCE 41 Section 9.2.4 with the following:

Linear procedures. Verification of the interstory lateral displacements, isolator displacements, the strength adequacy of the seismic force resisting system and isolation system, and anchorage to the foundation shall be accomplished using the nonlinear dynamic procedure.

3413A.1.23 ASCE 41 Section 9.2.5.1. Modify ASCE 41 Section 9.2.5.1 with the following:

Nonlinear static procedure. Verification of the interstory lateral displacements, isolator displacements, the strength adequacy of the seismic force resisting system and isolation system, and anchorage to the foundation shall be accomplished using the nonlinear dynamic procedure.

3413A.1.24 Reserved.

3413A.1.25 Reserved.

3413A.1.26 ASCE 41 Section 9.3.4. Modify ASCE 41 Section 9.3.4 with the following:

Linear Procedures. Verification of the interstory lateral displacements, damper relative velocities and displacements, the strength adequacy of the seismic force resisting system and damping system, and anchorage to the foundation shall be accomplished using the nonlinear dynamic procedure.

3413A.1.27 ASCE 41 Section 9.3.5.1. Modify ASCE 41 Section 9.3.5.1 with the following:

Nonlinear static procedure. Verification of the interstory lateral displacements, damper relative velocities and displacements, the strength adequacy of the seismic force resisting system and damping system, and anchorage to the foundation shall be accomplished using the nonlinear dynamic procedure.

3413A.1.28 Reserved.

3413A.1.29 ASCE 41 Chapter 10. Replace ASCE 41 Chapter 10 as follows:

Simplified rehabilitation. Not permitted by OSHPD.

3413A.1.30 ASCE 41 Section 11.3.2. Modify ASCE 41 Section 11.3.2 with the following:

Operational nonstructural performance level (NPC-5) requirements. All Structures shall meet immediate occupancy nonstructural performance level (N-B) and facility shall have on-site supplies of water and holding tanks for sewage and liquid waste, sufficient to support 72 hours emergency operations, are integrated into the building plumbing systems in accordance with the California Plumbing Code. An on-site emergency system as defined in the California Electrical Code is incorporated into the building electrical system for critical care areas. Additionally, the system shall provide for radiological service and an onsite fuel supply for 72 hours of acute care operation.

3413A.1.31 ASCE 41 Section 11.9.4.3.1. Modify ASCE 41 Section 11.9.4.3.1 with the following:

Ceilings in all categories shall satisfy requirements for ceilings in Category C specified in this section.

3413A.1.32 ASCE 41 Section 11.10.2.4. Modify ASCE 41 Section 11.10.2.4 by the following:

For general acute care hospital, nonstructural evaluation shall comply with requirements of Section 11.2, Chapter 6 of the California Administrative Code.

SECTION 3414A PEER REVIEW REQUIREMENTS

3414A.1 General. Independent peer review is an objective technical review by knowledgeable reviewer(s) experienced in structural design, analysis and performance issues involved. The reviewer(s) shall examine the available information on the condition of building, basic engineering concept employed and recommendations for action.

3414A.2 Timing of independent review. The independent reviewer(s) shall be selected prior to initiation of substantial portion of the design and analysis work that is to be reviewed, and review shall start as soon as practical and sufficient information defining the project is available.

3414A.3 Qualifications and terms of employment. The reviewer shall be independent from the design and construction team.

3414A.3.1 The reviewer(s) shall have no other involvement in the project before, during or after the review, except in a review capacity.

3414A.3.2 The reviewer shall be selected and paid by owner and shall have technical expertise in repair of buildings similar to the one being reviewed, as determined by enforcement agent.

3414A.3.3 The reviewer (in case of review team, the chair) shall be a California-licensed structural engineer who is

familiar with technical issues and regulations governing the work to be reviewed.

3414A.3.4 The reviewer shall serve through completion of the project and shall not be terminated except for failure to perform the duties specified herein. Such termination shall be in writing with copies to enforcement agent, owner, and the engineer of record. When a reviewer is terminated or resigns, a qualified replacement shall be appointed within 10 working days.

3414A.4 Scope of review. Review activities shall include, where appropriate, available construction documents, design criteria, observation of the condition of structure, all new and original inspection reports, including methods of sampling, analyses prepared by the engineer of record and consultants, and the retrofit or repair design. Review shall include consideration of the proposed design approach, method, materials and details.

3414A.5 Reports. The reviewer(s) shall prepare a written report to the owner and responsible enforcement agent that covers all aspect of the review performed including conclusions reached by the reviewer. Report shall be issued after the schematic phase, during design development, and at the completion of construction documents, but prior to their issuance of permit. Such report shall include, at the minimum, statement of the following.

1. Scope of engineering design peer review with limitations defined.
2. The status of the project documents at each review stage.
3. Ability of selected materials and framing systems to meet the performance criteria with given loads and configuration.
4. Degree of structural system redundancy and the deformation compatibility among structural and nonstructural elements.
5. Basic constructability of the retrofit or repair system.
6. Other recommendation that will be appropriate for the specific project.
7. Presentation of the conclusions of the reviewer identifying any areas that need further review, investigation and/or clarification.
8. Recommendations.

3414A.6 Responses and corrective actions. The engineer of record shall review the report from the reviewer(s) and shall develop corrective actions and other responses as appropriate. Changes observed during construction that affect the seismic-resisting system shall be reported to the reviewer in writing for review and recommendations. All reports, responses and corrective actions prepared pursuant to this section shall be submitted to the responsible enforcement agent and the owner along with other plans, specifications and calculations required. If the reviewer resigns or is terminated by the owner prior to completion of the project, then the reviewer shall sub-

mit copies of all reports, notes, and the correspondence to the responsible enforcement agent, the owner, and the engineer of record within 10 working days of such termination.

SECTION 3415A EARTHQUAKE MONITORING INSTRUMENTS FOR EXISTING BUILDINGS

3415A.1 Earthquake recording instrumentation of existing buildings. All owners of existing structures, selected by the enforcement agency for the installation of earthquake-recording instruments, shall provide space for the installation and access to such instruments. Location of said instruments shall be determined by the enforcement agency. The enforcement agency shall make arrangements to provide, maintain, and service the instruments. Data shall be the property of the enforcement agency, but copies of individual records shall be made available to the public on request and the payment of an appropriate fee.

SECTION 3416A COMPLIANCE ALTERNATIVES FOR SERVICES/SYSTEMS AND UTILITIES

3416A.1 General. The provisions of this section are intended to maintain or increase the current degree of public safety, health and general welfare in existing buildings while permitting repair, alteration, addition and change of occupancy without requiring full compliance with Chapters 2 through 33, or Sections 3401A.3, and 3403A through 3408A, except where compliance with other provisions of this code is specifically required in this section.

Services/systems and utilities that originate in and pass through or under buildings and are necessary to the operation of an acute care hospital, skilled nursing facility, intermediate care facility or correctional treatment center shall meet the structural requirements of this section. Examples of services/systems and utilities include but are not limited to normal power; emergency power; nurse call; fire alarm; communication and data systems; space-heating systems; process load systems; cooling systems; domestic hot and cold water systems; means of egress systems; fire-suppression systems; building drain and sewer systems; and medical gas systems that support basic and supplemental services.

After January 1, 2030, services/systems and utilities for acute care hospital buildings shall not originate in or pass through or under a nonhospital or Hospital building unless it has approved performance categories of SPC-3 or higher and NPC-5.

3416A.1.1 Services/systems and utilities. Services/systems and utilities that are necessary to the operation of an acute care hospital, skilled nursing facility, intermediate care facility, or correctional treatment center shall meet the structural requirements of this section, based upon the approved Structural Performance Category (SPC) of the building receiving the services/systems and utilities.

Services from an acute care hospital, skilled nursing facility or a correctional treatment center shall be permitted to serve a nonconforming building with prior approval of the Office. The services/systems and utilities in the nonconforming building shall be equipped with fail safe valves, switches or other equivalent devices that allow the nonconforming building to be isolated from the acute care hospital buildings.

Exception: Remodel projects that use available existing services/systems and utilities are exempted from the requirements of this section. The enforcing agency shall be permitted to exempt minor addition, minor alteration, and minor remodel projects and projects to upgrade existing services/systems and utilities from the requirements of this section.

3416A.1.1.1 Services/systems and utilities for hospital buildings.

3416A.1.1.1.1 New buildings, additions, alterations, and remodels of conforming (SPC-3, -4, or -5) hospital buildings. Services/systems and utilities for new buildings and additions, and alterations or remodels to existing conforming buildings shall originate in hospital buildings that have approved performance categories of SPC-3 or higher and NPC-4 or higher. The services/systems and utilities shall not pass through or under buildings that do not have approved performance categories of SPC-2 or higher and NPC-4 or higher.

Exception: Services/systems and utilities shall be permitted to pass through or under buildings that have approved nonstructural performance categories of NPC-3 or higher or NPC-2, provided that the building has an approved extension to the NPC-3 deadline. The services/systems and utilities feeding the new building addition, alteration, or remodel shall conform to the new building provisions of this code and shall be deemed by OSHPD to be free of adverse seismic interactions caused by potential failure of overhead or adjacent components.

3416A.1.1.1.2 Additions, alterations, and remodels of SPC-2 hospital buildings. Services/systems and utilities for additions, alterations, or remodels of SPC-2 hospital buildings shall be permitted to originate in and pass through or under SPC-2 or higher buildings that have an approved nonstructural performance category of NPC-3 or higher.

Exception: Services/systems and utilities shall be permitted to pass through or under buildings that have approved nonstructural performance categories of NPC-2, provided that the building has an approved extension to the NPC-3 deadline. Services/systems and utilities feeding the addition, alteration or remodel shall conform to the nonstructural bracing requirements for new buildings.

3416A.1.1.1.3 Alterations and remodels of SPC-1 hospital buildings. Services/systems and utilities for alterations or remodels of SPC-1 hospital buildings shall be permitted to originate in and pass through or under SPC-1 or higher buildings that have an approved nonstructural performance category of NPC-2 or higher.

3416A.1.1.1.4 Buildings without SPC/NPC ratings. When services/systems and utilities for new buildings, additions, alterations, or remodels pass through or under hospital buildings which would not otherwise require evaluation for an SPC rating, such buildings shall be evaluated in accordance with the requirements of Section 1.3, Chapter 6, California Administrative Code, to determine the appropriate ratings, or shall be shown to meet the structural requirements of these regulations for new hospital buildings. The services/systems and utilities feeding the new building addition, alteration, or remodel shall conform with new building provisions of this code and shall be deemed by OSHPD to be free of adverse seismic interactions caused by potential failure of overhead or adjacent components.

3416A.1.1.1.5 Buildings removed from acute-care hospital service. Services/systems and utilities for conforming acute care hospital buildings shall be permitted to pass through or under a building that has been removed from acute care hospital service until January 1, 2030 if the building removed from service meets the performance requirements of Section 3416A.1.1.1.1. Services/systems and utilities for nonconforming acute care hospital buildings shall be permitted to pass through or under a building that has been removed from acute care hospital service only if the building removed from service and meets the performance requirements of Section 3416A.1.1.1.2.

3416A.1.1.2 Services/systems and utilities for skilled nursing facilities, intermediate care facilities, and correctional treatment centers.

3416A.1.1.2.1 New buildings and additions. Services/systems and utilities for new buildings and additions shall not originate in or pass through or under nonconforming structures.

Exception: As an alternate to this section, skilled nursing and intermediate care facilities, and correctional treatment centers shall be permitted to meet the requirements in Section 3416A.1.1.1 for hospital buildings.

3416A.1.1.2.2 Alterations and remodels. Services/systems and utilities for alterations or remodels of existing buildings shall be permitted to pass through nonconforming structures, provided the new services/systems and utilities passing through the buildings are anchored and braced for seismic forces in accordance with these regulations for new buildings and are free of adverse seismic interactions caused by potential failure of overhead or adjacent components.

3416A.1.2 Jurisdiction. Services/systems and utilities for hospitals, skilled nursing facilities and intermediate-care facilities shall originate in and only pass through or under buildings that are under the jurisdiction of the Office of Statewide Health Planning and Development (OSHPD).

SECTION 3417A COMPLIANCE ALTERNATIVES FOR MEANS OF EGRESS

3417A.1 General. Means of egress through existing buildings shall be in accordance with Chapter 10 except as modified in this section.

3417A.1.1 Means of egress for hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers. Means of egress for acute care hospitals, skilled nursing facilities, intermediate care facilities and correctional treatment centers shall comply with the requirements of Sections 3417A.1.1.1 and 3417A.1.1.2.

Exception: The enforcing agency shall be permitted to exempt minor additions, minor alterations and minor remodel projects from these requirements.

3417A.1.1.1 Means of egress for hospital buildings. Means of egress for hospital buildings shall comply with the requirements of Sections 3417A.1.1.1 through 3417A.1.1.6.

3417A.1.1.1.1 New and existing conforming hospital buildings. Means of egress for new hospital buildings and additions to existing conforming hospital buildings shall only pass through buildings that comply with the requirements of SPC-3 or higher and NPC-4 or higher.

Exception: Existing means of egress that pass through hospital buildings that have approved nonstructural performance categories NPC-3, or NPC-2, if the building has an approved extension to the NPC-3 deadline, shall be permitted to remain for the duration of extension. The nonstructural components in the path of egress shall be braced in accordance with the new building provisions of this code.

3417A.1.1.1.2 Existing SPC-2 hospital buildings. Means of egress for additions to existing SPC-2 hospital buildings shall only pass through hospital buildings that have OSHPD-approved performance categories of SPC-2 or higher and NPC-4 or higher.

Exception: The means of egress shall be permitted to pass through hospital buildings that have approved nonstructural performance categories of NPC-3, or NPC-2 if the building has an approved extension to the NPC-3 deadline. Nonstructural components in the path of egress shall be braced in accordance with the new building provisions of this code.

3417A.1.1.1.3 Existing SPC-3 or higher hospital buildings. Means of egress for remodels of existing SPC-3 or higher hospital buildings shall only pass through hospital buildings that have approved perfor-

mance categories of SPC-2 or higher and NPC-4 or higher.

Exception: The means of egress shall be permitted to pass through hospital buildings that have approved nonstructural performance categories of NPC-3, or NPC-2 if the building has an approved extension to the NPC-3 deadline. Nonstructural components in the path of egress shall be braced in accordance with the new building provisions of this code.

3417A.1.1.1.4 Existing SPC-1 hospital buildings. Means of egress for remodels of existing SPC-1 hospital buildings shall only pass through hospital buildings that have approved performance categories of SPC-1 or higher and NPC-2 or higher.

Exception: Means of egress for acute care service spaces for hospitals licensed pursuant to subdivision (a) of Section 1250 of the Health and Safety Code shall comply with the requirements of Section 3417A.1.1.2.

3417A.1.1.1.5 Other nonconforming hospital buildings. Hospital buildings that would not otherwise require evaluation for an SPC rating, which are used as a part of the means of egress for acute care hospitals, shall be evaluated in accordance with the requirements of Section 1.3, Chapter 6, of the California Administrative Code to determine the appropriate rating, or shall meet the structural requirements of these regulations for conforming hospital buildings. Means of egress shall be in accordance with the requirements of Sections 3417A.1.1.1 through 3417A.1.1.4.

3417A.1.1.1.6 Buildings removed from hospital service. The means of egress for acute care hospitals shall be permitted to pass through buildings that are removed from hospital service only if the buildings remain under the jurisdiction of OSHPD, and only until January 1, 2030, subject to the following:

1. Egress for conforming hospital buildings shall be permitted to pass through buildings that have been removed from acute care hospital service that comply with the requirements of Section 3417A.1.1.1 or 3417A.1.1.3.
2. Egress for nonconforming hospital buildings shall be permitted to pass through buildings that have been removed from acute care hospital service that comply with the requirements of Section 3417A.1.1.2 or 3417A.1.1.4.

After January 1, 2030, the means of egress for acute care hospital buildings shall only pass through hospital buildings that have approved performance categories of SPC-3 or higher and NPC-5.

3417A.1.1.2 Means of egress for skilled nursing facilities, intermediate care facilities and correctional treatment centers. Means of egress for skilled nursing facilities, intermediate-care facilities and correctional treatment centers shall comply with the requirements of Sections 3417A.1.1.2.1 and 3417A.1.1.2.2.

3417A.1.1.2.1 New facilities or additions to existing facilities. Means of egress for new or additions to skilled nursing facilities, intermediate care facilities, or correctional treatment centers shall only pass through conforming buildings.

Exception: As an alternate, skilled nursing facilities, intermediate care facilities and correctional treatment centers shall be permitted to meet the egress requirements in Sections 3417A.1.1.1 through 3417A.1.1.5 for hospital buildings.

3417A.1.2 Jurisdiction. Means of egress for hospitals, skilled nursing facilities and intermediate-care facilities shall only pass through buildings that are under the jurisdiction of the Office of Statewide Health Planning and Development (OSHPD).

SECTION 3418A [OSHPD 1] REMOVAL OF HOSPITAL BUILDINGS FROM GENERAL ACUTE CARE SERVICES

3418A.1 General. The requirements of this section shall apply when general acute care services are completely removed from SPC buildings or when buildings are removed from OSHPD jurisdiction. All buildings that remain under the OSHPD jurisdiction, after one or more SPC buildings are removed, shall satisfy the requirements of the California Building Standards Code. Approval of construction documents and a building permit are required for removal of SPC Buildings from general acute care services or removal of buildings from OSHPD jurisdiction.

3418A.2 Definitions. The following words and terms are applicable to this section only:

BUILDING. The area included within surrounding exterior walls or any combination of exterior walls and fire walls (as described in Sections 202 and 706) exclusive of vent shafts and courts. Areas of the building not provided with surrounding walls shall be included in the building area if such areas are included within the horizontal projection of the roof or floor above. A building may consist of one or more adjacent SPC buildings.

GENERAL ACUTE CARE SERVICE. Means basic and supplemental services, as defined in Section 1224.3, provided in a general acute care hospital building, as defined in Section 1224.3 and the California Administrative Code, Chapter 6, Section 1.2.

> **SPC SEISMIC SEPARATION.** Means a building separation in accordance with the California Administrative Code, Chapter 6 Section 3.4.

STRUCTURAL SEPARATION. Means a building separation in accordance with this code.

3418A.3 Establishing eligibility for removal from general acute care service. In order to establish that one or more SPC buildings are eligible for removal from general acute care service, the hospital owner shall submit construction documents showing that after the SPC Buildings are removed from general acute care service:

1. All basic acute care services or supplemental services on the hospital's license are provided in SPC buildings

satisfying the requirements for SPC-2, SPC-3, SPC-4 or SPC-5.

Exception: If the hospital includes SPC-1 buildings that are not being removed from general acute care service, and these SPC-1 buildings have an approved extension to the SPC-2 deadline, basic acute care services or supplemental services on the hospital's license are permitted to remain in these SPC buildings for the duration of their extension or until these SPC-1 buildings are removed from general acute care service, whichever comes first.

2. All basic acute care services or supplemental services on the hospital's license are provided in SPC buildings satisfying the requirements for NPC-3, NPC-4 or NPC-5.

Exception: Services shall be permitted to be located in SPC buildings satisfying the requirements of NPC-2 if the SPC buildings has approved extension to NPC-3 deadline.

3. The hospital complies with all egress requirements, including occupant load, number of required exits and travel distance to exits, and provides evidence that no egress from any acute care hospital building passes through the SPC buildings removed from general acute care service, SPC-1 buildings, or through buildings not under OSHPD jurisdiction.

Exceptions:

1. If the SPC building has an approved extension to the SPC-2 deadline, existing egress through the SPC-1 building shall be permitted for the duration of the extension or until the SPC-1 building is removed from general acute care service, whichever comes first.
2. When permitted by Section 3417A.1.1.6.
4. No SPC building removed from general acute care service is used as a smoke compartment for any acute care hospital building. Buildings not under OSHPD jurisdiction shall not be used as a smoke compartment for any acute care hospital building.
5. Structural separation, fire barriers and fire walls shall satisfy the requirements of the California Building Standards Code.

Exception: An SPC seismic separation in accordance with the California Administrative Code Chapter 6 Section 3.4 shall be deemed to satisfy the building structural/seismic separation requirement in this section for SPC buildings that will remain under OSHPD jurisdiction.

6. If the SPC building removed from general acute care service shares a common fire alarm system with the acute care hospital, the main fire alarm control panel shall be located in an acute care hospital building. The SPC building removed from general acute care service shall be in a separate zone monitored by the main fire alarm control panel. Flexible connections shall be provided for conduits/conductors crossing structural or

SPC seismic separation joints. If the intent is to place the SPC building under local jurisdiction, the building shall satisfy Section 3418A.5.1

Exception: Flexible connections for fire alarm conduits/conductors crossing seismic separation joints and fail safe shut-off valves, and disconnects for utilities between an SPC building removed from general acute care service and adjacent SPC-1 or SPC-2 buildings may be omitted, provided the fire alarm and utilities in the adjacent SPC-1 and SPC-2 buildings have no connection to any SPC-3, SPC-4, and SPC-5 buildings providing general acute care service.

7. If the SPC building removed from general acute care service shares the fire sprinkler system with the acute care hospital, an isolation valve with a tamper switch shall be provided to isolate the portion of the system serving the SPC building removed from acute care service. Flexible connections shall be provided in piping that crosses structural or SPC seismic separation joints. The fire sprinkler system shall not originate in the SPC building removed from general acute care service. If the intent is to place the building under local jurisdiction, the building shall satisfy Section 3418A.5.1.
8. Patient access as required by Section 1224.4.7.5 does not pass through an SPC building removed from general acute care service or through buildings that are not under the jurisdiction of OSHPD.
9. The primary accessible entrance to the hospital is not through an SPC building removed from general acute care service or through buildings that are not under the jurisdiction of OSHPD.
10. No utilities servicing acute care hospital buildings originate in or pass through, over or under, an SPC building removed from general acute care service, except as permitted by Section 3416A.1.1.5, or a building not under OSHPD jurisdiction.
11. If utilities originating in an acute care hospital building feed an SPC building removed from general acute care hospital service, fail safe shut-off valves and/or disconnects shall be provided that permit isolation of the SPC building removed from general acute care service from the hospital utilities. Flexible connections shall be provided for all utilities crossing structural or SPC seismic separation joints.

Exception: Flexible connections for fire alarm conduits/conductors crossing seismic separation joints and fail safe shut-off valves, and disconnects for utilities between an SPC building removed from general acute care service and adjacent SPC-1 or SPC-2 buildings may be omitted, provided the fire alarm and utilities in the adjacent SPC-1 and SPC-2 buildings have no connection to any SPC-3, SPC-4, and SPC-5 buildings providing general acute care service.

3418A.4 Buildings intended to remain under OSHPD jurisdiction.

3418A.4.1 Qualifying nonacute care services. In order for a building to remain under OSHPD jurisdiction that is removed from general acute care service, it shall contain one or more qualifying services. Qualifying services include:

- a. Services considered "Outpatient Clinical Services" as defined in H&S § 129730 (a)
 - i. Administrative space
 - ii. Central sterile supply
 - iii. Storage
 - iv. Morgue and autopsy facilities
 - v. Employee dressing rooms and lockers
 - vi. Janitorial and housekeeping facilities
 - vii. Laundry
- b. Outpatient portions of the following services (with no more than 25 percent in-patient use), including but not limited to:
 - i. Surgical
 - ii. Chronic dialysis
 - iii. Psychiatry
 - iv. Rehabilitation, occupational therapy or physical therapy
 - v. Maternity
 - vi. Dentistry
 - vii. Chemical dependency
- c. Services that duplicate Basic Services, as defined in H&S §1250, or services that are provided as part of a Basic Service, but are not required for facility licensure (with no more than 25 percent in-patient use).

All hospital support services listed in Section 3418A.4.1 Item a that are located in an SPC building at the time general acute care services are removed may remain, provided the California Department of Public Health certifies to the Office that it has received and approved a plan that demonstrates how the health facility will continue to provide all basic services in the event of any emergency when the SPC building may no longer remain functional. This certification shall be submitted by hospital to the Office prior to approval of the application to remove the SPC building from general acute care service.

3418A.4.2 Maintaining existing nonacute care services under existing license. Existing approved nonacute care occupancies, or services, existing in the SPC building at the time it is removed from general acute care service shall be permitted to remain, and removal of the SPC building from general acute care service is not considered a change in occupancy. The enforcement agency shall be permitted to require evidence that the existing occupancies and services were in compliance at the time they were located in the SPC building. Any hospital support services located in the building removed

from general acute care service, including administrative services, central sterile supply, storage, morgue and autopsy, employee dressing rooms and lockers, janitorial and house-keeping service, and laundry, shall be in excess of the minimum requirements for licensure and operation. Prior approval by the California Department of Public Health shall be obtained by hospital to maintain these services in the SPC building removed from acute care service.

3418A.4.3 Change of licensed services under existing license. A change of service or function for all, or a portion, of the SPC building removed from general acute care service requires compliance with the current requirements for that service, including accessibility requirements in accordance with Chapter 11B.

3418A.4.3.1 Skilled nursing or acute psychiatric services. When general acute care services are removed from an SPC building which is intended to be used for skilled nursing or acute psychiatric services, and the new services will be licensed under the existing license of the general acute care hospital these new services shall comply with Section 3416A.1.1.1.5 for a nonconforming hospital building.

3418A.4.3.2 Outpatient clinical services. When general acute care services are removed from an SPC building that is intended to be used for outpatient clinical services under the existing acute care hospital license, the building is required to comply with the current OSHPD 3 code requirements for the new service.

3418A.4.4 SPC buildings removed from general acute care service with new license. When general acute care services are removed from an SPC building, and new services provided in the SPC building are issued an initial license, as determined by the California Department of Public Health, as a skilled nursing facility or acute psychiatric hospital, the SPC building shall comply with the new building code requirements or equivalent provisions of the California Building Standards code at the time of application.

3418A.4.5 Change of building occupancy or division. When an SPC building is removed from general acute care service with or without change of license, the new occupancy group and division of the building, and/or new service or function, shall be established. A new certificate of occupancy shall be required for the building removed from general acute care service.

3418A.5 Change in jurisdiction for buildings removed from general acute care service. Except as provided by Section 3418A.5.3, at the hospital's discretion, a building removed from general acute care service shall be permitted to be placed under the jurisdiction of the local enforcement agency. To be eligible for a change in jurisdiction, the building removed from general acute care service shall satisfy the requirements of Section 3418A.5.1.

3418A.5.1 Eligibility for change in jurisdiction. For a building removed from general acute care service to be eligible for a change in jurisdiction to the local enforcing agency, all the following criteria shall be satisfied:

- a. The building removed from general acute care service shall be freestanding, as defined in the California Administrative Code, Section 7-111.
- b. Any hospital support services located in the building removed from general acute care service, including administrative services, central sterile supply, storage, morgue and autopsy, employee dressing rooms and lockers, janitorial and house-keeping service, and laundry, shall be in excess of the minimum requirements for licensure and operation. Prior approval by the California Department of Public Health shall be obtained by hospital to locate these services in the building removed from general acute care service.
- c. Services/systems and utilities (e.g., power, emergency power, communication/data/nurse-call systems, space-heating systems, fire alarm system, fire-sprinkler system, medical gas and plumbing systems) shall be separate and independent from those serving any buildings under OSHPD jurisdiction.
- d. If the building being transferred to the jurisdiction of the local enforcing agency is adjacent to a building under OSHPD jurisdiction and fire resistive construction separations are required, they shall be located in the building under OSHPD jurisdiction.

3418A.5.2 Modification of buildings removed from OSHPD jurisdiction. The owner of the building shall be responsible for bringing the building into compliance with all requirements of the new authority having jurisdiction. If a building requires modification to become eligible for removal from OSHPD jurisdiction, the construction project shall be closed with compliance by OSHPD prior to the change in jurisdiction. All occupancy separation, set-back, and allowable area requirements shall be enforced.

3418A.5.3 Buildings not eligible for change in jurisdiction. The following freestanding buildings shall remain under OSHPD jurisdiction:

- a. Any building in which basic and/or supplementary services are provided for a general acute care hospital, acute psychiatric hospital and general acute care hospital providing only acute medical rehabilitation center services.
- b. Any building that provides required patient access, egress, or smoke compartment for a building under OSHPD's jurisdiction.
- c. Any building in which services under OSHPD jurisdiction are provided, including skilled nursing services, intermediate care services, acute psychiatric services, and distinct part skilled nursing or intermediate care services.
- d. Any building providing central plant or utility services to a building under OSHPD jurisdiction.
- e. Any building through which utilities pass through, over or under, to serve a building under OSHPD jurisdiction.

3418A.6 Vacant space. With the removal of general acute care services, the vacated space must be reclassified with an intended occupancy as required under Section 302. If the hospital determines that the building or space in the SPC building removed from general acute care service will be vacant, the hospital shall demonstrate that unsafe conditions as described in Section 116.1 are not created.

3418A.7 Demolition. Demolition of SPC buildings to be removed from general acute care services shall be permitted when buildings remaining under OSHPD's jurisdiction, after demolition, satisfy the requirements of the California Building Standards Code and demolition activity does not impair the operation and/or safety of any buildings that remain under OSHPD's jurisdiction. Demolition shall be in accordance with Section 3303.

SECTION 3419A [OSHPD 1]
HOSPITAL BUILDINGS REMOVED
FROM GENERAL ACUTE CARE SERVICES

3419A.1 General. The requirements of this section shall apply to buildings removed from general acute care services that remain under OSHPD jurisdiction.

3419A.2 Non-GAC buildings. Non-GAC buildings shall conform to the requirements of Section 1.10.1.

3419A.3 Freestanding buildings. Application and enforcement of freestanding buildings removed from general acute care services but remaining under OSHPD jurisdiction shall be in accordance with Section 1.10.

Freestanding hospital-owned clinics shall be permitted to be under the jurisdiction of OSHPD in accordance with California Administrative Code Sections 7-2104, 7-2105, and 7-2106.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 35 – REFERENCED STANDARDS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
 See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt entire chapter | X | | | | | | | | X | X | X | X | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | X | X | X | X | | X | X | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | X | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| AAMA 501.4-09 | | | | | | | X | X | | | | | | | | | | | |
| AAMA 501.6-09 | | | | | | | X | X | | | | | | | | | | | |
| ACI | | | | | | | X | X | | | | | | | | | | | |
| AF & PA | | | | | | | X | X | | | | | | | | | | | |
| AISC | | | | | | | X | X | | | | | | | | | | | |
| AISI | | | | | | | X | X | | | | | | | | | | | |
| AITC | | | | | | | X | X | | | | | | | | | | | |
| ANSI | | | | | | X | | | | | | | | | | | | | |
| ANSI-S3.4.1 | | | | | | X | | | | | | | | | | | | | |
| ANSI/SDI-C-2012 | | | | | | X | X | X | | | | | | | | | | | |
| ASCE/SEI | | | | | | | X | X | | | | | | | | | | | |
| ASME | | | | | | X | | | | | | | | | | | | | |
| ASME A17.1/CSA B44-07 | | X | | | | X | | | | | | | | | | | | | |
| ASME A17.1A/CSA B44A-08 | | | | | | | X | | | | | | | | | | | | |
| ASME A18.1-2008 | | | | | | | X | | | | | | | | | | | | |
| ASME BPE-2009 | | X | | | | | | | | | | | | | | | | | |
| ASTM | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 114-10 | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1157/C 1157M-11 | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1240-11 | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1249-06a (2011) | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1260-07 | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1293-08b | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1392-00 (2009) | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1394-03 (2008) | | | | | | | X | X | | | | | | | | | | | |
| ASTM C 1401-09a | | | | | | | X | X | | | | | | | | | | | |
| ASTM D 1586-11 | | | | | | | X | X | | | | | | | | | | | |
| ASTM D 3441-05 | | | | | | | X | X | | | | | | | | | | | |
| ASTM D 3966-07 | | | | | | | X | X | | | | | | | | | | | |
| ASTM E 648-04 | | X | | | | | | | | | | | | | | | | | |
| ASTM E 662-09 | | X | | | | | | | | | | | | | | | | | |
| ASTM F 1292-99 | | | | | | | X | | | | | | | | | | | | |
| ASTM F 1292-04 | | | | | | | X | | | | | | | | | | | | |
| ASTM F 1487-01 | | | | | | | X | | | | | | | | | | | | |
| ASTM F 1951-99 | | | | | | | X | | | | | | | | | | | | |
| AWPA | | | | | | | | X | X | | | | | | | | | | |
| AWS | | | | | | | | X | X | | | | | | | | | | |
| BHMA | | | | | | | X | | | | | | | | | | | | |
| BHMA A156.10-2011 | | | | | | | X | | | | | | | | | | | | |
| BHMA A156.19-2007 | | | | | | | X | | | | | | | | | | | | |
| CPSC | | | | | | | | | | | | | | | | | | | |
| FEMA 352-00 | | | | | | | | X | X | | | | | | | | | | |
| FM 1950-10 | | | | | | | | X | X | | | | | | | | | | |
| FM 3260-00 | | X | | | | | | | | | | | | | | | | | |

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CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 35 – REFERENCED STANDARDS—continued

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DHS | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | | | | | | | X | X | X | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | X | X | X | X | | X | X | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | X | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| FM3011-99 | | X | | | | | | | | | | | | | | | | | | |
| FM4430-12 | | X | | | | | | | | | | | | | | | | | | |
| FM4430-80 | | X | | | | | | | | | | | | | | | | | | |
| ICC | | | | | | X | X | | | | | | | | | | | | | |
| ICC ES AC 331 | | X | | | | | | | | | | | | | | | | | | |
| ICC ES AC 77 | | X | | | | | | | | | | | | | | | | | | |
| ISO 9001-08 | | | | | | X | X | | | | | | | | | | | | | |
| ISO 17025-05 | | | | | | X | X | | | | | | | | | | | | | |
| NFPA | | | | | | X | X | X | | | | | | | | | | | | |
| NFPA 11-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 13-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 13D-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 13R-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 14-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 15-12 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 17-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 17A-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 20-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 22-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 24-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 31-11 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 37-10 | | | | | | | | | | | | | | | | | | | | |
| NFPA 52-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 54-12 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 61-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 72-13 | | X | | | | X | | | | | | | | | | | | | | |
| NFPA 92-12 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 99-12 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 211-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 259-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 275-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 285-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 288-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 289-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 409-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 502-14 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 654-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 703-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 720-12 | | | X | X | X | | | | | | | | | | | | | | | |
| NFPA 1124-13 | | X | | | | | | | | | | | | | | | | | | |
| NFPA 2001-12 | | X | | | | | | | | | | | | | | | | | | |
| PCI | | | | | | X | X | | | | | | | | | | | | | |
| PTI | | | | | | | X | X | | | | | | | | | | | | |
| SFM 12-3 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7-3 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7A-1 | | X | | | | | | | | | | | | | | | | | | |

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CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 35 – REFERENCED STANDARDS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
 See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt entire chapter | X | | | | | | | | X | X | X | X | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | X | X | X | X | | | X | X | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | X | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| AAMA 501.4-09 | | | | | | | | | X | X | | | | | | | | | |
| AAMA 501.6-09 | | | | | | | | | X | X | | | | | | | | | |
| ACI | | | | | | | | | X | X | | | | | | | | | |
| AF & PA | | | | | | | | | X | X | | | | | | | | | |
| AISC | | | | | | | | | X | X | | | | | | | | | |
| AISI | | | | | | | | | X | X | | | | | | | | | |
| AITC | | | | | | | | | X | X | | | | | | | | | |
| ANSI | | | | | | | X | | | | | | | | | | | | |
| ANSI-S3.4.1 | | | | | | | X | | | | | | | | | | | | |
| ANSI/SDI-C-2012 | | | | | | | X | X | X | | | | | | | | | | |
| ASCE/SEI | | | | | | | | | X | X | | | | | | | | | |
| ASME | | | | | | | X | | | | | | | | | | | | |
| ASME A17.1/CSA B44-07 | | X | | | | | X | | | | | | | | | | | | |
| ASME A17.1A/CSA B44A-08 | | | | | | | X | | | | | | | | | | | | |
| ASME A18.1-2008 | | | | | | | X | | | | | | | | | | | | |
| ASME BPE-2009 | | X | | | | | | | | | | | | | | | | | |
| ASTM | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 114-10 | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1157/C 1157M-11 | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1240-11 | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1249-06a (2011) | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1260-07 | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1293-08b | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1392-00 (2009) | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1394-03 (2008) | | | | | | | | | X | X | | | | | | | | | |
| ASTM C 1401-09a | | | | | | | | | X | X | | | | | | | | | |
| ASTM D 1586-11 | | | | | | | | | X | X | | | | | | | | | |
| ASTM D 3441-05 | | | | | | | | | X | X | | | | | | | | | |
| ASTM D 3966-07 | | | | | | | | | X | X | | | | | | | | | |
| ASTM E 648-04 | | X | | | | | | | | | | | | | | | | | |
| ASTM E 662-09 | | X | | | | | | | | | | | | | | | | | |
| ASTM F 1292-99 | | | | | | | | X | | | | | | | | | | | |
| ASTM F 1292-04 | | | | | | | | | X | | | | | | | | | | |
| ASTM F 1487-01 | | | | | | | | | X | | | | | | | | | | |
| ASTM F 1951-99 | | | | | | | | | X | | | | | | | | | | |
| AWPA | | | | | | | | | X | X | | | | | | | | | |
| AWS | | | | | | | | | X | X | | | | | | | | | |
| BHMA | | | | | | | | | X | | | | | | | | | | |
| BHMA A156.10-2011 | | | | | | | | | X | | | | | | | | | | |
| BHMA A156.19-2007 | | | | | | | | | X | | | | | | | | | | |
| CPSC | | | | | | | | | | | | | | | | | | | |
| FEMA 352-00 | | | | | | | | | X | X | | | | | | | | | |
| FM 1950-10 | | | | | | | | | X | X | | | | | | | | | |
| FM 3260-00 | | | X | | | | | | | | | | | | | | | | |

(continued)

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 35 – REFERENCED STANDARDS—continued

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DHS | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | | | | | | | X | X | X | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | X | X | X | X | | | X | X | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | X | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| FM3011-99 | | | X | | | | | | | | | | | | | | | | | |
| FM4430-80 | | | X | | | | | | | | | | | | | | | | | |
| ICC | | | | | | | | | X | X | | | | | | | | | | |
| ICC ES AC 331 | | | X | | | | | | | | | | | | | | | | | |
| ICC ES AC 77 | | | X | | | | | | | | | | | | | | | | | |
| ISO 9001-08 | | | | | | | | | X | X | | | | | | | | | | |
| ISO 17025-05 | | | | | | | | | X | X | | | | | | | | | | |
| NFPA | | | | | | | | | X | X | X | | | | | | | | | |
| NFPA 11-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 13-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 13D-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 13R-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 14-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 15-12 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 17-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 17A-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 20-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 22-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 24-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 31-11 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 37-10 | | | | | | | | | | | | | | | | | | | | |
| NFPA 52-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 54-12 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 61-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 72-13 | | | X | | | | X | | | | | | | | | | | | | |
| NFPA 92a-12 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 211-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 259-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 275-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 285-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 288-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 289-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 409-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 654-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 703-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 720-12 | | | | X | X | X | | | | | | | | | | | | | | |
| NFPA 1124-13 | | | X | | | | | | | | | | | | | | | | | |
| NFPA 2001-12 | | | X | | | | | | | | | | | | | | | | | |
| PCI | | | | | | | | | X | X | | | | | | | | | | |
| PTI | | | | | | | | | X | X | | | | | | | | | | |
| SFM 12-3 | | | X | | | | | | | | | | | | | | | | | |
| SFM 12-7-3 | | | X | | | | | | | | | | | | | | | | | |
| SFM 12-7A-1 | | | X | | | | | | | | | | | | | | | | | |

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CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 35 – REFERENCED STANDARDS—continued

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DHS | AGR | DWR | CEC | CA | SL | SLC |
|---|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | X | | | | | | | | X | X | X | X | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | X | X | X | X | | X | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | X | | | | | | | | | | | | | |
| Chapter / Section | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7A-2 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7A-3 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7A-4 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7A-4A | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-7A-5 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-8-100 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-10-1 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-10-2 | | X | | | | | | | | | | | | | | | | | | |
| SFM 12-10-3 | | X | | | | | | | | | | | | | | | | | | |
| TMS | | | | | | | | | X | X | | | | | | | | | | |
| UBC 15-2 | | X | | | | | | | | | | | | | | | | | | |
| UBC 15-3 | | X | | | | | | | | | | | | | | | | | | |
| UBC 15-4 | | X | | | | | | | | | | | | | | | | | | |
| UL 13-96 | | X | | | | | | | | | | | | | | | | | | |
| UL 38-99 | | X | | | | | | | | | | | | | | | | | | |
| UL 193-04 | | X | | | | | | | | | | | | | | | | | | |
| UL 199-95 | | X | | | | | | | | | | | | | | | | | | |
| UL 217-06 | | X | | | | | | | | | | | | | | | | | | |
| UL 228-97 | | X | | | | | | | | | | | | | | | | | | |
| UL 260-04 | | X | | | | | | | | | | | | | | | | | | |
| UL 262-04 | | X | | | | | | | | | | | | | | | | | | |
| UL 268A-98 | | X | | | | | | | | | | | | | | | | | | |
| UL 312-04 | | X | | | | | | | | | | | | | | | | | | |
| UL 346-05 | | X | | | | | | | | | | | | | | | | | | |
| UL 464-03 | | X | | | | | | | | | | | | | | | | | | |
| UL 497B-04 | | X | | | | | | | | | | | | | | | | | | |
| UL 521-99 | | X | | | | | | | | | | | | | | | | | | |
| UL 539-00 | | X | | | | | | | | | | | | | | | | | | |
| UL 632-00 | | X | | | | | | | | | | | | | | | | | | |
| UL 753-04 | | X | | | | | | | | | | | | | | | | | | |
| UL 813-96 | | X | | | | | | | | | | | | | | | | | | |
| UL 864-03 | | X | | | | | | | | | | | | | | | | | | |
| UL 2034 | | | | X | X | X | | | | | | | | | | | | | | |
| UL 2075 | | | | X | X | X | | | | | | | | | | | | | | |

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.



CHAPTER 35

REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in *Chapter 1, Scope and Administration, Division 1, Sections 1.1.5 and 1.1.7, and in Chapter 1, Scope and Administration, Division II, Section 102.4.*

[DSA-SS, DSA-SS-CC & OSHPD 1 & 4] Reference to other chapters. In addition to the code sections referenced, the standards listed in this chapter are applicable to the respective code sections in Chapters 16A, 17A, 18A, 19A, 21A, 22A and 34A.

AA

Aluminum Association
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| ADM1—05 | Aluminum Design Manual: Part 1 A Specification for Aluminum Structures, Allowable Stress Design; and Part 1 B Aluminum Structures, Load and Resistance Factor Design | 1604.3.5, 2002.1 |
| ASM 35—00 | Aluminum Sheet Metal Work in Building Construction (Fourth Edition) | 2002.1 |

AAMA

American Architectural Manufacturers Association
1827 Waldon Office Square, Suite 550
Schaumburg, IL 60173

| Standard reference number | Title | Referenced in code section number |
|---------------------------------|--|-----------------------------------|
| 1402—86 | Standard Specifications for Aluminum Siding, Soffit and Fascia | 1404.5.1 |
| AAMA/WDMA/CSA 101.I.S.2/A440—08 | North American Fenestration Standard/Specifications for Windows, Doors and Skylights | 1715.5.1, 2405.5 |
| 501.4-09 | <i>Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts</i> | 2410.1 |
| 501.6-09 | <i>Recommended Dynamic Test Method for Determining the Seismic Drift Causing Glass Fallout from a Wall</i> | 2410.1 |

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331

| Standard reference number | Title | Referenced in code section number | |
|---------------------------|---|---|-----------------------|
| 216.1—07 | Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies | Table 720.1(2), 721.1 | |
| 318—11 | Building Code Requirements for Structural Concrete | 1604.3.2, 1614.3.1, 1614.4.1, 1704.3.1.3, Table 1704.3, 1704.4.1, Table 1704.4, <i>Table 1705A.2.1, 1705A.2.2.1.2, 1708.2, 1808.8.2, Table 1808.8.2, 1808.8.5, 1808.8.6, 1810A.3.10.4, 1810.2.4.1, 1810.3.2.1.1, 1810.3.2.1.2, 1810.3.8.3.1, 1810.3.8.3.3, 1810.3.9.4.2.1, 1810.3.9.4.2.2, 1810.3.11.1, 1901.2, 1901.3, 1901.4, 1902.1, 1903A, 1903.1, 1904.1, 1904.2, 1904.3, 1904.4.1, 1904.4.2, 1904.5, 1905A, 1905.1.1, 1905.2, 1905.3, 1905.4, 1905.5, 1905.6.2, 1905.6.3, 1905.6.4, 1905.6.5, 1905.7, 1905.8, 1905.9, 1905.10, 1905.11, 1905.12, 1905.13, 1906.1, 1906.2, 1906.3, 1906.4, 1907.1, 1907.2, 1907.3, 1907.4, 1907.5, 1907.6, 1907.7.1, 1907.7.2, 1907.7.3, 1907.7.4, 1907.7.5, 1907.7.6, 1907.8, 1907.9, 1907.10, 1907.11, 1907.12, 1907.13, 1908.1, 1908.1.1, 1908.1.2, 1908.1.3, 1908.1.4, 1908.1.5, 1908.1.6, 1908.1.7, 1908.1.8, 1908.1.9, 1908.1.10, 1909.1, 1909.3, 1909.4, 1909.5, 1909.6, 1912.1, 1913A.5, 1913A.7.2, 1913.2, 1913.3, 2108.3, 2205.3</i> | Table 720.1(2), 721.1 |
| 355.2-07 | <i>Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary</i> | 616A.1.19 | |
| 440.2R 08 | <i>Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures</i> | 1914A.3 | |
| 503.7—07 | <i>Specification for Crack Repair by Epoxy Injection</i> | 1914A.2 | |

REFERENCED STANDARDS

ACI—continued

| | | |
|----------|---|--|
| 506—05 | <i>Guide to Shotcrete</i> | 1913.4.5, 1910A.1, 1910A.3, 1910A.12, 1914A.2 |
| 530—11 | Building Code Requirements for Masonry Structures | 1405.5, 1405.5.2, 1405.9, 1604.3.4, 1704.5, 1704.5.1, Table 1704.5.1, 1704.5.2, 1704.5.3, Table 1704.5.3, 1807.1.6.3.2, 1808.9, 2101.2.2, 2101.2.3, 2101.2.4, 2101.2.5, 2101.2.6, 2103.1.3.6, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2107.5, 2108.1, 2108.2, 2108.3, |
| 530.1—08 | Specifications for Masonry Structures | 1405.5.1, Table 1704.5.1, Table 1704.5.3, 1807.1.6.3, 2103.8, 2103.11, 2103.12, 2103.13, 2104.1, 2104.1.1, 2104.1.2, 2104.1.3, 2104.2, 2104.3, 2104.4, 2105.2.2.1.1, 2105.2.2.1.2, 2105.2.2.1.3 |

AF&PA

American Forest & Paper Association
1111 19th St, NW Suite 800
Washington, DC 20036

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|---|
| WCD No. 4—89 | Wood Construction Data Plank and Beam Framing for Residential Buildings..... | 2306.1.2 |
| WFCM—01 | Wood Frame Construction Manual for One and Two family Dwellings | 1609.1.1, 1609.1.1.1, 2301.2, 2308.1, 2308.2.1 |
| NDS—2012 | National Design Specification (NDS) for Wood Construction with 2012 Supplement and addendum | 1905A.1.21, 721.6.3.2, 1716.1.1, 1716.1.4, 1809.12, 1810.3.2.4, Table 1810.3.2.6, 2302.1, 2304.12, 2306.1, Table 2306.2.1(1), Table 2306.2.1(2), Table 2306.3, Table 2306.6, 2307.1, 2307.1.1 |
| AF&PA—93 | Span Tables for Joists and Rafters | 2306.1.1, 2308.8, 2308.10.2, 2308.10.3 |
| ANSI/AF&PA PWF—07 | Permanent Wood Foundation Design Specification | 1805.2, 1807.1.4, 2304.9.5.2 |
| ANSI/AF&PA SDPWS—08 | Special Design Provisions for Wind and Seismic | 1613.6.1, 2305.1, 2306.1, 2306.2.1, 2306.2.2, 2306.2.3, 2306.3, Table 2306.3, 2306.4, 2306.5, 2306.6, 2306.7, Table 2306.7, 2307.1, 2307.1.1 |

AISC

American Institute of Steel Construction
One East Wacker Drive, Suite 700
Chicago, IL 60601 18021

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|--|
| 341—10 | Seismic Provisions for Structural Steel Buildings, including Supplement No. 1 dated 2005 | 1613.6.2, 1705A.2.1, 1707.2.2, 1708.3, 2212.2, 2205A, 2205.2.1, 2205.2.2, 2205.3, 2205.3.1, 2206A |
| 358 10 | <i>Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications including Supplement No. 1</i> | 2205A, 2206A.2, 2212.3, 3413A |
| 360—10 | Specification for Structural Steel Buildings | 1604.3.3, Table 1704.3, 1704.3.3, 1705A.2.1, Table 1705A.2.1, 2203.1, 2203.2, 2204A.2.2, 2205.1, 2205.3, 2206A.2, 2212.1.1, 2212.3, 2212A.1.2, 2212A.2.1 |

AISI

American Iron and Steel Institute
1140 Connecticut Avenue, 705
Suite 705
Washington, DC 20036

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|---|
| AISI S100—07/S2 10 | North American Specification for the Design of Cold formed Steel Structural Members | 1604.3.3, 1905A.1, 1913.3.8, 2203.1, 2203.2, 2209.1, 2210A.2, 2210.2, 2210.4, 2210.5, 2211A.1, 2212A.1.2 |
| S200—07 | North American Standard for Cold formed Steel Framing General Provisions | 2203.1, 2203.2, 2210.1 |
| S210—07 | North American Standard for Cold formed Steel Framing Floor and Roof System Design | 2210.5 |
| S211—07 | North American Standard for Cold formed Steel Framing Wall Stud Design | 2210.4 |
| S212—07 | North American Standard for Cold formed Steel Framing Header Design | 2210.2 |
| S213—07 | North American Standard for Cold formed Steel Framing Lateral Design | 2210.6, 2212A.2.1, 2212.5.3 |
| S214—07 | North American Standard for Cold formed Steel Framing Truss Design, with Supplement 2, dated 2008 | 2210.3.11, 2211A.3, 2212.5.1.2 |
| S230—07 | Standard for Cold-formed Steel Framing Prescriptive Method for One- and Two family Dwellings, with Supplement 2, dated 2008 | 1609.1.1, 1609.1.1.1, 2210.7 |

American Institute of Timber Construction
Suite 140
7012 S. Revere Parkway
Englewood, CO 80112



| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| AITC Technical Note 7 96 | Calculation of Fire Resistance of Glued Laminated Timbers..... | 721.6.3.3 |
| AITC 104—03 | Typical Construction Details | 2306.1 |
| AITC 110—01 | Standard Appearance Grades for Structural Glued Laminated Timber | 2306.1 |
| AITC 111 05 | <i>Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection.....</i> | 2303.1.3.1 |
| AITC 113 01 | Standard for Dimensions of Structural Glued Laminated Timber | 2306.1 |
| AITC 117 10 | Standard Specifications for Structural Glued Laminated Timber of Softwood Species | 2303.1.3.1, 2306.1 |
| AITC 119 96 | Standard Specifications for Structural Glued Laminated Timber of Hardwood Species | 2306.1 |
| AITC 200—04 | Manufacturing Quality Control Systems Manual for Structural Glued Laminated Timber..... | 2306.1 |
| AITC 404—05 | <i>Standard for Radially Reinforcing Curved Glued Laminate Timber Members to Resist Radial Tension</i> | 2303.1.3.1 |
| ANSI/AITC A 190.1—07 | Structural Glued Laminated Timber..... | 1705A.5.4, 2303.1.3, 2306.1 |

Automotive Lift Institute
P.O. Box 85
Courtland, NY 13045



| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| ALI ALCTV 2006 | Standard for Automobile Lifts—Safety Requirements for Construction, Testing and Validation (ANSI) | 3001.2 |

American National Standards Institute
25 West 43rd Street, Fourth Floor
New York, NY 10036



| Standard reference number | Title | Referenced in code section number |
|-------------------------------|---|---|
| A13.1 96 (Reaffirmed 2002) | Scheme for the Identification of Piping Systems | 415.8.6.4 |
| A108.1A 99 | Installation of Ceramic Tile in the Wet set Method, with Portland Cement Mortar | 2103.10 |
| A108.1B 99 | Installation of Ceramic Tile, quarry Tile on a Cured Portland Cement Mortar Setting Bed with Dry set or Latex portland Mortar | 2103.10 |
| A108.4—99 | Installation of Ceramic Tile with Organic Adhesives or Water cleanable Tile setting Epoxy Adhesive | 2103.10.6 |
| A108.5 99 | Installation of Ceramic Tile with Dry set Portland Cement Mortar or Latex portland Cement Mortar | 2103.10.1, 2103.10.2 |
| A108.6—99 | Installation of Ceramic Tile with Chemical resistant,Water Cleanable Tile setting and grouting Epoxy | 2103.10.3 |
| A108.8 99 | Installation of Ceramic Tile with Chemical resistant Furan Resin Mortar and Grout | 2103.10.4 |
| A108.9 99 | Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout | 2103.10.5 |
| A108.10 99 | Installation of Grout in Tilework | 2103.10.7 |
| A118.1 99 | American National Standard Specifications for Dry set Portland Cement Mortar | 2103.10.1 |
| A118.3 99 | American National Standard Specifications for Chemical resistant, Water cleanable Tile setting and grouting Epoxy and Water Cleanable Tile setting Epoxy Adhesive | 2103.10.3 |
| A118.4—99 | American National Standard Specifications for Latex portland Cement Mortar | 2103.10.2 |
| A118.5 99 | American National Standard Specifications for Chemical Resistant Furan Mortar and Grouts for Tile Installation | 2103.10.4 |
| A118.6—99 | American National Standard Specifications for Cement Grouts for Tile Installation | 2103.10.7 |
| A118.8 99 | American National Standard Specifications for Modified Epoxy Emulsion Mortar/Grout | 2103.10.5 |
| A136.1 99 | American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile | 2103.10.6 |
| A137.1 88 | American National Standard Specifications for Ceramic Tile | 2103.5 |
| A208.1 99 | Particleboard | 2303.1.7, 2303.1.7.1 |
| S3.41 | <i>American National Standard Specifications for Audible Emergency Evacuation Signal</i> | 907.5.2.1.3 |
| Z 97.1—09 | Safety Glazing Materials Used in Buildings Safety Performance Specifications and Methods of Test | 2406.1.2, 2406.2, Table 2406.2(2), 2406.3.1, 2407.1, 2407.1.4.1, 2408.2.1, 2408.3, 2409.1, 2409.2, 2409.3.1 |

REFERENCED STANDARDS

APA

APA Engineered Wood Association
7011 South 19th
Tacoma, WA 98466

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| APA PDS 04 | Panel Design Specification | 2306.1 |
| APA PDS Supplement 1 90 | Design and Fabrication of Plywood Curved Panels (revised 1995) | 2306.1 |
| APA PDS Supplement 2 92 | Design and Fabrication of Plywood lumber Beams (revised 1998) | 2306.1 |
| APA PDS Supplement 3 90 | Design and Fabrication of Plywood Stressed skin Panels (revised 1996) | 2306.1 |
| APA PDS Supplement 4 90 | Design and Fabrication of Plywood Sandwich Panels (revised 1993) | 2306.1 |
| APA PDS Supplement 5 95 | Design and Fabrication of All plywood Beams (revised 1995) | 2306.1 |
| EWS R540 02 | Builders Tips: Proper Storage and Handling of Glulam Beams | 2306.1 |
| EWS S475 01 | Glued Laminated Beam Design Tables | 2306.1 |
| EWS S560 03 | Field Notching and Drilling of Glued Laminated Timber Beams | 2306.1 |
| EWS T300—05 | Glulam Connection Details | 2306.1 |
| EWS X440 03 | Product Guide Glulam | 2306.1 |
| EWS X450 01 | Glulam in Residential Construction Western Edition | 2306.1 |

APSP

The Association of Pool & Spa Professionals
2111 Eisenhower Avenue
Alexandria, VA 22314

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| ANSI/APSP 7 06 | Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs and Catch Basins | 3109.5 |

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| EP 484.2 (2003) | Diaphragm Design of Metal clad, Post frame Rectangular Buildings | 2306.1 |
| EP 486.1 (2000) | Shallow post Foundation Design | 2306.1 |
| EP 559 (1997) | Design Requirements and Bending Properties for Mechanically Laminated Columns | 2306.1 |

ASCE/SEI

American Society of Civil Engineers
Structural Engineering Institute
1801 Alexander Bell Drive
Reston, VA 20191 4400

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|---|
| 3 91 | Structural Design of Composite Slabs | 1604.3.3, 2209.2.1 |
| 5 11 | Building Code Requirements for Masonry Structures | 1405.6, 1405.6.2, 1405.10, 1604.3.4, 1704.5, 1704.5.1, Table 1704.5.1, 1704.5.2, 1704.5.3, Table 1704.5.3, 1807.1.6.3.2, 1808.9, 2101.2.2, 2101.2.3, 2101.2.4, 2101.2.5, 2101.2.6, 2103.1.3.6, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2107.5, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, 2114.10, 2114.11 |
| 6 08 | Specification for Masonry Structures | 1405.6.1, Table 1704.5.1, Table 1704.5.3, 1807.1.6.3, 2103.8, 2103.11, 2103.12, 2103.13, 2104.1, 2104.1.1, 2104.1.2, 2104.1.3, 2104.2, 2104.3, 2104.4, 2105.2.2.1.1, 2105.2.2.1.2, 2105.2.2.1.3 |

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| 7—10 | ASCE—continued |
| | Minimum Design Loads for Buildings and Other Structures including Supplements No. 1 and 2, excluding Chapter 14 and Appendix 11A. <i>104.11, 202, Table 1504.8, 1509.7.1,</i> <i>1602.1, 1604.3, 1604.8.2, 1604.10, 1605.1, 1605.2.2, 1605.3.1.2, 1605.3.2, 1607.11.1,</i> <i>1608.1, 1608.2, 1609.1.1, 1609.1.1.2.1, 1609.1.1.2.2, 1609.1.2, 1609.3, 1609.4.4,</i> <i>1609.5.1, 1609.5.3, 1609.6, 1609.6.1.1, 1609.6.2, Table 1609.6.2(2), 1609.6.3,</i> <i>1609.6.4.1, 1609.6.4.2, 1611.2, 1612.2, 1612.4, 1613.1, 1613.2, Table 1613.5.3(1), Table 1613.5.3(2),</i> <i>1613.5.6, 1613.5.6.1, 1613.5.6.2, 1613.6, 1613.6.1, 1613.6.2, 1613.6.3, 1613.6.4, 1613.6.5, 1613.6.6,</i> <i>1613.6.7, 1613.7, <i>1603A.2 1613A, 1616A, 1616.9, 1616.10, 1702.1, 1705.3.4, 1708.1, 1708.5, 1803A.6, 1808.3.1,</i></i> <i>1810.3.6.1, 1810.3.9.4, 1810.3.11.2, 1810.3.12, 1905A.1.21, 1908.1.1, 1908.1.2, 1908.1.9, 1913.3.8, 2114A.1,</i> <i>2114.13, 2205.2.1, 2205.3, 2205.3.1, 2208.1, 2210A.2, 2212A.2.4, Table 2304.6.1, Table 2306.7,</i> <i>Table 2308.10.1, 2404.1, 2410.1.1, 2410.1.2, 2505.1, 2505.2, 3404.4, 3404.5, 3419.7.2</i> |
| 8 02 | Standard Specification for the Design of Cold formed Stainless Steel Structural Members. <i>1604.3.3, 2209.1</i> |
| 19—10 | Structural Applications of Steel Cables for Buildings. <i>2207.1, 2207.2</i> |
| 24—05 | Flood Resistant Design and Construction. <i>1203.3.2, 1612.4, 1612.5, 3001.2, G103.1, G401.3, G401.4</i> |
| 29 05 | Standard Calculation Methods for Structural Fire Protection. <i>721.1</i> |
| 32 01 | Design and Construction of Frost Protected Shallow Foundations. <i>1809.5</i> |
| 41 06 | <i>Seismic Rehabilitation of Existing Buildings including Supplement No. 1.</i> <i>1603A.2, 1616A.1.30, 3401.5, 3412A, 3413A,</i> <i>3417.5, 3417.8, 3418.1, 3419.1, 3419.2, 3419.5, 3419.7.2, 3419.8, 3419.9, 3420.1, 3421.2.2, 3412A, 3413A</i> |

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016 5990

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| A17.1/CSA B44 2007 (with A17.1a/CSA B44a 08 addenda) | Safety Code for Elevators and Escalators 11B 407.1, 11B 407.2.2, 11B 407.4.9, 11B 408.1, 11B 409.1, 11B 410.1, 11B 810.9, 1607.8.1, 1607.9.1, 1613.6.5, 3001.2, 3001.4, 3002.5, 3003.2, 3007.1, 3007.2, 3008.2, 3008.2.1, 3008.7.6, 3008.8.1, 3411.8.2 | |
| A18.1 2008 | Safety Standard for Platform Lifts and Stairway Chairlifts | 2702.2.6, 3411.8.3 |
| A90.1 03 | Safety Standard for Belt Manlifts | 3001.2 |
| B16.18 2001 (Reaffirmed 2005) | Cast Copper Alloy Solder Joint Pressure Fittings | 909.13.1 |
| B16.22 2001 (Reaffirmed 2005) | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings | 909.13.1 |
| B20.1 2006 | Safety Standard for Conveyors and Related Equipment | 3001.2, 3005.3 |
| <i>BPE 2009</i> | <i>Bio processing Equipment Standard</i> | |
| B31.3 2004 | Process Piping | 415.8.6.1 |

ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428 2959

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|--|
| A 36/A 36M 05 | Specification for Carbon Structural Steel | 1810.3.2.3 |
| A 153/A 153M 05 | Specification for Zinc Coating (Hot dip) on Iron and Steel Hardware | 2304, 2304.9.5 |
| A227 06 (2011) | <i>Standard Specification for Steel Wire, Cold Drawn for Mechanical Springs</i> | 1211.1.1 |
| A229 12 | <i>Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs</i> | 1211.1.1 |
| A 240/A 240M 07 | Standard Specification for Chromium and Chromium nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications | Table 1507.4.3(1) |
| A 252 98 (2002) | Specification for Welded and Seamless Steel Pipe Piles | 1810.3.2.3 |
| A 283/A 283M 03 | Specification for Low and Intermediate Tensile Strength Carbon Steel Plates | 1810.3.2.3 |
| A 307 04e01 | Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength | 1911.1 |
| A370 10 | <i>Standard Test Methods and Definitions for Mechanical Testing of Steel Products</i> | 3413A.1.3 |
| A 416/A 416M 06 | Specification for Steel Strand, Uncoated Seven wire for Prestressed Concrete..... | 1810.3.2.2 |
| A 463/A 463M 05 | Standard Specification for Steel Sheet, Aluminum coated, by the Hot dip Process..... | Table 1507.4.3(2) |
| A 572/A 572M 07 | Specification for High strength Low alloy Columbium vanadium Structural Steel | 1810.3.2.3 |
| A 588/A 588M 05 | Specification for High strength Low alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inches (100 mm) Thick | 1810.3.2.3 |
| A 615/A 615M 04a | Specification for Deformed and Plain Billet steel Bars for Concrete Reinforcement..... | 1708.2, 1810.3.10.2 |
| A 653/A 653M 07 | Specification for Steel Sheet, Zinc coated Galvanized or Zinc iron Alloy coated Galvannealed by the Hot dip Process | Table 1507.4.3(1), Table 1507.4.3(2), 2304.9.5.1 |

REFERENCED STANDARDS

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| | | |
|-------------------------|---|---|
| A 690/A 690M —07 | Standard Specification for High strength Low alloy Nickel, Copper, Phosphorus Steel H piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments | 1810.3.2.3 |
| A 706/A 706M 05a | Specification for Low alloy Steel Deformed and Plain Bars for Concrete Reinforcement | Table 1704.3, 1704.4.1, 2107.4, 2108.3 |
| A 722/A 722M 07 | Specification for Uncoated High strength Steel Bar for Prestressing Concrete..... | 1810.3.10.2, J106.2.4.2, 1811A.4 |
| A 755/A 755M 03 | Specification for Steel Sheet, Metallic coated by the Hot dip Process and Prepainted by the Coil coating Process for Exterior Exposed Building Products..... | Table 1507.4.3(1), Table 1507.4.3(2) |
| A 792/A 792M—06a | Specification for Steel Sheet, 55% Aluminum zinc Alloy coated by the Hot dip Process | Table 1507.4.3(1), Table 1507.4.3(2) |
| A 875/A 875M—06 | Standard Specification for Steel Sheet Zinc 5 percent, Aluminum Alloy coated by the Hot dip Process..... | Table 1507.4.3(2) |
| A 913/A 913M—04 | Specification for High strength Low alloy Steel Shapes of Structural Quality, Produced by Quenching and Self tempering Process (QST) | 1810.3.2.3 |
| A 924/A 924M —07 | Standard Specification for General Requirements for Steel Sheet, Metallic coated by the Hot dip Process..... | Table 1507.4.3(1) |
| A 992/A 992M—06a | Standard Specification for Structural Shapes | 1810.3.2.3 |
| B 42 02e01 | Specification for Seamless Copper Pipe, Standard Sizes | 909.13.1 |
| B 43 98 (2004) | Specification for Seamless Red Brass Pipe, Standard Sizes | 909.13.1 |
| B 68 02 | Specification for Seamless Copper Tube, Bright Annealed (Metric) | 909.13.1 |
| B 88 03 | Specification for Seamless Copper Water Tube..... | 909.13.1 |
| B 101 02 | Specification for Lead coated Copper Sheet and Strip for Building Construction..... | Table 1404.5.3, Table 1507.2.9.2, Table 1507.4.3(1) |
| B 209 06 | Specification for Aluminum and Aluminum Alloy Steel and Plate | Table 1507.4.3(1) |
| B 251 02e01 | Specification for General Requirements for Wrought Seamless Copper and Copper alloy Tube..... | 909.13.1 |
| B 280—03 | Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service | 909.13.1 |
| B 370 —03 | Specification for Cold rolled Copper Sheet and Strip for Building Construction | 1404.5.2, Table 1507.2.9.2, Table 1507.4.3(1) |
| B 695 04 | Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel | 2304.9.1.1, 2304.9.5.1, 2304.9.5.3 |
| C 5 03 | Specification for Quicklime for Structural Purposes | Table 2507.2 |
| C 22/C 22M 00 (2005)e01 | Specification for Gypsum | Table 2506.2 |
| C 27 98 (2002) | Specification for Standard Classification of Fireclay and High alumina Refractory Brick..... | 2111.5 |
| C 28/C 28M 00 (2005) | Specification for Gypsum Plasters | Table 2507.2 |
| C 31/C 31M —06 | Practice for Making and Curing Concrete Test Specimens in the Field..... | Table 1704.4 |
| C 33 03 | Specification for Concrete Aggregates | 721.3.1.4, 721.4.1.1.3 |
| C 34—03 | Specification for Structural Clay Load bearing Wall Tile | 2103.2 |
| C 35 01 (2005) | Specification for Inorganic Aggregates for Use in Gypsum Plaster | Table 2507.2 |
| C 36/C 36M—03 | Specification for Gypsum Wallboard | Figure 721.5.1(2), Figure 721.5.1(3), Table 2506.2 |
| C 37/C 37M—01 | Specification for Gypsum Lath | Table 2507.2 |
| C 55 06e01 | Specification for Concrete Building Brick | Table 721.3.2, 2103.1, 2105.2.2.1.2 |
| C 56 05 | Specification for Structural Clay Nonload Bearing Tile..... | 2103.2 |
| C 59/C 59M 00 (2006) | Specification for Gypsum Casting and Molding Plaster | Table 2507.2 |
| C 61/C 61M 00 (2006) | Specification for Gypsum Keene's Cement | Table 2507.2 |
| C 62—05 | Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)..... | 1807.1.6.3, 2103.2, 2105.2.2.1.1 |
| C 67 07 | Test Methods of Sampling and Testing Brick and Structural Clay Tile | 721.4.1.1.1, 2109.3.1.1 |
| C 73 05 | Specification for Calcium Silicate Face Brick (Sand lime Brick) | Table 721.3.2, 2103.1 |
| C 79—04a | Specification for Treated Core and Nontreated Core Gypsum Sheathing Board | Table 2506.2 |
| C 90 06b | Specification for Loadbearing Concrete Masonry Units | Table 721.3.2, 1807.1.6.3, 2103.1 |
| C 91 05 | Specification for Masonry Cement | Table 2507.2 |
| C 94/C 94M 07 | Specification for Ready mixed Concrete | 110.3.1, J1705A.3.3 |
| C 114 10 | Standard Test Methods for Chemical Analysis of Hydraulic Cement | I903A.6, I913.2.3 |
| C 126 99 (2005) | Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick and Solid Masonry Units | 2103.2 |
| C 140 07 | Test Method Sampling and Testing Concrete Masonry Units and Related Units | 721.3.1.2 |
| C 144—04 | Standard Specification for Aggregate for Masonry Mortar | 2103A.8 |
| C 150 07 | Specification for Portland Cement | I903A, I913A, I913.2. Table 2507.2 |
| C 172 04 | Practice for Sampling Freshly Mixed Concrete | Table 1704.4 |
| C 199 84 (2005) | Test Method for Pier Test for Refractory Mortars | 2111.5, 2111.8, 2113.12 |
| C 206—03 | Specification for Finishing Hydrated Lime..... | Table 2507.2 |
| C 208 95 (2001) | Specification for Cellulosic Fiber Insulating Board | Table 1508.2, 2303.1.5 |
| C 212 00 (2006) | Specification for Structural Clay Facing Tile | 2103.2 |
| C 216—07 | Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) | 1807.1.6.3, 2103.2, 2105.2.2.1.1 |
| C 270 08a | Specification for Mortar for Unit Masonry | 2103.8, 2114.2 |
| C 289—07 | Standard Test Method for Potential Alkali Silica Reactivity of Aggregates | I903A.3, I913.2.3 |

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|------------------------|---|---|
| C 315—07 | Specification for Clay Flue Liners and Chimney Pots | 2111.8, 2113.11, Table 2113.16(1) |
| C 317/C 317M 00 (2005) | Specification for Gypsum Concrete | 1914.1 |
| C 330 05 | Specification for Lightweight Aggregates for Structural Concrete | 721.1.1 |
| C 331 05 | Specification for Lightweight Aggregates for Concrete Masonry Units | 721.3.1.4, 721.4.1.1.3 |
| C 406—06e01 | Specification for Roofing Slate | 1507.7.5 |
| C 442/C 442M—04 | Specification for Gypsum Backing Board and Coreboard and Gypsum Shaftliner Board | Table 2506.2 |
| C 472—99 (2004) | Specification for Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete | Table 2506.2 |
| C 473 06a | Test Method for Physical Testing of Gypsum Panel Products | Table 2506.2 |
| C 474—05 | Test Methods for Joint Treatment Materials for Gypsum Board Construction | Table 2506.2 |
| C 475—05 | Specification for Joint Compound and Joint Tape for Finishing Gypsum Wallboard | Table 2506.2 |
| C 503 05 | Specification for Marble Dimension Stone (Exterior) | 2103.4 |
| C 514 04 | Specification for Nails for the Application of Gypsum Board | Table 720.1(2), Table 720.1(3), Table 2306.7, Table 2506.2 |
| C 516—02 | Specifications for Vermiculite Loose Fill Thermal Insulation | 721.3.1.4, 721.4.1.1.3 |
| C 547—06 | Specification for Mineral Fiber Pipe Insulation | Table 720.1(2), Table 720.1(3) |
| C 549—06 | Specification for Perlite Loose Fill Insulation | 721.3.1.4, 721.4.1.1.3 |
| C 552 03 | Standard Specification for Cellular Glass Thermal Insulation | Table 1508.2 |
| C 557 03e01 | Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing | Table 2506.2 |
| C 568 03 | Specification for Limestone Dimension Stone | 2103.4 |
| C 578—07 | Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation | Table 1508.2 |
| C 587 04 | Specification for Gypsum Veneer Plaster | Table 2507.2 |
| C 588/C 588M 01 | Specification for Gypsum Base for Veneer Plasters | Table 2507.2 |
| C 595 08a | Specification for Blended Hydraulic Cements | 1903A.6, 1913A.1, 1913.2, Table 2507.2 |
| C 615 03 | Specification for Granite Dimension Stone | 2103.4 |
| C 616—03 | Specification for Quartz Dimension Stone | 2103.4 |
| C 618—08a | <i>Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete</i> | 1903A.3, 1913A.1, 1913.2 |
| C 629 03 | Specification for Slate Dimension Stone | 2103.4 |
| C 630/C 630M 03 | Specification for Water resistant Gypsum Backing Board | Table 2506.2 |
| C 631 95a (2004) | Specification for Bonding Compounds for Interior Gypsum Plastering | Table 2507.2 |
| C 635/C 635M—07 | Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay in Panel Ceilings | 808.1.1, 1616.10.16, 1616A.1.20, 2506.2.1, H107.1.1 |
| C 636/C 636M—08 | Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay in Panels | 808.1.1, 1616.10.16, 1616A.1.20 |
| C 645 07 | Specification for Nonstructural Steel Framing Members | Table 2506.2, Table 2507.2 |
| C 652—05a | Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale) | 1807.1.6.3, 2103.2, 2105.2.2.1.1 |
| C 728 05 | Standard Specification for Perlite Thermal Insulation Board | Table 1508.2 |
| C 744 05 | Specification for Prefaced Concrete and Calcium Silicate Masonry Units | Table 721.3.2, 2103.1 |
| C 754 04 | Specification for Installation of Steel Framing Members to Receive Screw attached Gypsum Panel Products | Table 2508.1, Table 2511.1.1 |
| C 836—06 | Specification for High solids Content, Cold Liquid applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course | 1507.15.2 |
| C 840 07 | Specification for Application and Finishing of Gypsum Board | Table 2508.1, 2509.2 |
| C 841—03 | Specification for Installation of Interior Lathing and Furring | Table 2508.1, Table 2511.1.1 |
| C 842 05 | Specification for Application of Interior Gypsum Plaster | Table 2511.1.1, 2511.3, 2511.4 |
| C 843 99 (2006) | Specification for Application of Gypsum Veneer Plaster | Table 2511.1.1 |
| C 844 04 | Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster | Table 2508.1 |
| C 847 06 | Specification for Metal Lath | Table 2507.2 |
| C 887 05 | Specification for Packaged, Dry Combined Materials for Surface Bonding Mortar | 1805.2.2, 2103.9 |
| C 897 05 | Specification for Aggregate for Job mixed Portland Cement based Plaster | Table 2507.2 |
| C 920 05 | Standard for Specification for Elastomeric Joint Sealants | Table 2506.2 |
| C 926 98a (2005) | Specification for Application of Portland Cement based Plaster | 2109.3.4.6, 2510.3, Table 2511.1.1, 2511.3, 2511.4, 2512.1, 2512.1.2, 2512.2, 2512.6, 2512.8.2, 2512.9, 2513.7 |
| C 931/C 931M 04 | Specification for Exterior Gypsum Soffit Board | Table 2506.2 |
| C 932 —06 | Specification for Surface applied Bonding Compounds Agents for Exterior Plastering | Table 2507.2 |
| C 933 05 | Specification for Welded Wire Lath | Table 2507.2 |
| C 946 91 (2001) | Specification for Practice for Construction of Dry stacked, Surface bonded Walls | 2103.9, 2109.2.2 |

REFERENCED STANDARDS

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|-------------------|---|-----------------------------------|
| C 954 04 | Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch (0.84 mm) to 0.112 inch (2.84 mm) in Thickness | Table 2506.2, Table 2507.2 |
| C 955 06 | Standard Specification for Load bearing Transverse and Axial Steel Studs, Runners Tracks, and Bracing or Bridging, for Screw Application of Gypsum Panel Products and Metal Plaster Bases | Table 2506.2, Table 2507.2 |
| C 956 04 | Specification for Installation of Cast in place Reinforced Gypsum Concrete | 1914.1 |
| C 957 06 | Specification for High solids Content, Cold Liquid applied Elastomeric Waterproofing Membrane with Integral Wearing Surface | 1507.15.2 |
| C 960—04 | Specification for Predecorated Gypsum Board | Table 2506.2 |
| C 989 09 | <i>Standard Specification for Slag Cement for Use in Concrete and Mortars</i> | 1903A.5, 1903A.6, 1913A.1, 1913.2 |
| C 1002 04 | Specification for Steel Self piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs | Table 2506.2, Table 2507.2 |
| C 1007 04 | Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories | Table 2508.1, Table 2511.1.1 |
| C 1019 05 | Test Method of Sampling and Testing Grout 2105.2.2.1.1, 2105.2.2.1.2, 2105.2.2.1.3, 2105.2.2.1.4, 2114.2.9.1 | |
| C 1029 05a | Specification for Spray applied Rigid Cellular Polyurethane Thermal Insulation | 1507.14.2 |
| C 1032 06 | Specification for Woven Wire Plaster Base | Table 2507.2 |
| C 1047 05 | Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base | Table 2506.2, Table 2507.2 |
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| C 1088 07a | Specification for Thin Veneer Brick Units Made from Clay or Shale | Table 720.1(2), 2103.2 |
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| C 1240 11 | <i>Standard Specification for Silica Fume Used in Cementitious Mixtures</i> | 1903A.6 |
| C 1249 06a(2010) | <i>Standard Guide for Secondary Seal for Sealed Insulated Glass Units for Structural Sealant Glazing Applications</i> | 1903A.6, 2410.1 |
| C 1260—07 | <i>Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)</i> | 1903A.6, 2410.1.1 |
| C 1261 07 | Specification for Firebox Brick for Residential Fireplaces | 2111.5, 2111.8 |
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| C 1392 00(2009) | <i>Standard Guide for Evaluating Failure of Structural Sealant Glazing</i> | 2410.1.3 |
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| C 1567 08 | <i>Standard Test Method for Determining the Potential Alkali Silica Reactivity of the Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)</i> 1903A.6, 1913.2.3 | |
| C 1586—05 | <i>Standard Guide for Quality Assurance of Mortars</i> | 2105A.2.2.1.4, 2114.9.1 |
| C 1629/C 1629M 06 | Standard Classification for Abuse resistant Nondecorated Interior Gypsum Panel Products and Fiber reinforced Cement Panels 403.2.3.1, 403.2.3.2, 403.2.3.4 | |
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| D 1586—11 | | <i>Standard Test Method for Standard for Penetration Test (SPT) and Split barrel Sampling of Soils</i> | J112.2 |
| D 1761—06 | | Test Method for Mechanical Fasteners in Wood | 1716.1.1, 1716.1.2, 1716.1.3 |
| D 1863—05 | | Specification for Mineral Aggregate Used on Built up Roofs..... | Table 1507.10.2 |
| D 1929 | 96 (2001)e01 | Test Method for Determining Ignition Properties of Plastics | 402.16.4, 406.5.3, 1407.11.2.1, 2606.4 |
| D 1970—01 | | Specification for Self adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roof Underlayment for Ice Dam Protection..... | 1507.2.4, 1507.2.9.2, 1507.3.9, 1507.5.7, 1507.8.8, 1507.9.9 |
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| D 2178 | 04 | Specification for Asphalt Glass Felt Used in Roofing and Waterproofing | Table 1507.10.2 |
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| D 3201—07 | | Test Method for Hygroscopic Properties of Fire retardant treated Wood and Wood based Products | 2303.2.7 |
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| D 3441 | 05 | <i>Standard Test Method for Mechanical Cone Penetration Tests of Soil</i> | J112.2 |
| D 3462—07 | | Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules | 1507.2.5 |
| D 3468 | 99 (2006)e01 | Specification for Liquid applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing | 1507.15.2 |
| D 3679—06a | | Specification for Rigid Poly [Vinyl Chloride (PVC) Siding] | 1404.9, 1405.14 |
| D 3689 | 90 (1995) | Method for Testing Individual Piles Under Static Axial Tensile Load | 1810.3.3.1.5 |
| D 3737 | 07 | Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam) | 2303.1.3 |
| D 3746 | 85 (2002) | Test Method for Impact Resistance of Bituminous Roofing Systems | 1504.7 |
| D 3747 | 79 (2007) | Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation | Table 1507.10.2 |
| D 3909 | 97b (2004)e01 | Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules | 1507.2.9.2, 1507.6.5, Table 1507.10.2 |
| D 3957—06 | | Standard Practices for Establishing Stress Grades for Structural Members Used in Log Buildings | 2303.1.10 |
| D 3966—07 | | <i>Standard Test Method for Piles Under Lateral Loads</i> | 1810A.3.3.2 |
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| D 4434—06 | | Specification for Poly (Vinyl Chloride) Sheet Roofing | 1507.13.2 |
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|----------------------|------------|---|---|
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| D 4945 | 00 | Test Method for High strain Dynamic Testing of Piles | 1810.3.3.1.2 |
| D 4990—97a (2005)e01 | | Specification for Coal Tar Glass Felt Used in Roofing and Waterproofing | Table 1507.10.2 |
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| D 5516 | 03 | Test Method of Evaluating the Flexural Properties of Fire retardant treated Softwood Plywood Exposed to the Elevated Temperatures | 2303.2.5.1 |
| D 5643 | 06 | Specification for Coal Tar Roof Cement, Asbestos free | Table 1507.10.2 |
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| D 5665 | 99a (2006) | Specification for Thermoplastic Fabrics Used in Cold applied Roofing and Waterproofing | Table 1507.10.2 |
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| D 6083 | 05e01 | Specification for Liquid Applied Acrylic Coating Used in Roofing | Table 1507.10.2, 1507.15.2 |
| D 6162 | 00A | Specification for Styrene butadiene styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements | 1507.11.2 |
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| D 6298 | 05 | Specification for Fiberglass Reinforced Styrene butadiene styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface | 1507.11.2 |
| D 6305 | 02e01 | Practice for Calculating Bending Strength Design Adjustment Factors for Fire retardant treated Plywood Roof Sheathing | 2303.2.5.1 |
| D 6380—03 | | Standard Specification for Asphalt Roll Roofing (Organic) Felt | 1507.2.9.2, 1507.3.3, 1507.6.5 |
| D 6509 | 00 | Standard Specification for Atactic Polypropylene (APP) Modified Bituminous base Sheet Materials Using Glass Fiber Reinforcements | 1507.11.2 |
| D 6694 | 07 | Standard Specification for Liquid applied Silicone Coating Used in Spray Polyurethane Foam Roofing | 1507.15.2 |
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| D 6878 | 06a | Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing | 1507.13.2 |
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| D 7158 | 07 | Standard Test Method for Wind Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method) | 1507.2.7.1, Table 1507.2.7.1(1) |
| E 84 | 07 | Test Methods for Surface Burning Characteristics of Building Materials | 402.11, 402.16.4, 406.5.3, 703.4.2, 719.1, 719.4, 802.1, 803.1.1, 803.9, 806.5, 1407.9, 1407.10.1, 2303.2, 2603.3, 2603.4.1.13, 2603.5.4, 2604.2.4, 2606.4, 3105.4, D102.2.8 |
| E 90 | 04 | Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements | 1207.2, 1207.2.1 |
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| E 119 | 07 | Test Methods for Fire Tests of Building Construction and Materials | 703.2, 703.2.1, 703.2.3, 703.3, 703.5, 704.12, 705.7, 705.8.5, 707.6, 712.3.2, 713.3.1, 713.4.1.1, 714.1, 715.2, 715.4.5, 716.5.2, 716.5.3, 716.6.1, 716.6.2.1, Table 720.1(1), 1407.10.2, 2103.2, 2603.4, 2603.5.1 |
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| E 331 | 00 | Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference | 1403.2 |
| E 492—04 | | Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor ceiling Assemblies Using the Tapping Machine | 1207.3 |
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| E 605 | 93 (2006) | Test Method for Thickness and Density of Sprayed Fire resistive Material (SFRM) Applied to Structural Members | 1704.12.4.1, 1704.12.4.2, 1704.12.4.3, 1704.12.5 |

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| E 648 04 | <i>Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source</i> | 804.4.1, 804.4.2 |
| E662 09 | <i>Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials</i> | 804.4.1, 804.4.2 |
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| E 814 06 | Test Method of Fire Tests of Through penetration Firestops | 702.1, 713.3.1.2, 713.3.2, 713.4.1.1.2 |
| E 970 —00 | Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source | 719.3.1 |
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| E 1592 01 | Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference | 1504.3.2 |
| E 1602 03 | Guide for Construction of Solid Fuel burning Masonry Heaters | 2112.2 |
| E 1886 05 | Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials | 1609.1.2 |
| E 1966 01 | Test Method for Fire resistant Joint Systems | 702.1, 714.3 |
| E 1996—06 | Specification for Performance of Exterior Windows, Glazed Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes | 1609.1.2, 1609.1.2.1 |
| E 2072 04 | Standard Specification for Photoluminescent (Phosphorescent) Safety Markings | 1024.4 |
| E 2273 03 | Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies | 1408.4.1 |
| E 2307 04e01 | Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate scale, Multistory Test Apparatus | 714.4 |
| E 2404 —07a | Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Vinyl Wall or Ceiling Coverings to Assess Surface Burning Characteristics | 803.1.4 |
| E 2568 07 | Standard Specification for PB Exterior Insulation and Finish Systems (EIFS) | 1408.2 |
| E 2570 07 | Standard Test Method for Evaluating Water resistive Barrier (WRB) Coatings Used Under Exterior Insulation and Finish Systems (EIFS) for EIFS with Drainage | 1408.4.1.1, 1704.12.1 |
| E 2573 07 | Standard Practice for Specimen Preparation and Mounting of Site fabricated Stretch Systems to Assess Surface Burning Characteristics | 803.9 |
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| F 1292 99 | Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment | 11B 1008.2.6.2 |
| F 1292 04 | Standard Specification for Impact Attenuation of Surface Materials within the Use Zone of Playground Equipment | 11B 1008.2.6.2 |
| F 1346 91 (2003) | Performance Specification for Safety Covers and Labeling Requirements for | 3109.4, 3109.4.1.8 |
| F 1487 01 | Standard Consumer Safety Performance Specification for Playground Equipment for Public Use | 202 USE ZONE |
| F 1667 05 | Specification for Driven Fasteners: Nails, Spikes and Staples | Table 720.1(2), Table 720.1(3), 1507.2.6, 2303.6, Table 2506.2 |
| F 1951 99 | Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment | 11B 1008.2.6.1 |
| F 2006 00 (2005) 10 | Standard/Safety Specification for Window Fall Prevention Devices with Emergency Escape (Egress) and Rescue (Ingress) Windows | 1405.13.2 |
| F 2090 —01a (2007) | Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms | 1405.13.2 |
| F 2200 05 | Standard Specification for Automated Vehicular Gate Construction | 3110.3 |
| G 152 06 | Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials | 1504.6 |
| G 154 05 | Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials | 1504.6 |
| G 155 05a | Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials | 1504.6 |



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| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| 12 B 98 | Technical Manual 12 B Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire resistive Materials; an Annotated Guide, First Edition | 1704.13 |

REFERENCED STANDARDS

AWPA

American Wood Protection Association
P.O. Box 361784
Birmingham, AL 35236 1784

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|---|
| C1—03 | All Timber Products—Preservative Treatment by Pressure Processes..... | 1505.6 |
| M4—06 | Standard for the Care of Preservative-treated Wood Products..... | 1810.3.2.4.1, 2303.1.8 |
| U1—07 | USE CATEGORY SYSTEM: User Specification for Treated Wood Except Section 6, Commodity Specification H..... | 1403.5, Table 1507.9.6, 1807.1.4, 1807.3.1, 1809.12, 1810.3.2.4.1, 2303.1.8, 2304.11.2, 2304.11.4, 2304.11.6, 2304.11.7, J106.2.2 |

AWS

American Welding Society
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| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| D1.1 10 | <i>Structural Welding Code -Steel</i> Table 1704.3, 1704.3.1.1, <i>Table 1705A.2.1, 1705A.2.2.5, 2212.6.2, 2213A.2</i> | |
| D1.3—08 | Structural Welding Code—Sheet Steel..... Table 1704.3, 1704.3.1.2, <i>Table 1705A.2.1, 1705A.2.2.1.1</i> | |
| D1.4—11 | Structural Welding Code—Reinforcing Steel..... Table 1704.3, 1704.3.1.3, Table 1704.4, <i>Table 1705A.2.1, 1705.2.2.1.2, 2107A.3, 2107A.4</i> | |
| D1.8—09 | <i>Structural Welding Code Seismic Supplement</i> 1704A.3.1.4, 1705A.2.2.5, 2204A.1.1, 2204A.1.3, 2211.1 | |
| QC1 06 | <i>Standard for AWS Certification of Welding Inspectors</i> 1704A.3.1.4, 1705A.2.2.5 | |

BHMA

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| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|---|
| A 156.10 11 | Power Operated Pedestrian Doors | 11B-404.2.9, 11B-404.3, 1008.1.4.2 |
| A 156.19—07 | Standard for Power Assist and Low Energy Operated Doors..... | 11B-404.2.9, 11B-404.3, 11B-408.3.2.1, 11B-409.3.1, 1008.1.4.2 |

CGSB

Canadian General Standards Board
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| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| 37-GP-52M (1984) | Roofing and Waterproofing Membrane, Sheet Applied, Elastomeric | 1504.7, 1507.12.2 |
| 37-GP-56M (1980) | Membrane, Modified, Bituminous, Prefabricated and Reinforced for Roofing— with December 1985 Amendment | 1507.11.2 |
| CAN/CGSB 37.54—95 | Polyvinyl Chloride Roofing and Waterproofing Membrane | 1507.13.2 |

CPA

Composite Panel Association
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| Standard reference number | Title | Referenced in code section number |
|---------------------------|--------------------------------------|-----------------------------------|
| ANSI A135.4—2004 | Basic Hardboard | 1404.3.1, 2303.1.6 |
| ANSI A135.5—2004 | Prefinished Hardboard Paneling | 2303.1.6, 2304.6.2 |
| ANSI A135.6—1998 | Hardboard Siding | 1404.3.2, 2303.1.6 |

CPSC

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| <u>Standard reference number</u> | <u>Title</u> | <u>Referenced in code section number</u> |
|----------------------------------|---|---|
| 16 CFR Part 1201 (2002) | Safety Standard for Architectural Glazing Material | 2406.2, Table 2406.2(1), 2406.3.1, 2407.1, 2407.1.4.1, 2408.2.1, 2408.3, 2409.1, 2409.2, 2409.3.1 |
| 16 CFR Part 1209 (1979) | Interim Safety Standard for Cellulose Insulation | 719.6 |
| 16 CFR Part 1404 (1979) | Cellulose Insulation..... | 719.6 |
| 16 CFR Part 1500 (1991) | Hazardous Substances and Articles; Administration and Enforcement Regulations | 307.2 |
| 16 CFR Part 1500.44 (2001) | Method for Determining Extremely Flammable and Flammable Solids | 307.2 |
| 16 CFR Part 1507 (2001) | Fireworks Devices..... | 307.2 |
| 16 CFR Part 1630 (2000) | Standard for the Surface Flammability of Carpets and Rugs..... | 804.4.1 |

CSA

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario Canada L4W 5N6

| <u>Standard reference number</u> | <u>Title</u> | <u>Referenced in code section number</u> |
|----------------------------------|--|--|
| 101/I.S.2/A440—08 | Specifications for Windows, Doors and Unit Skylights | 1715.5.1, 2405.5 |

CSSB

Cedar Shake and Shingle Bureau
P. O. Box 1178
Sumas, WA 98295 1178

| <u>Standard reference number</u> | <u>Title</u> | <u>Referenced in code section number</u> |
|----------------------------------|---|--|
| CSSB 97 | Grading and Packing Rules for Western Red Cedar Shakes and Western Red Shingles of the Cedar Shake and Shingle Bureau | Table 1507.8.5, Table 1507.9.6 |

DASMA

Door and Access Systems Manufacturers Association International
1300 Summer Avenue
Cleveland, OH 44115 2851

| <u>Standard reference number</u> | <u>Title</u> | <u>Referenced in code section number</u> |
|----------------------------------|--|--|
| ANSI/DASMA 107 1997 (R2004) | Room Fire Test Standard for Garage Doors Using Foam Plastic Insulation | 2603.4.1.9 |
| 108 05 | Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference | 1715.5.2 |
| 115 05 | Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure | 1609.1.2.2 |

DOC

U.S. Department of Commerce
National Institute of Standards and Technology
1401 Constitution Avenue NW
Washington, DC 20230

| <u>Standard reference number</u> | <u>Title</u> | <u>Referenced in code section number</u> |
|----------------------------------|---|---|
| PS 1—07 | Structural Plywood..... | 2303.1.4, 2304.6.2, Table 2304.7(4), Table 2304.7(5), Table 2306.2.1(1), Table 2306.2.1(2) |
| PS 2—04 | Performance Standard for Wood based Structural use Panels | 2303.1.4, 2304.6.2, Table 2304.7(5), Table 2306.2.1(1), Table 2306.2.1(2) |
| PS 20 05 | American Softwood Lumber Standard..... | 1810.3.2.4, 2302.1, 2303.1.1 |

REFERENCED STANDARDS**DOJ**

U.S. Department of Justice
950 Pennsylvania Avenue, NW
Civil Rights Division, Disability Rights Section NYA
Washington, DC 20530

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| DOJ 36 CFR Part 1192 | American with Disabilities Act (ADA) Accessibility Guidelines for Transportation Vehicles (ADAAG) Department of Justice, 1991 | E109.2.4 |

DOL

U.S. Department of Labor
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402 9325

| Standard reference number | Title | Referenced in code section number |
|------------------------------|------------------------|-----------------------------------|
| 29 CFR Part 1910.1000 (1974) | Air Contaminants | 902.1 |

DOTn

U.S. Department of Transportation
c/o Superintendent of Documents
1200 New Jersey Avenue, SE
Washington, DC 20402 9325

| Standard reference number | Title | Referenced in code section number |
|-----------------------------|---|-----------------------------------|
| 49 CFR Parts 100 185 2005 | Hazardous Materials Regulations | 307.2 |
| 49 CFR Parts 173.137 (2005) | Shippers General Requirements for Shipments and Packaging Class 8 Assignment of Packing Group | 307.2 |
| 49 CFR 1998 | Specification of Transportation of Explosive and Other Dangerous Articles, UN 0335, UN 0336 Shipping Containers | 307.2 |

EN

European Committee for Standardization (EN)
Central Secretariat
Rue de Stassart 36
B 10 50 Brussels

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| EN 1081 98 | Resilient Floor Coverings Determination of the Electrical Resistance | 406.5.2 |

FEMA

Federal Emergency Management Agency
Federal Center Plaza
500 C Street S.W.
Washington, DC 20472

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| 352—00 | <i>Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment frame Buildings</i> | 3419.2 |
| FIA TB11 01 | Crawl space Construction for Buildings Located in Special Flood Hazard Areas | 1805.1.2.1 |

FM

Factory Mutual Global Research
Standards Laboratories Department
1301 Atwood Avenue, P.O. Box 7500
Johnston, RI 02919

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| FM 1950 10 | <i>Approval Standard for Seismic Sway Braces for Automatic Sprinkler Systems</i> | 1705A.12.3 |
| 3260 00 | <i>Radiant Energy Sensing Fire Detectors for Automatic Fire Alarm Signaling</i> . | |
| 3011 99 | <i>Approval Standard for Central Station Service for Fire Alarm and Protective Equipment Supervision</i> | |
| FM 4430 12 | <i>Approved Standard for Smoke and Heat Vents</i> | 910.3.2 |
| 4430 80 | <i>Acceptance Criteria for Smoke and Heat Vents</i> | 910.3.1 |
| 4450 (1989) | <i>Approval Standard for Class 1 Insulated Steel Deck Roofs—</i> with Supplements through July 1992 | 1508.1, 2603.3, 2603.4.1.5 |
| 4470 (1992) | <i>Approval Standard for Class 1 Roof Covers</i> | 1504.7 |
| 4474 (04) | <i>Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies</i> Using Static Positive and/or Negative Differential Pressures | 1504.3.1 |
| 4880 (2005) | <i>American National Standard for Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior and Exterior Finish Systems</i> | 2603.4, 2603.9 |

GA

Gypsum Association
810 First Street N.E. #510
Washington, DC 20002 4268

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|--|
| GA 216—07 | <i>Application and Finishing of Gypsum Panel Products</i> | Table 2508.1, 2509.2 |
| GA 600—06 | <i>Fire resistance Design Manual, 18th Edition</i> | Table 720.1(1), Table 720.1(2), Table 720.1(3) |

HPVA

Hardwood Plywood Veneer Association
1825 Michael Faraday Drive
Reston, VA 20190

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| HP-1—2004 | <i>Standard for Hardwood and Decorative Plywood</i> | 2303.3, 2304.6.2 |

HUD

U.S. Department of Housing and Urban Development
451 7th Street, SW
Washington, DC 20410

| Standard reference number | Title | Referenced in code section number |
|--------------------------------|--|-----------------------------------|
| HUD 24 CFR Part 3280 (1994) | <i>Manufactured Home Construction and Safety Standards</i> | G201 |

ICC

International Code Council, Inc.
500 New Jersey Ave, NW
6th Floor
Washington, DC 20001

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| ICC 300—12 | <i>ICC Standard on Bleachers, Folding and Telescopic Seating and Grandstands</i> .. 1028.1.1, Table 1607.1, 3401.1 | |
| ICC 400—12 | <i>Standard on Design and Construction of Log Structures</i> | 2301.2 |
| ICC 500—08 | <i>ICC/NSSA Standard on the Design and Construction of Storm Shelters</i> | 202, 423.1, 423.2 |
| ICC 600—08 | <i>Standard for Residential Construction in High Wind Regions</i> | 1609.1.1, 1609.1.1.1, 2308.2.1 |
| ICC ESAC 01 12* | <i>Acceptance Criteria for Expansion Anchors in Masonry Elements</i> | 1616A.1.19 |
| ICC ESAC 58 12* | <i>Acceptance Criteria for Adhesive Anchors in Masonry Elements</i> | 1616A.1.19 |
| ICC ESAC 70 12* | <i>Acceptance Criteria for Fasteners Power Driven into Concrete, Steel and Masonry Elements</i> | 908A.1.1 |
| ICC ESAC 77 | <i>Acceptance Criteria for Smoke Containment Systems Used with Fire resistance rated Elevator Hoistway Doors and Frames</i> | 707.14.1 |

REFERENCED STANDARDS

ICC—continued

| | | |
|--------------------------|--|-----------------------------|
| <i>ICC ES AC 106—12*</i> | <i>Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry</i> | <i>1616A.1.19</i> |
| <i>ICC ES AC 125 12*</i> | <i>Acceptance Criteria for Concrete, and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber Reinforced Polymer (FRP) Composite Systems</i> | <i>1914.3</i> |
| <i>ICC ES AC 156—12</i> | <i>Acceptance Criteria for Seismic Certification by Shake Table Testing of Nonstructural Components</i> | <i>1705A.12.4</i> |
| <i>ICC ES AC 178 12*</i> | <i>Acceptance Criteria for Inspection and Verification of Concrete, and Reinforced and Unreinforced Masonry Strengthening Using Fiber Reinforced Polymer (FRP) Composite Systems</i> | <i>1914A.3</i> |
| <i>ICC ES AC 193 12*</i> | <i>Acceptance Criteria for Mechanical Anchors in Concrete Elements</i> | <i>1616A.1.19, 1909A.11</i> |
| <i>ICC ES AC 308—12</i> | <i>Acceptance Criteria for Post Installed Adhesive Anchors in Concrete Elements</i> | <i>1616A.1.19</i> |
| <i>ICC ES AC 331</i> | <i>Acceptance Criteria for Smoke and Heat Vents</i> | <i>910.3.1</i> |
| <i>ICC ES AC 358 12</i> | <i>Acceptance Criteria for Helical Foundation Systems and Devices</i> | <i>1810A.3.1.5.1</i> |
| <i>SBCCI SSTD 11—97</i> | <i>Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles</i> | <i>1716.2.1, 1716.2.2</i> |

* Refers to International Building Code, 2012 as a reference standard.

ISO

International Organization for Standardization
ISO Central Secretariat
1 ch, de la Voie Creuse, Case Postale 56
CH 1211 Geneva 20, Switzerland

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| <i>ISO 8115—86</i> | <i>Cotton Bales—Dimensions and Density</i> | <i>Table 415.8.2.1.1</i> |
| <i>ISO 9001 08</i> | <i>Quality Management Systems Requirements</i> | <i>1705A.12.4</i> |
| <i>ISO 17025 05</i> | <i>General Requirement for Competence of Testing and Calibration Laboratories</i> | <i>1705A.12.4</i> |

NAAMM

National Association of Architectural Metal Manufacturers
800 Roosevelt Road, Bldg. C, Suite 312
Glen Ellyn, IL 60137

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| <i>FP 1001—07</i> | <i>Guide Specifications for Design of Metal Flag Poles</i> | <i>1609.1.1</i> |

NCMA

National Concrete Masonry Association
13750 Sunrise Valley
Herndon, VA 22071 4662

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| <i>TEK 5-84 (1996)</i> | <i>Details for Concrete Masonry Fire Walls</i> | <i>Table 720.1(2)</i> |

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169 7471

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|--|
| <i>11—10</i> | <i>Low, Medium and High Expansion Foam</i> | <i>904.7</i> |
| <i>12—05</i> | <i>Carbon Dioxide Extinguishing Systems</i> | <i>904.8, 904.11</i> |
| <i>12A—04 Halon 1301</i> | <i>Halon 1301 Fire Extinguishing Systems</i> | <i>904.9</i> |
| <i>13—13</i> | <i>Installation of Sprinkler Systems, as amended*</i> | <i>708.2, 903.3.1.1, 903.3.2, 903.3.5.1.1, 903.3.5.2, 904.11, 905.3.4, 907.6.3, 1613.6.3, 1616.9.5, 1616.10.17</i> |

*NFPA 13, Amended Sections as follows:

Revise Section 2.2 and add publications as follows:
2.2 NFPA Publications.

NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2013 California edition.

NFPA—continued

Revise Section 8.15.1.2.15 as follows:

8.15.1.2.15 Exterior columns under 10 ft² (0.93m²) in total area, formed by studs or wood joist, *with no sources of ignition within the column*, supporting exterior canopies that are fully protected with a sprinkler system, shall not require sprinkler protection.

Revise Section 8.15.5.7 as follows:

8.15.5.7 *The sprinkler required at the top and bottom of the elevator hoistway by 8.15.5.6 shall not be required where permitted by Chapter 30 of the California Building Code.*

Revise Section 8.15.7.1* as follows:

8.15.7.1* Unless the requirements of 8.15.7.2 or 8.15.7.3 are met, sprinklers shall be installed under exterior roofs, canopies, porte cochere, balconies, decks, or similar projections exceeding 4 ft (1.2 m) in width.

Revise Section 8.15.7.2* as follows:

8.15.7.2* Sprinklers shall be permitted to be omitted where the canopies, roofs, balconies, decks, or similar projections are constructed with materials that are noncombustible, limited-combustible, or fire retardant treated wood as defined in NFPA 703, *Standard for Fire Retardant Treated Wood and Fire-Retardant Coatings for Building Materials*.

Delete Section A.8.15.7.2 of Annex

Revise Section 8.15.7.3

8.15.7.3 Sprinklers shall be permitted to be omitted from below the canopies, roofs, balconies, decks, or similar projections are combustible construction, provided the exposed finish material on the roof, or canopy is noncombustible, limited-combustible, or fire retardant treated wood as defined in NFPA 703, *Standard for Fire Retardant Treated Wood and Fire-Retardant Coatings for Building Materials*, and the roofs, or canopies contains only sprinklered concealed spaces or any of the following unsprinklered combustible concealed spaces:

- (1) *Combustible concealed spaces filled entirely with noncombustible insulation.*
- (2) *Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are directly attached to the bottom of solid wood joists so as to create enclosed joist spaces 160 ft³ (4.5 m³) or less in volume, including space below insulation that is laid directly on top or within the ceiling joists in an otherwise sprinklered attic [See 11.2.3.1.4(4)(d)].*
- (3) *Concealed spaces over isolated small roofs, or canopies not exceeding 55 ft² (5.1 m²).*

**Delete language to section 8.15.7.4 and reserve section number.
8.15.7.4.**

Revise Annex Section A.8.15.7.5 as follows:

A. 8.15.7.5 The presence of planters, newspaper machines and *similar items*, should not be considered storage.

Add Section 8.15.7.6 as follows:

8.15.7.6 Sprinklers may be omitted for following structures:

- (1) *Solar photovoltaic panel structures with no use underneath. Signs may be provided, as determined by the enforcing agency prohibiting any use underneath including storage.*
- (2) *Solar photovoltaic (PV) panels supported by framing that have sufficient uniformly distributed and unobstructed openings throughout the top of the array (horizontal plane) to allow heat and gases to escape, as determined by the enforcing agency.*

Add new Sections 8.16.1.1.4 and 8.16.1.1.5 as follows:

8.16.1.1.4 Where a system includes floor control valves, a hydraulic design information sign containing information for the floor shall be provided at each floor control valve. A hydraulic design information sign shall be provided for each area calculated. The installing contractor shall identify a hydraulically designed sprinkler system with a permanently marked weatherproof metal or rigid plastic sign secured with corrosion resistant wire, chain, or other approved means. Such signs shall be placed at the alarm valve, dry pipe valve, preaction valve, or deluge valve supplying the corresponding hydraulically designed area.

8.16.1.1.5 Control valves, check valves, drain valves, antifreeze valves shall be readily accessible for inspection, testing, and maintenance. Valves located more than 7 feet above the finished floor shall be provided with a means of opening and closing the valve from the floor level.

NFPA—continued

Add new Sections 8.16.1.7, 8.16.1.7.1, 8.16.1.7.1.1, 8.16.1.7.1.2, 8.16.1.7.1.2, 8.16.1.7.1.3 and 8.16.1.7.2, as follows:

8.16.1.7 Sectional Valves.

8.16.1.7.1 Private fire service main systems shall have sectional control valves at appropriate points in order to permit sectionalizing the system in the event of a break or for the making of repairs or extensions.

8.16.1.7.1.1 Sectional control valves are not required when the fire service main system serves less than six fire appurtenances.

8.16.1.7.1.2 Sectional control valves shall be indicating valves in accordance with Section 6.7.1.3.

8.16.1.7.1.3 Sectional control valves shall be located so that no more than five fire appurtenances are affected by shut down of any single portion of the fire service main. Each fire hydrant, fire sprinkler system riser, and standpipe riser shall be considered a separate fire appurtenance. In rack sprinkler systems shall not be considered as a separate appurtenance.

8.16.1.7.1.4 The number of fire appurtenances between sectional control valves is allowed to be modified by the authority having jurisdiction.

8.16.1.7.2 A valve shall be provided on each bank where a main crosses a body of water or outside the building foundation(s) where the main or section of main runs under a building.

Add new Section 9.1.3.9.1.1 as follows:

9.1.3.9.1.1 Powder driven studs used for attaching hangers to the building structure are prohibited in Seismic design Categories C, D, E and F

Revise Section 9.3.5.11.4 as follows:

9.3.5.11.4 Where threaded pipe is used for sway bracing, it shall have a wall thickness of not less than Schedule 40.

Replace Section 9.3.5.12.4 as follows:

Lag screws or power driven fasteners shall not be used to attach braces to the building structure.

Add language to the beginning of Section 9.3.5.12.6 as follows:

9.3.5.12.6 Fastening methods other than those identified in 9.3.5.12 shall not apply to other fastening methods, which shall be acceptable for use if certified by a registered professional engineer to support the loads determined in accordance with the criteria in 9.3.5.9. Calculations shall be submitted to the authority having jurisdiction.

Revise Section 9.3.5.12.7.2 as follows:

9.3.5.12.7.2 Concrete anchors other than those shown in Figure 9.3.5.12.1 and identified in 9.3.5.11.11 shall be acceptable for use where designed in accordance with the requirements of the building code and certified by a registered professional engineer.

Revise Section 9.3.6.1(3) as follows:

9.3.6.1*(3) No. 12, 440 lb (200 Kg) wire installed at least 45 degrees from the vertical plane and anchored on both sides of the pipe. Powder driven fasteners for attaching restraint is allowed to be used provided that the restraint component does not support the dead load.

Revise Section 10.6.4 as follows:

10.6.4 Pipe joints shall not be located under foundation footings. The pipe under the building or building foundation shall not contain mechanical joints.

Exceptions:

1. Where allowed in accordance with 10.6.2.
2. Alternate designs may be utilized where designed by a registered professional engineer and approved by the enforcing agency.

Revise Section 11.2.3.1.4(4)(i) as follows:

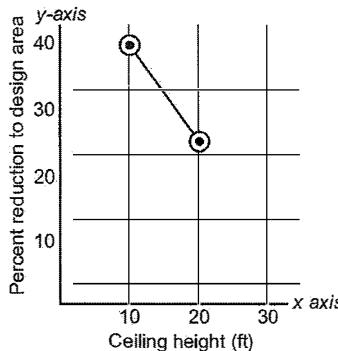
11.2.3.1.4(4)(i) Exterior columns under 10 ft² (0.93m²) in total area, formed by studs or wood joist, with no sources of ignition within the column, supporting exterior canopies that are fully protected with a sprinkler system.

NFPA—continued

Revise Section 11.2.3.2.3.1 as follows:

11.2.3.2.3.1 Where listed quick response sprinklers, excluding extended coverage quick response sprinklers, are used throughout a system or portion of a system having the same hydraulic design basis, the system area of operation shall be permitted to be reduced without revising the density as indicated in Figure 11.2.3.2.3.1 when all of the following conditions are satisfied:

- (1) Wet pipe system.
- (2) Light hazard occupancy.
- (3) 20 ft (6.1 m) maximum ceiling height.
- (4) There are no unprotected ceiling pockets as allowed by 8.6.7 and 8.8.7 exceeding 32 ft² (3 m²).



Note: $y = \frac{3x}{2} + 55$

For ceiling height ≥ 10 ft and ≤ 20 ft, $y = \frac{-3x}{2} + 55$

For ceiling height < 10 ft, $y = 40$

For ceiling height > 20 ft, $y = 0$

For SI units, 1 ft = 0.31 m.

FIGURE 11.2.3.2.3.1 Design Area Reduction for Quick-Response Sprinklers.

Revise Section 11.2.3.2.3.2 as follows:

11.2.3.2.3.2 The number of sprinklers in the design area shall never be less than seven.

Revise Section 12.1.1.2 as follows:

12.1.1.2 Early suppression fast response (ESFR) sprinklers shall not be used in buildings with automatic heat or smoke vents unless the vents use a standard response operating mechanism with a minimum temperature rating of 360°F (182°C) or 100°F (56°C) above the operating temperature of the sprinklers, whichever is higher.

Add Section 25.1(5)

25.1 Approval of Sprinkler Systems and Private Fire Service Mains.

The installing contractor shall do the following:

- (1) Notify the authority having jurisdiction and the property owner or property owner's authorized representative of the time and date testing will be performed.
- (2) Perform all required testing (see Section 24.2).
- (3) Complete and sign the appropriate contractor's material and test certificate(s) (see Figure 24.1).
- (4) Remove all caps and straps prior to placing the sprinkler system in service.
- (5) Upon system acceptance by the authority having jurisdiction a label prescribed by Title 19 California Code of Regulations, Chapter 5 shall be affixed to each system riser.

Revise Section 25.4(2) and Add Section 25.4(3) as follows:

25.4 Instructions.

The installing contractor shall provide the property owner or the property owner's authorized representative with the following:

- (1) All literature and instructions provided by the manufacturer describing proper operation and maintenance of any equipment and devices installed.

NFPA—continued

(2) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems, 2013 California Edition.*

(3) *Title 19, California Code of Regulations, Chapter 5, “Fire Extinguishing Systems.”*

Add sentence at the end of Section 25.5.1 as follows:

25.5.1 “*Pipe schedule systems shall be provided with a sign indicating that the system was designed and installed as a pipe schedule system and the hazard classification(s) included in the design.*”

Revise Section 25.5.2(3) and Add Sections 25.5.2(7) to (14) as follows:

25.5.2 The sign shall include the following information:

(3) Required flow and pressure of the system at the base of the riser.

(7) *Required flow and pressure of the system at the water supply source.*

(8) *Required flow and pressure of the system at the discharge side of the fire pump where a fire pump is installed.*

(9) *Type or types and number of sprinklers or nozzles installed including the orifice size, temperature rating, orientation, K Factor, sprinkler identification number (SIN) for sprinkler heads when applicable, and response type.*

(10) *The minimum discharge flow rate and pressure required from the hydraulically most demanding sprinkler.*

(11) *The required pressure settings for pressure reducing valves.*

(12) *For deluge sprinkler systems, the required flow and pressure at the hydraulically most demanding sprinkler or nozzle.*

(13) *The protection area per sprinkler based on the hydraulic calculations.*

(14) *The edition of NFPA 13 to which the system was designed and installed.*

Revise Section 25.6.1 as follows:

25.6.1 *California Edition NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems.*

13D—13

Standard for the Installation of Sprinkler Systems in One-and Two Family Dwellings
and Manufactured Homes as amended* 903.3.1.3, 903.3.5.1.1

***NFPA 13D, Amended Sections as follows:**

Revise 6.2.2, 6.2.2.1, 6.2.4 to read as follows:

6.2.2 Where a well, pump, tank or combination thereof is the source of supply for a fire sprinkler system, the water supply shall serve both domestic and fire sprinkler systems, and the following shall be met:

(1) A test connection shall be provided downstream of the pump that creates a flow of water equal to the smallest sprinkler on the system. The connection shall return water to the tank.

(2) Any disconnecting means for the pump shall be approved.

(3) A method for refilling the tank shall be piped to the tank.

(4) A method of seeing the water level in the tank shall be provided without having to open the tank.

(5) The pump shall not be permitted to sit directly on the floor.

6.2.2.1 Where a fire sprinkler system is supplied by a stored water source with an automatically operated means of pressurizing the system other than an electric pump, the water supply may serve the sprinkler system only.

6.2.4 Where a water supply serves both domestic and fire sprinkler systems, 5 gpm (19 L/min) shall be added to the sprinkler system demand at the point where the systems are connected, to determine the size of common piping and the size of the total water supply requirements where no provision is made to prevent flow into the domestic water system upon operation of a sprinkler.

8.3.4* Sprinklers shall not be required in detached garages, open attached porches, carports with no habitable space above, and similar structures.

NFPA—continued**Add Section 8.4 as follows:****8.4 Sprinklers shall be permitted to be omitted for following structures:**

(1) Solar photovoltaic panel structures with no use underneath. Signs may be provided, as determined by the enforcing agency prohibiting any use underneath including storage.

(2) Solar photovoltaic (PV) panels supported by framing that have sufficient uniformly distributed and unobstructed openings throughout the top of the array (horizontal plane) to allow heat and gases to escape, as determined by the enforcing agency.

13R—13

Installation of Sprinkler Systems in Residential Occupancies

up to and Including Four Stories in Height as amended 903.3.1.2, 903.3.5.1.1, 903.3.5.1.2, 903.4

NFPA 13R, Amended Sections as follows:*Revise Section 2.2 and add publications as follows:****2.2 NFPA Publications.**

NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems, 2013 California edition.

Add new Section 6.6.9, as follows:**6.6.9 Sprinklers shall be permitted to be omitted for following structures:**

(1) Solar photovoltaic panel structures with no use underneath. Signs may be provided, as determined by the enforcing agency prohibiting any use underneath including storage.

(2) Solar photovoltaic (PV) panels supported by framing that have sufficient uniformly distributed and unobstructed openings throughout the top of the array (horizontal plane) to allow heat and gases to escape, as determined by the enforcing agency.

Revise Section 11.4:**11.4 Instructions.**

The installing contractor shall provide the property owner or the property owner's authorized representative with the following:

(1) All literature and instructions provided by the manufacturer describing proper operation and maintenance of any equipment and devices installed.

(2) NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems 2013 California Edition and Title 19, California Code of Regulations, Chapter 5.

(3) Once the system is accepted by the authority having jurisdiction a label as prescribed by Title 19, California Code of Regulations, Chapter 5, shall be affixed to each system riser.

14—13

Installation of Standpipe and Hose System, as amended*

905.2, 905.3.4, 905.4.2, 905.6.2, 905.8

NFPA 14, Amended Sections as follows: Replace Section 6.3.7.1

6.3.7.1 System water supply valves, isolation control valves, and other valves in fire mains shall be supervised in an approved manner in the open position by one of the following methods:

(1) Where a building has a fire alarm system or a sprinkler monitoring system installed, the valve shall be supervised by:
 (a) a central station, proprietary, or remote supervising station, or
 (b) a local signaling service that initiates an audible signal at a constantly attended location.

(2) Where a building does not have a fire alarm system or a sprinkler monitoring system installed, the valve shall be supervised by:
 (a) Locking the valves in the open position, or
 (b) Sealing of valves and a approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner.

15 12

Water Spray Fixed Systems for Fire Protection

16—07

Installation of Foam-water Sprinkler and Foam-water Spray Systems 904.7, 904.11

17 13

Dry Chemical Extinguishing Systems 904.6, 904.11

17A 13

Wet Chemical Extinguishing Systems 904.5, 904.11

20—13

Installation of Stationary Pumps for Fire Protection 913.1, 913.2.1, 913.5

22 13

Water Tanks for Private Fire Protection

24 13

Installation of Private Fire Service Mains and Their Appurtenances, as amended*

NFPA—continued**NFPA 24, Amended Sections as follows: Amend Section 4.2.1**

Section 4.2.1. Installation work shall be done by fully experienced and responsible contractors. Contractors shall be appropriately licensed in the State of California to install private fire service mains and their appurtenances.

Revise Section 4.2.2 as follows:

4.2.2 Installation or modification of private fire service mains shall not begin until plans are approved and appropriate permits secured from the authority having jurisdiction.

Add Section 4.2.2.1 as follows:

4.2.2.1 As approved by the authority having jurisdiction, emergency repair of existing system may start immediately, with plans being submitted to the authority having jurisdiction within 96 hours from the start of the repair work.

Revise Section 5.9.1.2 as follows:

Section 5.9.1.2 Fire department connections shall be properly supported and protected from mechanical damage.

Revise Section 5.9.5.1 as follows:

5.9.5.1 Fire department connections shall be on the street side of buildings and as approved by the authority having jurisdiction.

Revise Section 6.5.1 as follows:

6.5.1 Private fire service main systems shall have sectional control valves at appropriate points in order to permit sectionalizing the system in the event of a break or for the making of repairs or extensions.

Add Sections 6.5.2.1 6.5.2.3

6.5.2.1 Sectional control valves are not required when the fire service main system serves less than six fire appurtenances.

6.5.2.2 Sectional control valves shall be indicating valves in accordance with Section 6.7.1.3.

6.5.2.3 Sectional control valves shall be located so that no more than five fire appurtenances are affected by shut down of any single portion of the fire service main. Each fire hydrant, fire sprinkler system riser, and standpipe riser shall be considered a separate fire appurtenance. In rack sprinkler systems shall not be considered as a separate appurtenance.

6.5.2.4 The number of fire appurtenances between sectional control valves is allowed to be modified by the authority having jurisdiction.

Revise Section 6.6.2 as follows:

6.6.2 A sectional valve shall be provided at the following locations: (1) On each bank where a main crosses a body of water

(2) Outside the building foundation(s) where a main or a section of a main runs under a building

Revise Section 10.6.5 as follows:

10.6.5 Pipe joints shall not be located under foundation footings. The pipe under the building or building foundation shall not contain mechanical joints.

Exceptions:

1. Where allowed in accordance with Section 10.6.2

2. Alternate designs may be utilized where designed by a registered professional engineer and approved by the enforcing agency.

Revise Section 10.9.1 as follows:

10.9.1 Backfill shall be well tamped in layers or puddle under and around pipes to prevent settlement or lateral movement.

Backfill shall consist of clean fill sand or pea gravel to a minimum 6" below and to a minimum of 12" above the pipe and shall contain no ashes, cinders, refuse, organic matter, or other corrosive materials. Other backfill materials and methods are permitted where designed by a registered professional engineer and approved by the enforcing agency.

| | | |
|-------|---|--|
| 30—08 | Flammable and Combustible Liquids Code | 415.3 |
| 31—11 | Installation of Oil burning Equipment | 2113.15 |
| 32—07 | Dry Cleaning Plants | 415.6.4 |
| 37—10 | Installation and Use of Stationary Combustion Engines and Gas Turbines | |
| 40—07 | Storage and Handling of Cellulose Nitrate Film | 409.1 |
| 52—13 | Compressed Natural Gas (CNG) Vehicular Gaseous Fuel Systems Code | |
| 54—12 | National Fuel Gas Code | |
| 58—08 | Liquefied Petroleum Gas Code | 415.6.3 |
| 61—13 | Prevention of Fires and Dust Explosions in Agricultural and Food Product Facilities | 415.6.1 |
| 70—08 | National Electrical Code | 108.3, 415.8.2.8.2, 904.3.1, 907.6.1, 909.12.1, 909.16.3, 1205.4.1, 2701.1, 3401.3, H106.1, H106.2, K101, K111.1 |

NFPA—continued

72—13

National Fire Alarm and Signaling Code, as amended* 901.6, 903.4.1, 904.3.5, 907.2, 907.2.5, 907.2.11, 907.2.13.2, 907.3, 907.3.3, 907.3.4, 907.5.2.1.2, 907.5.2.2, 907.6, 907.6.1, 907.6.5, 907.7, 907.7.1, 907.7.2, 911.1.5, 3006.5, 3007.6

*NFPA 72, Amended Sections as follows:

10.3.1 Equipment constructed and installed in conformity with this code shall be listed for the purpose for which it is used. *Fire alarm systems and components shall be California State Fire Marshal approved and listed in accordance with California Code of Regulations, Title 19, Division 1.*

10.3.3 All devices and appliances that receive their power from the initiating device circuit or signaling line circuit of a control unit shall be *California State Fire Marshal* listed for use with the control unit.

10.7.1 Where approved by the authority having jurisdiction, ECS priority signals when evaluated by stakeholders through risk analysis in accordance with 24.3.1.1 shall be permitted to take precedence over all other signals.

14.4.6.1 Testing. Household fire alarm systems shall be tested in accordance with the manufacturer's published instructions according to the methods of Table 14.4.3.2.

17.15 Fire Extinguisher Electronic Monitoring Device. A fire extinguisher electronic monitoring device shall indicate those conditions for a specific fire extinguisher required by *California Code of Regulations, Title 19, Division 1, Chapter 1, Section 574.2(c) and California Fire Code to a fire alarm control unit.*

21.3.6 Smoke detectors shall not be installed in unsprinklered elevator hoistways unless they are installed to activate the elevator hoistway smoke relief equipment or where required by Chapter 30 of the California Building Code.

12.3.7 (4) Where the vertically run conductors are contained in a 2 hour rated cable assembly, or enclosed (installed) in a 2 hour rated enclosure or a listed circuit integrity (C.I.) cable, which meets or exceeds a 2 hour fire resistive rating.

23.8.5.1.2 Where connected to a supervising station, fire alarm systems employing automatic fire detectors or waterflow detection devices shall include a manual fire alarm box to initiate a signal to the supervising station.

Exception: Fire alarm systems dedicated to elevator recall control, supervisory service and fire sprinkler monitoring as permitted in section 21.3 of NFPA 72.

23.8.5.4.1 Systems equipped with alarm verification features shall be permitted under the following conditions:

(1) The alarm verification feature is not initially enabled unless conditions or occupant activities that are expected to cause nuisance alarms are anticipated in the area that is protected by the smoke detectors. Enabling of the alarm verification feature shall be protected by password or limited access.

(2) A smoke detector that is continuously subjected to a smoke concentration above alarm threshold does not delay the system functions of Sections 10.7 through 10.16, 23.8.1.1, or 21.2.1 by more than 30 seconds.

(3) Actuation of an alarm initiating device other than a smoke detector causes the system functions of Sections 10.7 through 10.16, 23.8.1.1, or 21.2.1 without additional delay.

(4) The current status of the alarm verification feature is shown on the record of completion (see Figure 7.8.2(a), item 4.3).

(5) Operation of a patient room smoke detector in I 2 and R 2.1 Occupancies shall not include an alarm verification feature.

29.3.1 All devices, combinations of devices, and equipment to be installed in conformity with this chapter shall be approved and listed by the *California State Fire Marshal* for the purposes for which they are intended.

29.5.2.1.1* Smoke and Heat Alarms. Unless exempted by applicable laws, codes, or standards, smoke or heat alarms used to provide a fire warning function, and when two or more alarms are installed within a dwelling unit, suite of rooms, or similar area, shall be arranged so that the operation of any smoke or heat alarm causes all alarms within these locations to sound.

Exception to 29.5.2.1.1 not adopted by the SFM.

29.7.2.1 The alarm verification feature shall not be used for household fire warning equipment.

29.7.6.7.1 The alarm verification feature shall not be used for household fire warning equipment.

29.8.3.4 Specific Location Requirements. The installation of smoke alarms and smoke detectors shall comply with the following requirements:

(1) Smoke alarms and smoke detectors shall not be located where ambient conditions, including humidity and temperature, are outside the limits specified by the manufacturer's published instructions.

(2) Smoke alarms and smoke detectors shall not be located within unfinished attics or garages or in other spaces where temperatures can fall below 40°F (4°C) or exceed 100°F (38°C).

NFPA—continued

(3) Where the mounting surface could become considerably warmer or cooler than the room, such as a poorly insulated ceiling below an unfinished attic or an exterior wall, smoke alarms and smoke detectors shall be mounted on an inside wall.

(4) *Smoke alarms or smoke detectors shall be installed a minimum of 20 feet horizontal distance from a permanently installed cooking appliance.*

Exception: Ionization smoke alarms with an alarm silencing switch or photoelectric smoke alarms shall be permitted to be installed 10 feet (3 m) or greater from a permanently installed cooking appliance.

Photoelectric smoke alarms shall be permitted to be installed greater than 6 feet (1.8 m) from a permanently installed cooking appliance where the kitchen or cooking area and adjacent spaces have no clear interior partitions and the 10 ft distances would prohibit the placement of a smoke alarm or smoke detector required by other sections of the code.

Smoke alarms listed for use in close proximity to a permanently installed cooking appliance.

(5) *Installation near bathrooms. Smoke alarms shall be installed not less than a 3 foot (0.91 m) horizontal distance from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by other sections of the code.*

(6) Smoke alarms and smoke detectors shall not be installed within a 36 in. (910 mm) horizontal path from the supply registers of a forced air heating or cooling system and shall be installed outside of the direct airflow from those registers.

(7) Smoke alarms and smoke detectors shall not be installed within a 36 in. (910 mm) horizontal path from the tip of the blade of a ceiling suspended (paddle) fan.

(8) Where stairs lead to other occupied levels, a smoke alarm or smoke detector shall be located so that smoke rising in the stairway cannot be prevented from reaching the smoke alarm or smoke detector by an intervening door or obstruction.

(9) For stairways leading up from a basement, smoke alarms or smoke detectors shall be located on the basement ceiling near the entry to the stairs.

(10) For tray shaped ceilings (coffered ceilings), smoke alarms and smoke detectors shall be installed on the highest portion of the ceiling or on the sloped portion of the ceiling within 12 in. (300 mm) vertically down from the highest point.

(11) Smoke alarms and detectors installed in rooms with joists or beams shall comply with the requirements of 17.7.3.2.4.

(12) Heat alarms and detectors installed in rooms with joists or beams shall comply with the requirements of 17.6.3.

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|--------|---|--|
| 80—13 | Fire Doors and Other Opening Protectives | 410.3.5, 508.2.5.2, 715.4, 715.4.5, 715.4.6, 715.4.7.1, 715.4.8.2, 715.5, 715.5.5, 1008.1.4.3 |
| 85—07 | Boiler and Combustion System Hazards Code | 415.6.1 |
| | (Note: NFPA 8503 has been incorporated into NFPA 85) | |
| 92—12 | Standard for Smoke Control Systems | 909.8 |
| 99—12 | Health Care Facilities Code | 407.10 |
| 101—12 | Life Safety Code | 807.4.3.2, 1028.6.2 |
| 105—13 | Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives | 405.4.2, 715.4.3.1, 909.20.4.1 |
| 110—13 | Emergency and Standby Power Systems | 2702.1 |
| 111—13 | Stored Electrical Energy Emergency and Standby Power Systems | 2702.1 |
| 120—10 | Fire Prevention and Control in Coal Mines | 415.6.1 |
| 170—09 | Standard for Fire Safety and Emergency Symbols | 907.1.2 |
| 211—13 | Chimneys, Fireplaces, Vents and Solid Fuel-burning Appliances | 2112.5 |
| 252—03 | Standard Methods of Fire Tests of Door Assemblies | 715.3, 715.4.1, 715.4.2, 715.4.3, 715.4.7.3.1 |
| 253—06 | Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source | 402.12.1, 406.6.4, 804.2, 804.3 |
| 257—07 | Standard for Fire Test for Window and Glass Block Assemblies | 715.3, 715.4.3.2, 715.5, 715.5.1, 715.5.2, 715.5.9.1 |
| 259—13 | Test Method for Potential Heat of Building Materials | 2603.4.1.10, 2603.5.3 |
| 265—07 | Method of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings on Full Height Panels and Walls | 803.1.3, 803.1.3.1 |
| 268—07 | Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source | 1406.2.1, 1406.2.1.1, 1406.2.1.2, 2603.5.7, D105.1 |
| 275—13 | Standard Method of Fire Tests for the Evaluation of Thermal Barriers Used Over Foam Plastic Insulation | |
| 285—06 | Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components | 1407.10.4, 2603.5.5 |
| 286—06 | Standard Method of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth | 402.16.4, 803.1.2, 803.1.2.1, 803.9, 2603.4, 2603.9 |
| 288—12 | Standard Method of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire-resistance-rated Assemblies | 712.8 |
| 289—13 | Standard Method of Fire Test for Individual Fuel Packages | |
| 409—11 | Aircraft Hangars | 412.4.6, Table 412.4.6, 412.4.6.1, 412.6.5 |

NFPA—continued

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|---------|---|---|
| 418—06 | Standard for Heliports | 412.7.4 |
| 484—06 | Combustible Metals | 415.6.1 |
| 502—14 | <i>Standard for Road Tunnels, Bridges, and Other Limited Access Highways</i> | 429 |
| 654—13 | Prevention of Fire & Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids | 415.6.1 |
| 655—07 | Prevention of Sulfur Fires and Explosions | 415.6.1 |
| 664—07 | Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities | 415.6.1 |
| 701—04 | Standard Methods of Fire Tests for Flame-propagation of Textiles and Films | 402.12.1, 410.3.6, 801.1.4, 806.1, 806.1.2, 806.2, 3102.3, 3102.3.1, 3102.6.1.1, 3105.4, D102.2.8, H106.1.1 |
| 704—07 | Standard System for the Identification of the Hazards of Materials for Emergency Response | 414.7.2, 415.2 |
| 720—I2 | <i>Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment</i> | 420.6 |
| 1124—I3 | Manufacture, Transportation, Storage, and Retail Sales of Fireworks and Pyrotechnic Articles | 415.3.1 |
| 2001—I2 | Clean Agent Fire Extinguishing Systems, <i>as amended*</i> | Table 901.6.1, 904.10 |

NFPA 2001, Amended Sections as follows:*4.3.5.1.1 Alarms signals from the fire extinguishing system shall not interfere with the building fire alarm signal.****4.3.5.2.1 The lens on visual appliances shall be “red” in color.***Exception: Other lens colors are permitted where approved by the enforcing agency.***PCI**

Precast Prestressed Concrete Institute
209 W. Jackson Boulevard, Suite 500
Chicago, IL 60606 6938

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| MNL 124—89 | Design for Fire Resistance of Precast Prestressed Concrete | 721.2.3.1 |
| MNL 128—01 | Recommended Practice for Glass Fiber Reinforced Concrete Panels | 1913.2.1 |
| PCI 120—I0 | <i>PCI Design Handbook 7th Edition</i> | 1905A.1 |

PTI

Post Tensioning Institute
8601 North Black Canyon Highway, Suite 103
Phoenix, AZ 85021

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|---|
| PTI 2004 | <i>Recommendations for Prestressed Rock and Soil Anchors (4th Edition)</i> | 1811A.2, 1810A.3.10.4, J106.2.4, J106.2.5 |
| PTI—2007 | Standard Requirements for Analysis of Shallow Concrete Foundations on Expansive Soils, Third Edition | 1808.6.2 |
| PTI—2007 | Standard Requirements for Design of Shallow Post-tensioned Concrete Foundation on Expansive Soils, Second Edition | 1808.6.2 |

REFERENCED STANDARDS

SFM

*State of California
Department of Forestry and Fire Protection
Office of the State Fire Marshal
P.O. Box 944246
Sacramento, CA 94246 2460*

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| 12 3 | <i>Releasing Systems for Security Bars in Dwellings</i> | 1029.4 |
| 12 7 3 | <i>Fire testing Furnaces</i> | NA |
| 12 7A 1 | <i>Exterior Wall Siding and Sheathing</i> | 703A.7, 707A.2 |
| 12 7A 2 | <i>Exterior Window</i> | 703A.7, 708A.2.1 |
| 12 7A 3 | <i>Under Eave</i> | 703A.7, 707A.8 |
| 12 7A 4 | <i>Decking</i> | 703A.7, 709A.3 |
| SFM 12 7A 4A | <i>Decking Alternate Method A</i> | 703A.7, 709A.3 |
| SFM 12-7A 5 | <i>Ignition Resistant Building Material</i> | 703A.7, 709A.3 |
| 12 8 100 | <i>Room Fire Tests for Wall and Ceiling Materials</i> | NA |
| 12 10 1 | <i>Power Operated Exit Doors</i> | NA |
| 12 10 2 | <i>Single Point Latching or Locking Devices</i> | NA |
| 12 10 3 | <i>Emergency Exit and Panic Hardware</i> | NA |

(The Office of the State Fire Marshal standards referred to above are found in the California Code of Regulations, Title 24, Part 12.)

RMI

Rack Manufacturers Institute
8720 Red Oak Boulevard, Suite 201
Charlotte, NC 28217

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| ANSI/MH16.1—08 | Specification for Design, Testing and Utilization of Industrial Steel Storage Racks..... | 2208.1 |

SDI

Steel Deck Institute
P. O. Box 25
Fox River Grove, IL 60021

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| ANSI/NC1.0—06 | Standard for Noncomposite Steel Floor Deck | 2209.2.2, 2209.2.2.1 |
| ANSI/RD1.0—06 | Standard for Steel Roof Deck | 2209.2.3 |
| ANSI/SDI-C-2012 | Standard for Composite Steel Floor Deck Slabs..... | 2210A.1.1.3 |

SJI

Steel Joist Institute
1173B London Links Drive
Forest, VA 24551

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| CJ-1.0—06 | Standard Specification for Composite Steel Joists, CJ-series..... | 1604.3.3, 2203.2, 2206.1 |
| JG-1.1—05 | Standard Specification for Joist Girders | 1604.3.3, 2203.2, 2206.1 |
| K-1.1 05 | Standard Specification for Open Web Steel Joists, K-series..... | 1604.3.3, 2203.2, 2206.1 |
| LH/DLH-1.1—05 | Standard Specification for Longspan Steel Joists, LH-series and Deep Longspan Steel Joists, DLH-series | 1604.3.3, 2203.2, 2206.1 |

SPRI

Single Ply Roofing Institute
411 Waverly Oaks Road, Suite 331B
Waltham, MA 02452

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| SPRI/ANSI/ES-1—03 | Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems..... | 1504.5 |
| RP-4—02 | Wind Design Guide for Ballasted Single-ply Roofing Systems | 1504.4 |

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TIA

Telecommunications Industry Association
2500 Wilson Boulevard
Arlington, VA 22201 3834

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| TIA 222 G 05 | Structural Standards for Steel Antenna Towers and Antenna Supporting Structures including Addendum 1, 222 G 1, Dated 2007 | 1609.1.1, 3108.1, 3108.2 |

TMS

The Masonry Society
3970 Broadway, Unit 201 D
Boulder, CO 80304 1135

| Standard reference number | Title | Referenced in code section number | |
|---------------------------|---|---|--|
| 0216—97 | Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies | Table 720.1(2), 721.1 | |
| 0302 07 | Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls | 1207.2.1 | |
| 402 11 | Building Code Requirements for Masonry Structures | 1405.6, 1405.6.2, 1405.10, 1410.2.1, 1604.3.4, Table 1703.4.5.3, 1704.5, 1704.5.1, Table 1704.5.1, 1704.5.2, 1704.5.3, 1807.1.6.3.2, 1808.9, 2101.2.2, 2101.2.3, 2101.2.4, 2101.2.5, 2101.2.6, 2103.1.3.6, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2107.5, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, 2114.10, 2114.11 | |
| 602 08 | Specification for Masonry Structures | 1405.6.1, Table 1704.5.1, Table 1704.5.3, 1807.1.6.3, 2103.8, 2103.11, 2103.12, 2103.13, 2104.1, 2104.1.1, 2104.1.2, 2104.1.3, 2104.2, 2104.3, 2104.4, 2105.2.2.1.1, 2105.2.2.1.2, 2105.2.2.1.3 | |

TPI

Truss Plate Institute
218 N. Lee Street, Suite 312
Alexandria, VA 22314

| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| TPI 1 2007 | National Design Standards for Metal plate connected Wood Truss Construction | 2303.4.6, 2306.1 |

UBC

International Code Council, Inc.
500 New Jersey Avenue, NW 6th Floor
Washington, DC 20001

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| UBC Standard 15-2 | Test Standard for Determining the Fire Retardancy of Roof Covering Materials | 1505.6 |
| UBC Standard 15-3 | Wood Shakes | 1505.6 |
| UBC Standard 15-4 | Wood Shingles | 1505.6 |

UL

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062 2096

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| 9 2000 | Fire Tests of Window Assemblies with Revisions through April 2005 ... 715.3, 715.4.3.2, 715.5, 715.5.1, 715.5.2, 715.5.9.1 | |
| 10A 98 | Tin Clad Fire Doors with Revisions through March 2003 | 715.4 |
| 10B 97 | Fire Tests of Door Assemblies with Revisions through October 2001 | 715.4.2 |
| 10C 98 | Positive Pressure Fire Tests of Door Assemblies with Revisions through November 2001 | 715.4.1, 715.4.3 |
| 13 96 | <i>Power limited Circuit Cables</i> | |
| 14B 98 | Sliding Hardware for Standard Horizontally mounted Tin Clad Fire Doors with Revisions through July 2000 | 715.4 |
| 14C—06 | Swinging Hardware for Standard Tin Clad Fire Doors Mounted Singly and in Pairs | 715.4 |
| 38—99 | <i>Manually Actuated Signaling Boxes with revisions through February 2, 2005 as amended.*</i> | |

UL—continued

**Amend Section 14.1.5 as follows:*

14.1.5 A signaling box having a glass panel, disc, rod or similar part that must be broken to operate it for a signal or for access to its actuating means shall satisfactorily complete five part breaking operations using the means provided with the box, without jamming of the mechanism or other interference by broken particles. It shall be practicable to remove and replace the broken parts. A signaling box shall not have a glass panel, disc, rod or similar part requiring a striking action by grasping a tool to operate it for a signal. The force required to activate controls shall be no greater than 5 pounds (22 N) of force.

**Add Appendix B chapter to UL 38 (1999) as follows:*

Appendix B,

14.1.5 Operation. Controls and operating mechanisms shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist.

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|-----------|---|--|
| 103—01 | Factory built Chimneys, for Residential Type and Building Heating Appliances with Revisions through June 2006 | 717.2.5.1 |
| 127 96 | Factory built Fireplaces with Revisions through November 2006 | 717.2.5.1, 2111.11 |
| 193 04 | <i>Alarm Valves for Fire Protection Service</i> | |
| 199 95 | <i>Automatic Sprinklers for Fire Protection Service with revisions through August 19, 2005</i> | |
| 199E—04 | Outline of Investigation for Fire Testing of Sprinklers and Water Spray Nozzles for Protection of Deep Fat Fryers | 904.11.4.1 |
| 217—06 | Single and Multiple Station Smoke Alarms with Revisions through August 2005 | 907.2.11 |
| 228—97 | <i>Door Closers/Holders, with or without Integral Smoke Detectors with revisions through January 26, 2006</i> | |
| 260—04 | <i>Dry Pipe and Deluge Valves for Fire Protection Service</i> | |
| 262 04 | <i>Gate Valves for Fire Protection Service</i> | |
| 263—03 | Standard for Fire Test of Building Construction and Materials..... 703.2, 703.2.1, 703.2.3, 703.3, 703.5, 704.12, 705.7, 707.7, 712.3.2, 713.3.1, 713.4.1.1, 714.1, 715.2, 716.5.2, 716.5.3, 716.6.1, Table 716.6.2(1), Table 720.1(1), 1407.10.2, 2103.2, 2603.4, 2603.5.1 | |
| 268—06 | <i>Smoke Detectors for Fire Protective Signaling Systems with Revisions through January 1999</i> | 407.7, 907.2.6.2 |
| 268A 98 | <i>Smoke Detectors for Duct Application with revisions through October 22, 2003</i> | |
| 300—05 | Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas..... | 904.11 |
| 305—07 | Panic Hardware | 1008.1.10 |
| 312 04 | <i>Check Valves for Fire Protection Service</i> | |
| 325—02 | Door, Drapery, Gate, Louver and Window Operations and Systems with Revisions through February 2006 | 406.1.5, 3110.4 |
| 346—05 | <i>Waterflow Indicators for Fire Protective Signaling Systems</i> | |
| 464 03 | <i>Audible Signal Appliances with revisions through October 10, 2003</i> | |
| 497B—04 | <i>Protectors for Data Communication and Fire Alarm Circuits</i> | |
| 521 99 | <i>Heat Detectors for Fire Protective Signaling Systems with Revisions through July 20, 2005</i> | |
| 539 00 | <i>Single and Multiple Station Heat Detectors with Revisions through August 15, 2005</i> | |
| 555 2006 | Fire Dampers..... | 716.3 |
| 555C 2006 | Ceiling Dampers | 716.3, 716.6.2 |
| 555S 99 | Smoke Dampers with Revisions through July 2006..... | 716.3, 716.3.1.1 |
| 580 2006 | Test for Uplift Resistance of Roof Assemblies | 1504.3.1, 1504.3.2 |
| 632 00 | <i>Electrically Actuated Transmitters</i> | |
| 641 95 | Type L Low temperature Venting Systems with Revisions through August 2005 | 2113.11.1.4 |
| 710B—04 | Recirculating Systems with Revisions through April 2006..... | 904.11 |
| 723—03 | Standard for Test for Surface Burning Characteristics of Building Materials with Revisions through May 2005 | 402.11, 402.16.4, 406.5.3, 703.4.2, 719.1, 719.4, 802.1, 803.1.1, 803.9, 806.5, 1407.9, 1407.10.1, 2303.2, 2603.3, 2603.4.1.13, 2603.5.4, 2604.2.4, 2606.4, 3105.4, D102.2.8 |
| 753—04 | <i>Alarm Accessories for Automatic Water Supply Valves for Fire Protection Service</i> | |
| 790—04 | Standard Test Methods for Fire Tests of Roof Coverings | 1505.1, 2603.6, 2610.2, 2610.3 |
| 793—03 | Standards for Automatically Operated Roof Vents for Smoke and Heat with Revisions through April 2004 | 910.3.1 |
| 813 96 | <i>Commercial Audio Equipment with revisions through December 7, 1999</i> | |
| 864 03 | <i>Control Units for Fire Protective Signaling Systems, as amended* with revisions through February 2010</i> | 909.12 |

**Amend No. 55.1 as follows:*

RETARD-RESET-RESTART PERIOD – MAXIMUM 30 SECONDS No alarm obtained from control unit. Maximum permissible time is 30 seconds.

UL—continued***Amend Section 55.2.2 as follows:**

Where an alarm verification feature is provided, the maximum retard reset restart period before an alarm signal can be confirmed and indicated at the control unit, including any control unit reset time and the power up time for the detector to become operational for alarm, shall not exceed 30 seconds. (The balance of the section text is to remain unchanged).

***Add Section 55.2.9 as follows:**

Smoke detectors connected to an alarm verification feature shall not be used as releasing devices.

Exception: Smoke detectors which operate their releasing function immediately upon alarm actuation independent of alarm verification feature.

***Amend Section 89.1.10 as follows:**

The existing text of this section is to remain as printed with one editorial amendment as follows:

THE TOTAL DELAY (CONTROL UNIT PLUS SMOKE DETECTORS) SHALL NOT EXCEED 30 SECONDS.

(The balance of the section text is to remain unchanged.)

| | | |
|-----------|---|---|
| 924—06 | Standard for Safety Emergency Lighting and Power Equipment | 1011.4 |
| 1040—96 | Fire Test of Insulated Wall Construction with Revisions through June 2001..... | 1407.10.3, 2603.4, 2603.9 |
| 1256—02 | Fire Test of Roof Deck Construction with Revisions through January 2007..... | 1508.1, 2603.3, 2603.4.1.5 |
| 1479—03 | Fire Tests of Through penetration Firestops with Revisions through April 2007 | 702.1, 713.3.1.2, 713.3.2, 713.4.1.1.2 |
| 1482 96 | Solid fuel type Room Heater with Revisions through November 2006..... | 2112.2, 2112.5 |
| 1715 97 | Fire Test of Interior Finish Material with Revisions through March 2004..... | 1407.10.2, 1407.10.3, 2603.4, 2603.9 |
| 1777 04 | Chimney Liners | 2113.11.1, 2113.19 |
| 1784 01 | Air Leakage Tests of Door Assemblies with Revisions through December 2004..... | 708.14.1, 711.5.2, 715.4.3.1, 715.4.6.1, 715.4.6.3, 3007.4.3 |
| 1897 04 | Uplift Tests for Roof Covering Systems | 1504.3.1 |
| 1975 06 | Fire Test of Foamed Plastics Used for Decorative Purposes | 402.11, 402.12.1, 402.16.5 |
| 1994 04 | Standard for Luminous Egress Path Marking Systems with Revisions through February 2005 | 411.7, 1024.2.1, 1024.2.3, 1024.2.4, 1024.4 |
| 2017 2000 | Standards for General purpose Signaling Devices and Systems with Revisions through August 2005 | 3109.4.1.8 |
| 2034—2008 | Standard for Single and Multiple Station Carbon Monoxide Alarms with Revisions through February 2009..... | 420.6, 908.7 |
| 2075 | <i>Gas and Vapor Detectors and Sensors Effective September 1, 2009</i> | 420.6 |
| 2075 2007 | Standard for Gas and Vapor Detectors and Sensors | 406.6.6.1 |
| 2079 04 | Tests for Fire Resistance of Building Joint Systems with Revisions through March 2006..... | 702.1, 714.3, 714.6 |
| 2200 04 | Stationary Engine Generator Assemblies with Revisions through July 2004 | 2702.1.1 |

Underwriters Laboratories of Canada
7 Underwriters Road
Toronto, Ontario, Canada M1R3B4



| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| CAN/ULC S102.2 1988 | Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies with 2000 Revisions | 719.4 |

United States Code
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402 9325



| Standard reference number | Title | Referenced in code section number |
|---------------------------|---|-----------------------------------|
| 18 USC Part 1, Ch.40 | Importation, Manufacture, Distribution and Storage of Explosive Materials | 307.2 |

REFERENCED STANDARDS

Window and Door Manufacturers Association
1400 East Touhy Avenue #470
Des Plaines, IL 60018

| Standard reference number | Title | Referenced in code section number |
|---------------------------------|--|-----------------------------------|
| AAMA/WDMA/CSA 101/I.S.2/A440—08 | Specifications for Windows, Doors and Unit Skylights | 1715.5.1, 2405.5 |



Wire Reinforcement Institute, Inc.
942 Main Street, Suite 300
Hartford, CT 06103

| Standard reference number | Title | Referenced in code section number |
|---------------------------|--|-----------------------------------|
| WRI/CRSI—81 | Design of Slab on ground Foundations with 1996 Update..... | 1808.6.2 |

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX A – EMPLOYEE QUALIFICATIONS

(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |

APPENDIX A

EMPLOYEE QUALIFICATIONS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION A101

BUILDING OFFICIAL QUALIFICATIONS

A101.1 Building official. The building official shall have at least 10 years' experience or equivalent as an architect, engineer, inspector, contractor or superintendent of construction, or any combination of these, five years of which shall have been supervisory experience. The building official should be certified as a building official through a recognized certification program. The building official shall be appointed or hired by the applicable governing authority.

A101.2 Chief inspector. The building official can designate supervisors to administer the provisions of the *California Building, Mechanical and Plumbing Codes* and *California Fuel Gas Code*. Each supervisor shall have at least 10 years' experience or equivalent as an architect, engineer, inspector, contractor or superintendent of construction, or any combination of these, five years of which shall have been in a supervisory capacity. They shall be certified through a recognized certification program for the appropriate trade.

A101.3 Inspector and plans examiner. The building official shall appoint or hire such number of officers, inspectors, assistants and other employees as shall be authorized by the jurisdiction. A person shall not be appointed or hired as inspector of construction or plans examiner who has not had at least 5 years' experience as a contractor, engineer, architect, or as a superintendent, foreman or competent mechanic in charge of construction. The inspector or plans examiner shall be certified through a recognized certification program for the appropriate trade.

A101.4 Termination of employment. Employees in the position of building official, chief inspector or inspector shall not be removed from office except for cause after full opportunity has been given to be heard on specific charges before such applicable governing authority.

SECTION A102

REFERENCED STANDARDS

| | | |
|---------|----------------------------|--------|
| IBC—12 | California Building Code | A101.2 |
| IMC—12 | California Mechanical Code | A101.2 |
| IPC—12 | California Plumbing Code | A101.2 |
| IFGC—12 | California Fuel Gas Code | A101.2 |

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX B – BOARD OF APPEALS

(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |



APPENDIX B

BOARD OF APPEALS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION B101 GENERAL

B101.1 Application. The application for appeal shall be filed on a form obtained from the building official within 20 days after the notice was served.

B101.2 Membership of board. The board of appeals shall consist of persons appointed by the chief appointing authority as follows:

1. One for five years; one for four years; one for three years; one for two years; and one for one year.
2. Thereafter, each new member shall serve for five years or until a successor has been appointed.

The building official shall be an ex officio member of said board but shall have no vote on any matter before the board.

B101.2.1 Alternate members. The chief appointing authority shall appoint two alternate members who shall be called by the board chairperson to hear appeals during the absence or disqualification of a member. Alternate members shall possess the qualifications required for board membership and shall be appointed for five years, or until a successor has been appointed.

B101.2.2 Qualifications. The board of appeals shall consist of five individuals, one from each of the following professions or disciplines:

1. Registered design professional with architectural experience or a builder or superintendent of building construction with at least ten years' experience, five of which shall have been in responsible charge of work.
2. Registered design professional with structural engineering experience.
3. Registered design professional with mechanical and plumbing engineering experience or a mechanical contractor with at least ten years' experience, five of which shall have been in responsible charge of work.
4. Registered design professional with electrical engineering experience or an electrical contractor with at least ten years' experience, five of which shall have been in responsible charge of work.
5. Registered design professional with fire protection engineering experience or a fire protection contractor with at least ten years' experience, five of which shall have been in responsible charge of work.

B101.2.3 Rules and procedures. The board is authorized to establish policies and procedures necessary to carry out its duties.

B101.2.4 Chairperson. The board shall annually select one of its members to serve as chairperson.

B101.2.5 Disqualification of member. A member shall not hear an appeal in which that member has a personal, professional or financial interest.

B101.2.6 Secretary. The chief administrative officer shall designate a qualified clerk to serve as secretary to the board. The secretary shall file a detailed record of all proceedings in the office of the chief administrative officer.

B101.2.7 Compensation of members. Compensation of members shall be determined by law.

B101.3 Notice of meeting. The board shall meet upon notice from the chairperson, within 10 days of the filing of an appeal or at stated periodic meetings.

B101.3.1 Open hearing. All hearings before the board shall be open to the public. The appellant, the appellant's representative, the building official and any person whose interests are affected shall be given an opportunity to be heard.

B101.3.2 Procedure. The board shall adopt and make available to the public through the secretary procedures under which a hearing will be conducted. The procedures shall not require compliance with strict rules of evidence, but shall mandate that only relevant information be received.

B101.3.3 Postponed hearing. When five members are not present to hear an appeal, either the appellant or the appellant's representative shall have the right to request a postponement of the hearing.

B101.4 Board decision. The board shall modify or reverse the decision of the building official by a concurring vote of two-thirds of its members.

B101.4.1 Resolution. The decision of the board shall be by resolution. Certified copies shall be furnished to the appellant and to the building official.

B101.4.2 Administration. The building official shall take immediate action in accordance with the decision of the board.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

APPENDIX C – GROUP U – AGRICULTURAL BUILDINGS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | X | | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |



APPENDIX C

GROUP U—AGRICULTURAL BUILDINGS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION C101 GENERAL

C101.1 Scope. The provisions of this appendix shall apply exclusively to agricultural buildings. Such buildings shall be classified as Group U and shall include the following uses:

1. Livestock shelters or buildings, including shade structures and milking barns.
2. Poultry buildings or shelters.
3. Barns.
4. Storage of equipment and machinery used exclusively in agriculture.
5. Horticultural structures, including detached production greenhouses and crop protection shelters.
6. Sheds.
7. Grain silos.
8. Stables.

SECTION C102 ALLOWABLE HEIGHT AND AREA

C102.1 General. Buildings classified as Group U Agricultural shall not exceed the area or height limits specified in Table C102.1.

C102.2 One-story unlimited area. The area of a one-story Group U agricultural building shall not be limited if the building is surrounded and adjoined by public ways or yards not less than 60 feet (18 288 mm) in width.

C102.3 Two-story unlimited area. The area of a two-story Group U agricultural building shall not be limited if the building is surrounded and adjoined by public ways or yards not less than 60 feet (18 288 mm) in width and is provided with an approved automatic sprinkler system throughout in accordance with Section 903.3.1.1.

TABLE C102.1
BASIC ALLOWABLE AREA FOR A GROUP U, ONE STORY IN HEIGHT AND MAXIMUM HEIGHT OF SUCH OCCUPANCY

| I | | II | | III and IV | | V | |
|---|--------|--------|--------|--------------|--------|--------|--------|
| A | B | A | B | III A and IV | III B | A | B |
| ALLOWABLE AREA (square feet) ^a | | | | | | | |
| Unlimited | 60,000 | 27,100 | 18,000 | 27,100 | 18,000 | 21,100 | 12,000 |
| MAXIMUM HEIGHT IN STORIES | | | | | | | |
| Unlimited | 12 | 4 | 2 | 4 | 2 | 3 | 2 |
| MAXIMUM HEIGHT IN FEET | | | | | | | |
| Unlimited | 160 | 65 | 55 | 65 | 55 | 50 | 40 |

For SI: 1 square foot = 0.0929 m².

a. See Section C102 for unlimited area under certain conditions.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX D – FIRE DISTRICTS

(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

APPENDIX D

FIRE DISTRICTS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION D101 GENERAL

D101.1 Scope. The fire district shall include such territory or portion as outlined in an ordinance or law entitled “An Ordinance (Resolution) Creating and Establishing a Fire District.” Wherever, in such ordinance creating and establishing a fire district, reference is made to the fire district, it shall be construed to mean the fire district designated and referred to in this appendix.

D101.1.1 Mapping. The fire district complying with the provisions of Section D101.1 shall be shown on a map that shall be available to the public.

D101.2 Establishment of area. For the purpose of this code, the fire district shall include that territory or area as described in Sections D101.2.1 through D101.2.3.

D101.2.1 Adjoining blocks. Two or more adjoining blocks, exclusive of intervening streets, where at least 50 percent of the ground area is built upon and more than 50 percent of the built-on area is devoted to hotels and motels of Group R-1; Group B occupancies; theaters, nightclubs, restaurants of Group A-1 and A-2 occupancies; garages, express and freight depots, warehouses and storage buildings used for the storage of finished products (not located with and forming a part of a manufactured or industrial plant); or Group S occupancy. Where the average height of a building is two and one-half stories or more, a block should be considered if the ground area built upon is at least 40 percent.

D101.2.2 Buffer zone. Where four contiguous blocks or more comprise a fire district, there shall be a buffer zone of 200 feet (60 960 mm) around the perimeter of such district. Streets, rights-of-way and other open spaces not subject to building construction can be included in the 200-foot (60 960 mm) buffer zone.

D101.2.3 Developed blocks. Where blocks adjacent to the fire district have developed to the extent that at least 25 percent of the ground area is built upon and 40 percent or more of the built-on area is devoted to the occupancies specified in Section D101.2.1, they can be considered for inclusion in the fire district, and can form all or a portion of the 200-foot (60 960 mm) buffer zone required in Section D101.2.2.

SECTION D102 BUILDING RESTRICTIONS

D102.1 Types of construction permitted. Within the fire district every building hereafter erected shall be either Type I, II, III or IV, except as permitted in Section D104.

D102.2 Other specific requirements.

D102.2.1 Exterior walls. Exterior walls of buildings located in the fire district shall comply with the requirements in Table 601 except as required in Section D102.2.6.

D102.2.2 Group H prohibited. Group H occupancies shall be prohibited from location within the fire district.

D102.2.3 Construction type. Every building shall be constructed as required based on the type of construction indicated in Chapter 6.

D102.2.4 Roof covering. Roof covering in the fire district shall conform to the requirements of Class A or B roof coverings as defined in Section 1505.

D102.2.5 Structural fire rating. Walls, floors, roofs and their supporting structural members shall be a minimum of 1-hour fire-resistance-rated construction.

Exceptions:

1. Buildings of Type IV construction.
2. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
3. Automobile parking structures.
4. Buildings surrounded on all sides by a permanently open space of not less than 30 feet (9144 mm).
5. Partitions complying with Section 603.1, Item 10.

D102.2.6 Exterior walls. Exterior load-bearing walls of Type II buildings shall have a fire-resistance rating of 2 hours or more where such walls are located within 30 feet (9144 mm) of a common property line or an assumed property line. Exterior nonload-bearing walls of Type II buildings located within 30 feet (9144 mm) of a common property line or an assumed property line shall have fire-resistance ratings as required by Table 601, but not less than 1 hour. Exterior walls located more than 30 feet (9144 mm) from a common property line or an assumed property line shall comply with Table 601.

Exception: In the case of one-story buildings that are 2,000 square feet (186 m^2) or less in area, exterior walls located more than 15 feet (4572 mm) from a common property line or an assumed property line need only comply with Table 601.

D102.2.7 Architectural trim. Architectural trim on buildings located in the fire district shall be constructed of approved noncombustible materials or fire-retardant-treated wood.

D102.2.8 Permanent canopies. Permanent canopies are permitted to extend over adjacent open spaces provided all of the following are met:

1. The canopy and its supports shall be of noncombustible material, fire-retardant-treated wood, Type IV construction or of 1-hour fire-resistance-rated construction.

Exception: Any textile covering for the canopy shall be flame resistant as determined by tests conducted in accordance with NFPA 701 after both accelerated water leaching and accelerated weathering.

2. Any canopy covering, other than textiles, shall have a flame spread index not greater than 25 when tested in accordance with ASTM E 84 or UL 723 in the form intended for use.
3. The canopy shall have at least one long side open.
4. The maximum horizontal width of the canopy shall not exceed 15 feet (4572 mm).
5. The fire resistance of exterior walls shall not be reduced.

D102.2.9 Roof structures. Structures, except aerial supports 12 feet (3658 mm) high or less, flagpoles, water tanks and cooling towers, placed above the roof of any building within the fire district shall be of noncombustible material and shall be supported by construction of non-combustible material.

D102.2.10 Plastic signs. The use of plastics complying with Section 2611 for signs is permitted provided the structure of the sign in which the plastic is mounted or installed is noncombustible.

D102.2.11 Plastic veneer. Exterior plastic veneer is not permitted in the fire district.

SECTION D103 CHANGES TO BUILDINGS

D103.1 Existing buildings within the fire district. An existing building shall not hereafter be increased in height or area unless it is of a type of construction permitted for new buildings within the fire district or is altered to comply with the requirements for such type of construction. Nor shall any existing building be hereafter extended on any side, nor square footage or floors added within the existing building unless such modifications are of a type of construction permitted for new buildings within the fire district.

D103.2 Other alterations. Nothing in Section D103.1 shall prohibit other alterations within the fire district provided there is no change of occupancy that is otherwise prohibited and the fire hazard is not increased by such alteration.

D103.3 Moving buildings. Buildings shall not hereafter be moved into the fire district or to another lot in the fire district

unless the building is of a type of construction permitted in the fire district.

SECTION D104 BUILDINGS LOCATED PARTIALLY IN THE FIRE DISTRICT

D104.1 General. Any building located partially in the fire district shall be of a type of construction required for the fire district, unless the major portion of such building lies outside of the fire district and no part is more than 10 feet (3048 mm) inside the boundaries of the fire district.

SECTION D105 EXCEPTIONS TO RESTRICTIONS IN FIRE DISTRICT

D105.1 General. The preceding provisions of this appendix shall not apply in the following instances:

1. Temporary buildings used in connection with duly authorized construction.
2. A private garage used exclusively as such, not more than one story in height, nor more than 650 square feet (60 m^2) in area, located on the same lot with a dwelling.
3. Fences not over 8 feet (2438 mm) high.
4. Coal tipples, material bins and trestles of Type IV construction.
5. Water tanks and cooling towers conforming to Sections 1509.3 and 1509.4.
6. Greenhouses less than 15 feet (4572 mm) high.
7. Porches on dwellings not over one story in height, and not over 10 feet (3048 mm) wide from the face of the building, provided such porch does not come within 5 feet (1524 mm) of any property line.
8. Sheds open on a long side not over 15 feet (4572 mm) high and 500 square feet (46 m^2) in area.
9. One- and two-family dwellings where of a type of construction not permitted in the fire district can be extended 25 percent of the floor area existing at the time of inclusion in the fire district by any type of construction permitted by this code.
10. Wood decks less than 600 square feet (56 m^2) where constructed of 2-inch (51 mm) nominal wood, pressure treated for exterior use.
11. Wood veneers on exterior walls conforming to Section 1405.5.
12. Exterior plastic veneer complying with Section 2605.2 where installed on exterior walls required to have a fire-resistance rating not less than 1 hour, provided the exterior plastic veneer does not exhibit sustained flaming as defined in NFPA 268.

SECTION D106 REFERENCED STANDARDS

| | | |
|--------------|--|----------|
| ASTM E 84—04 | Test Method for Surface Burning Characteristics of Building Materials | D102.2.8 |
| NFPA 268—01 | Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source | D105.1 |
| NFPA 701—99 | Methods of Fire Tests for Flame-Propagation of Textiles and Films | D102.2.8 |
| UL 723—03 | Standard for Test for Surface Burning Characteristics of Building Materials, with Revisions through May 2005 | D102.2.8 |

APPENDIX E
RESERVED

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX F – RODENTPROOFING

(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |



APPENDIX F

RODENTPROOFING

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION F101 GENERAL

F101.1 General. Buildings or structures and the walls enclosing habitable or occupiable rooms and spaces in which persons live, sleep or work, or in which feed, food or food-stuffs are stored, prepared, processed, served or sold, shall be constructed in accordance with the provisions of this section.

F101.2 Foundation wall ventilation openings. Foundation wall ventilator openings shall be covered for their height and width with perforated sheet metal plates no less than 0.070 inch (1.8 mm) thick, expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick, cast-iron grills or grating, extruded aluminum load-bearing vents or with hardware cloth of 0.035 inch (0.89 mm) wire or heavier. The openings therein shall not exceed $\frac{1}{4}$ inch (6.4 mm).

F101.3 Foundation and exterior wall sealing. Annular spaces around pipes, electric cables, conduits, or other openings in the walls shall be protected against the passage of rodents by closing such openings with cement mortar, concrete masonry or noncorrosive metal.

F101.4 Doors. Doors on which metal protection has been applied shall be hinged so as to be free swinging. When closed, the maximum clearance between any door, door jambs and sills shall not be greater than $\frac{3}{8}$ inch (9.5 mm).

F101.5 Windows and other openings. Windows and other openings for the purpose of light or ventilation located in exterior walls within 2 feet (610 mm) above the existing ground level immediately below such opening shall be covered for their entire height and width, including frame, with hardware cloth of at least 0.035-inch (0.89 mm) wire or heavier.

F101.5.1 Rodent-accessible openings. Windows and other openings for the purpose of light and ventilation in the exterior walls not covered in this chapter, accessible to rodents by way of exposed pipes, wires, conduits and other appurtenances, shall be covered with wire cloth of at least 0.035-inch (0.89 mm) wire. In lieu of wire cloth covering, said pipes, wires, conduits and other appurtenances shall be blocked from rodent usage by installing solid sheet metal guards 0.024 inch (0.61 mm) thick or heavier. Guards shall be fitted around pipes, wires, conduits or other appurtenances. In addition, they shall be fastened securely to and shall extend perpendicularly from the exterior wall for a minimum distance of 12 inches (305 mm) beyond and on either side of pipes, wires, conduits or appurtenances.

F101.6 Pier and wood construction.

F101.6.1 Sill less than 12 inches above ground. Buildings not provided with a continuous foundation shall be provided with protection against rodents at grade by providing either an apron in accordance with Section F101.6.1.1 or a floor slab in accordance with Section F101.6.1.2.

F101.6.1.1 Apron. Where an apron is provided, the apron shall not be less than 8 inches (203 mm) above, nor less than 24 inches (610 mm) below, grade. The apron shall not terminate below the lower edge of the siding material. The apron shall be constructed of an approved nondecayable, water-resistant rodentproofing material of required strength and shall be installed around the entire perimeter of the building. Where constructed of masonry or concrete materials, the apron shall not be less than 4 inches (102 mm) in thickness.

F101.6.1.2 Grade floors. Where continuous concrete grade floor slabs are provided, open spaces shall not be left between the slab and walls, and openings in the slab shall be protected.

F101.6.2 Sill at or above 12 inches above ground. Buildings not provided with a continuous foundation and which have sills 12 or more inches (305 mm) above the ground level shall be provided with protection against rodents at grade in accordance with any of the following:

1. Section F101.6.1.1 or F101.6.1.2;
2. By installing solid sheet metal collars at least 0.024 inch (0.6 mm) thick at the top of each pier or pile and around each pipe, cable, conduit, wire or other item which provides a continuous pathway from the ground to the floor; or
3. By encasing the pipes, cables, conduits or wires in an enclosure constructed in accordance with Section F101.6.1.1.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX G – FLOOD RESISTANT CONSTRUCTION
(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

APPENDIX G

FLOOD-RESISTANT CONSTRUCTION

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION G101 ADMINISTRATION

G101.1 Purpose. The purpose of this appendix is to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific flood hazard areas through the establishment of comprehensive regulations for management of flood hazard areas designed to:

1. Prevent unnecessary disruption of commerce, access and public service during times of flooding;
2. Manage the alteration of natural flood plains, stream channels and shorelines;
3. Manage filling, grading, dredging and other development which may increase flood damage or erosion potential;
4. Prevent or regulate the construction of flood barriers which will divert floodwaters or which can increase flood hazards; and
5. Contribute to improved construction techniques in the flood plain.

G101.2 Objectives. The objectives of this appendix are to protect human life, minimize the expenditure of public money for flood control projects, minimize the need for rescue and relief efforts associated with flooding, minimize prolonged business interruption, minimize damage to public facilities and utilities, help maintain a stable tax base by providing for the sound use and development of flood-prone areas, contribute to improved construction techniques in the flood plain and ensure that potential owners and occupants are notified that property is within flood hazard areas.

G101.3 Scope. The provisions of this appendix shall apply to all proposed development in a flood hazard area established in Section 1612 of this code, including certain building work exempt from permit under Section 105.2.

G101.4 Violations. Any violation of a provision of this appendix, or failure to comply with a permit or variance issued pursuant to this appendix or any requirement of this appendix, shall be handled in accordance with Section 114.

SECTION G102 APPLICABILITY

G102.1 General. This appendix, in conjunction with the *California Building Code*, provides minimum requirements for development located in flood hazard areas, including the subdivision of land; installation of utilities; placement and replacement of manufactured homes; new construction and repair, reconstruction, rehabilitation or additions to new con-

struction; substantial improvement of existing buildings and structures, including restoration after damage, temporary structures, and temporary or permanent storage, utility and miscellaneous Group U buildings and structures, and certain building work exempt from permit under Section 105.2.

G102.2 Establishment of flood hazard areas. Flood hazard areas are established in Section 1612.3 of the *California Building Code*, adopted by the applicable governing authority on [INSERT DATE].

SECTION G103 POWERS AND DUTIES

G103.1 Permit applications. The building official shall review all permit applications to determine whether proposed development sites will be reasonably safe from flooding. If a proposed development site is in a flood hazard area, all site development activities (including grading, filling, utility installation and drainage modification), all new construction and substantial improvements (including the placement of prefabricated buildings and manufactured homes) and certain building work exempt from permit under Section 105.2 shall be designed and constructed with methods, practices and materials that minimize flood damage and that are in accordance with this code and ASCE 24.

G103.2 Other permits. It shall be the responsibility of the building official to assure that approval of a proposed development shall not be given until proof that necessary permits have been granted by federal or state agencies having jurisdiction over such development.

G103.3 Determination of design flood elevations. If design flood elevations are not specified, the building official is authorized to require the applicant to:

1. Obtain, review and reasonably utilize data available from a federal, state or other source, or
2. Determine the design flood elevation in accordance with accepted hydrologic and hydraulic engineering techniques. Such analyses shall be performed and sealed by a registered design professional. Studies, analyses and computations shall be submitted in sufficient detail to allow review and approval by the building official. The accuracy of data submitted for such determination shall be the responsibility of the applicant.

G103.4 Activities in riverine flood hazard areas. In riverine flood hazard areas where design flood elevations are specified but floodways have not been designated, the building official shall not permit any new construction, substantial improvement or other development, including fill, unless the

applicant demonstrates that the cumulative effect of the proposed development, when combined with all other existing and anticipated flood hazard area encroachment, will not increase the design flood elevation more than 1 foot (305 mm) at any point within the community.

G103.5 Floodway encroachment. Prior to issuing a permit for any floodway encroachment, including fill, new construction, substantial improvements and other development or land-disturbing activity, the building official shall require submission of a certification, along with supporting technical data, that demonstrates that such development will not cause any increase of the level of the base flood.

G103.5.1 Floodway revisions. A floodway encroachment that increases the level of the base flood is authorized if the applicant has applied for a conditional Flood Insurance Rate Map (FIRM) revision and has received the approval of the Federal Emergency Management Agency (FEMA).

G103.6 Watercourse alteration. Prior to issuing a permit for any alteration or relocation of any watercourse, the building official shall require the applicant to provide notification of the proposal to the appropriate authorities of all affected adjacent government jurisdictions, as well as appropriate state agencies. A copy of the notification shall be maintained in the permit records and submitted to FEMA.

G103.6.1 Engineering analysis. The building official shall require submission of an engineering analysis which demonstrates that the flood-carrying capacity of the altered or relocated portion of the watercourse will not be decreased. Such watercourses shall be maintained in a manner which preserves the channel's flood-carrying capacity.

G103.7 Alterations in coastal areas. Prior to issuing a permit for any alteration of sand dunes and mangrove stands in flood hazard areas subject to high velocity wave action, the building official shall require submission of an engineering analysis which demonstrates that the proposed alteration will not increase the potential for flood damage.

G103.8 Records. The building official shall maintain a permanent record of all permits issued in flood hazard areas, including copies of inspection reports and certifications required in Section 1612.

SECTION G104 PERMITS

G104.1 Required. Any person, owner or authorized agent who intends to conduct any development in a flood hazard area shall first make application to the building official and shall obtain the required permit.

G104.2 Application for permit. The applicant shall file an application in writing on a form furnished by the building official. Such application shall:

1. Identify and describe the development to be covered by the permit.

2. Describe the land on which the proposed development is to be conducted by legal description, street address or similar description that will readily identify and definitely locate the site.
3. Include a site plan showing the delineation of flood hazard areas, floodway boundaries, flood zones, design flood elevations, ground elevations, proposed fill and excavation and drainage patterns and facilities.
4. Indicate the use and occupancy for which the proposed development is intended.
5. Be accompanied by construction documents, grading and filling plans and other information deemed appropriate by the building official.
6. State the valuation of the proposed work.
7. Be signed by the applicant or the applicant's authorized agent.

G104.3 Validity of permit. The issuance of a permit under this appendix shall not be construed to be a permit for, or approval of, any violation of this appendix or any other ordinance of the jurisdiction. The issuance of a permit based on submitted documents and information shall not prevent the building official from requiring the correction of errors. The building official is authorized to prevent occupancy or use of a structure or site which is in violation of this appendix or other ordinances of this jurisdiction.

G104.4 Expiration. A permit shall become invalid if the proposed development is not commenced within 180 days after its issuance, or if the work authorized is suspended or abandoned for a period of 180 days after the work commences. Extensions shall be requested in writing and justifiable cause demonstrated. The building official is authorized to grant, in writing, one or more extensions of time, for periods not more than 180 days each.

G104.5 Suspension or revocation. The building official is authorized to suspend or revoke a permit issued under this appendix wherever the permit is issued in error or on the basis of incorrect, inaccurate or incomplete information, or in violation of any ordinance or code of this jurisdiction.

SECTION G105 VARIANCES

G105.1 General. The board of appeals established pursuant to Section 112 shall hear and decide requests for variances. The board of appeals shall base its determination on technical justifications, and has the right to attach such conditions to variances as it deems necessary to further the purposes and objectives of this appendix and Section 1612.

G105.2 Records. The building official shall maintain a permanent record of all variance actions, including justification for their issuance.

G105.3 Historic structures. A variance is authorized to be issued for the repair or rehabilitation of a historic structure

upon a determination that the proposed repair or rehabilitation will not preclude the structure's continued designation as a historic structure, and the variance is the minimum necessary to preserve the historic character and design of the structure.

Exception: Within flood hazard areas, historic structures that are not:

1. Listed or preliminarily determined to be eligible for listing in the National Register of Historic Places; or
2. Determined by the Secretary of the U.S. Department of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined to qualify as an historic district; or
3. Designated as historic under a state or local historic preservation program that is approved by the Department of Interior.

G105.4 Functionally dependent facilities. A variance is authorized to be issued for the construction or substantial improvement of a functionally dependent facility provided the criteria in Section 1612.1 are met and the variance is the minimum necessary to allow the construction or substantial improvement, and that all due consideration has been given to methods and materials that minimize flood damages during the design flood and create no additional threats to public safety.

G105.5 Restrictions. The board of appeals shall not issue a variance for any proposed development in a floodway if any increase in flood levels would result during the base flood discharge.

G105.6 Considerations. In reviewing applications for variances, the board of appeals shall consider all technical evaluations, all relevant factors, all other portions of this appendix and the following:

1. The danger that materials and debris may be swept onto other lands resulting in further injury or damage;
2. The danger to life and property due to flooding or erosion damage;
3. The susceptibility of the proposed development, including contents, to flood damage and the effect of such damage on current and future owners;
4. The importance of the services provided by the proposed development to the community;
5. The availability of alternate locations for the proposed development that are not subject to flooding or erosion;
6. The compatibility of the proposed development with existing and anticipated development;
7. The relationship of the proposed development to the comprehensive plan and flood plain management program for that area;
8. The safety of access to the property in times of flood for ordinary and emergency vehicles;
9. The expected heights, velocity, duration, rate of rise and debris and sediment transport of the floodwaters

and the effects of wave action, if applicable, expected at the site; and

10. The costs of providing governmental services during and after flood conditions including maintenance and repair of public utilities and facilities such as sewer, gas, electrical and water systems, streets and bridges.

G105.7 Conditions for issuance. Variances shall only be issued by the board of appeals upon:

1. A technical showing of good and sufficient cause that the unique characteristics of the size, configuration or topography of the site renders the elevation standards inappropriate;
2. A determination that failure to grant the variance would result in exceptional hardship by rendering the lot undevelopable;
3. A determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, nor create nuisances, cause fraud on or victimization of the public or conflict with existing local laws or ordinances;
4. A determination that the variance is the minimum necessary, considering the flood hazard, to afford relief; and
5. Notification to the applicant in writing over the signature of the building official that the issuance of a variance to construct a structure below the base flood level will result in increased premium rates for flood insurance up to amounts as high as \$25 for \$100 of insurance coverage, and that such construction below the base flood level increases risks to life and property.

SECTION G201 DEFINITIONS

G201.1 General. The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the *California Building Code* for general definitions.

G201.2 Definitions.

DEVELOPMENT. Any manmade change to improved or unimproved real estate, including but not limited to, buildings or other structures, temporary structures, temporary or permanent storage of materials, mining, dredging, filling, grading, paving, excavations, operations and other land-disturbing activities.

FUNCTIONALLY DEPENDENT FACILITY. A facility which cannot be used for its intended purpose unless it is located or carried out in close proximity to water, such as a docking or port facility necessary for the loading or unloading of cargo or passengers, shipbuilding or ship repair. The term does not include long-term storage, manufacture, sales or service facilities.

MANUFACTURED HOME. A structure that is transportable in one or more sections, built on a permanent chassis, designed for use with or without a permanent foundation when attached to the required utilities, and constructed to the

Federal Mobile Home Construction and Safety Standards and rules and regulations promulgated by the U.S. Department of Housing and Urban Development. The term also includes mobile homes, park trailers, travel trailers and similar transportable structures that are placed on a site for 180 consecutive days or longer.

MANUFACTURED HOME PARK OR SUBDIVISION. A parcel (or contiguous parcels) of land divided into two or more manufactured home lots for rent or sale.

RECREATIONAL VEHICLE. A vehicle that is built on a single chassis, 400 square feet (37.16 m^2) or less when measured at the largest horizontal projection, designed to be self-propelled or permanently towable by a light-duty truck, and designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel or seasonal use. A recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect-type utilities and security devices and has no permanently attached additions.

VARIANCE. A grant of relief from the requirements of this section which permits construction in a manner otherwise prohibited by this section where specific enforcement would result in unnecessary hardship.

VIOLATION. A development that is not fully compliant with this appendix or Section 1612, as applicable.

SECTION G301 SUBDIVISIONS

G301.1 General. Any subdivision proposal, including proposals for manufactured home parks and subdivisions, or other proposed new development in a flood hazard area shall be reviewed to assure that:

1. All such proposals are consistent with the need to minimize flood damage;
2. All public utilities and facilities, such as sewer, gas, electric and water systems are located and constructed to minimize or eliminate flood damage; and
3. Adequate drainage is provided to reduce exposure to flood hazards.

G301.2 Subdivision requirements. The following requirements shall apply in the case of any proposed subdivision, including proposals for manufactured home parks and subdivisions, any portion of which lies within a flood hazard area:

1. The flood hazard area, including floodways and areas subject to high velocity wave action, as appropriate, shall be delineated on tentative and final subdivision plats;
2. Design flood elevations shall be shown on tentative and final subdivision plats;
3. Residential building lots shall be provided with adequate buildable area outside the floodway; and
4. The design criteria for utilities and facilities set forth in this appendix and appropriate *California Codes* shall be met.

SECTION G401 SITE IMPROVEMENT

G401.1 Development in floodways. Development or land disturbing activity shall not be authorized in the floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment will not result in any increase in the level of the base flood.

G401.2 Flood hazard areas subject to high-velocity wave action. In flood hazard areas subject to high-velocity wave action:

1. New buildings and buildings that are substantially improved shall only be authorized landward of the reach of mean high tide.
2. The use of fill for structural support of buildings is prohibited.

G401.3 Sewer facilities. All new or replaced sanitary sewer facilities, private sewage treatment plants (including all pumping stations and collector systems) and on-site waste disposal systems shall be designed in accordance with Chapter 7, ASCE 24, to minimize or eliminate infiltration of floodwaters into the facilities and discharge from the facilities into floodwaters, or impairment of the facilities and systems.

G401.4 Water facilities. All new or replacement water facilities shall be designed in accordance with the provisions of Chapter 7, ASCE 24, to minimize or eliminate infiltration of floodwaters into the systems.

G401.5 Storm drainage. Storm drainage shall be designed to convey the flow of surface waters to minimize or eliminate damage to persons or property.

G401.6 Streets and sidewalks. Streets and sidewalks shall be designed to minimize potential for increasing or aggravating flood levels.

SECTION G501 MANUFACTURED HOMES

G501.1 Elevation. All new and replacement manufactured homes to be placed or substantially improved in a flood hazard area shall be elevated such that the lowest floor of the manufactured home is elevated to or above the design flood elevation.

G501.2 Foundations. All new and replacement manufactured homes, including substantial improvement of existing manufactured homes, shall be placed on a permanent, reinforced foundation that is designed in accordance with Section 1612.

G501.3 Anchoring. All new and replacement manufactured homes to be placed or substantially improved in a flood hazard area shall be installed using methods and practices which minimize flood damage. Manufactured homes shall be securely anchored to an adequately anchored foundation system to resist flotation, collapse and lateral movement. Methods of anchoring are authorized to include, but are not limited to, use of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable state and local anchoring requirements for resisting wind forces.

SECTION G601 RECREATIONAL VEHICLES

G601.1 Placement prohibited. The placement of recreational vehicles shall not be authorized in flood hazard areas subject to high-velocity wave action and in floodways.

G601.2 Temporary placement. Recreational vehicles in flood hazard areas shall be fully licensed and ready for highway use, and shall be placed on a site for less than 180 consecutive days.

G601.3 Permanent placement. Recreational vehicles that are not fully licensed and ready for highway use, or that are to be placed on a site for more than 180 consecutive days, shall meet the requirements of Section G501 for manufactured homes.

SECTION G701 TANKS

G701.1 Underground tanks. Underground tanks in flood hazard areas shall be anchored to prevent flotation, collapse or lateral movement resulting from hydrostatic loads, including the effects of buoyancy, during conditions of the design flood.

G701.2 Above-ground tanks. Above-ground tanks in flood hazard areas shall be elevated to or above the design flood elevation or shall be anchored or otherwise designed and constructed to prevent flotation, collapse or lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy, during conditions of the design flood.

G701.3 Tank inlets and vents. In flood hazard areas, tank inlets, fill openings, outlets and vents shall be:

1. At or above the design flood elevation or fitted with covers designed to prevent the inflow of floodwater or outflow of the contents of the tanks during conditions of the design flood.
2. Anchored to prevent lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy, during conditions of the design flood.

SECTION G801 OTHER BUILDING WORK

G801.1 Detached accessory structures. Detached accessory structures shall be anchored to prevent flotation, collapse or lateral movement resulting from hydrostatic loads, including the effects of buoyancy, during conditions of the design flood. Fully enclosed accessory structures shall have flood openings to allow for the automatic entry and exit of flood waters.

G801.2 Fences. Fences in floodways that may block the passage of floodwaters, such as stockade fences and wire mesh fences, shall meet the requirement of Section G103.5.

G801.3 Oil derricks. Oil derricks located in flood hazard areas shall be designed in conformance with the flood loads in Sections 1603.1.7 and 1612.

G801.4 Retaining walls, sidewalks and driveways. Retaining walls, sidewalks and driveways shall meet the requirements of Section 1803.4.

G801.5 Prefabricated swimming pools. Prefabricated swimming pools in floodways shall meet the requirements of Section G103.5.

SECTION G901 TEMPORARY STRUCTURES AND TEMPORARY STORAGE

G901.1 Temporary structures. Temporary structures shall be erected for a period of less than 180 days. Temporary structures shall be anchored to prevent flotation, collapse or lateral movement resulting from hydrostatic loads, including the effects of buoyancy, during conditions of the design flood. Fully enclosed temporary structures shall have flood openings to allow for the automatic entry and exit of floodwaters.

G901.2 Temporary storage. Temporary storage includes storage of goods and materials for a period of less than 180 days. Stored materials shall not include hazardous materials.

G901.3 Floodway encroachment. Temporary structures and temporary storage in floodways shall meet the requirements of G103.5.

SECTION G1001 UTILITY AND MISCELLANEOUS GROUP U

G1001.1 Utility and miscellaneous Group U. Utility and miscellaneous Group U includes buildings that are accessory in character and miscellaneous structures not classified in any specific occupancy in the *California Building Code*, including, but not limited to, agricultural buildings, aircraft hangars (accessory to a one- or two-family residence), barns, carports, fences more than 6 feet (1829 mm) high, grain silos (accessory to a residential occupancy), greenhouses, livestock shelters, private garages, retaining walls, sheds, stables and towers.

G1001.2 Flood loads. Utility and miscellaneous Group U buildings and structures, including substantial improvement of such buildings and structures, shall be anchored to prevent flotation, collapse or lateral movement resulting from flood loads, including the effects of buoyancy, during conditions of the design flood.

G1001.3 Elevation. Utility and miscellaneous Group U buildings and structures, including substantial improvement of such buildings and structures, shall be elevated such that the lowest floor, including basement, is elevated to or above the design flood elevation in accordance with Section 1612 of the *California Building Code*.

G1001.4 Enclosures below design flood elevation. Fully enclosed areas below the design flood elevation shall be at or above grade on all sides and conform to the following:

1. In flood hazard areas not subject to high-velocity wave action, enclosed areas shall have flood openings to

allow for the automatic inflow and outflow of floodwaters.

2. In flood hazard areas subject to high-velocity wave action, enclosed areas shall have walls below the design flood elevation that are designed to break away or collapse from a water load less than that which would occur during the design flood, without causing collapse, displacement or other structural damage to the building or structure.

G1001.5 Flood-damage-resistant materials. Flood-damage-resistant materials shall be used below the design flood elevation.

G1001.6 Protection of mechanical, plumbing and electrical systems. Mechanical, plumbing and electrical systems, including plumbing fixtures, shall be elevated to or above the design flood elevation.

Exception: Electrical systems, equipment and components, and heating, ventilating, air conditioning, and plumbing appliances, plumbing fixtures, duct systems and other service equipment shall be permitted to be located below the design flood elevation provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation in compliance with the flood-resistant construction requirements of this code. Electrical wiring systems shall be permitted to be located below the design flood elevation provided they conform to the provisions of NFPA 70.

SECTION G1101 REFERENCED STANDARDS

| | | |
|-----------------------------------|---|------------------------------|
| ASCE 24—05 | Flood Resistance Design and Construction | G103.1, G401.3, G401.4 |
| HUD 24 CFR Part 3280 (1994) | Manufactured Home Construction and Safety Standards | G201 |
| IBC—12 | California Building Code | G102.2 |
| NFPA 70—08 | National Electrical Code | G1001.6 |

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX H – SIGNS

(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |



APPENDIX H

SIGNS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION H101 GENERAL

H101.1 General. A sign shall not be erected in a manner that would confuse or obstruct the view of or interfere with exit signs required by Chapter 10 or with official traffic signs, signals or devices. Signs and sign support structures, together with their supports, braces, guys and anchors, shall be kept in repair and in proper state of preservation. The display surfaces of signs shall be kept neatly painted or posted at all times.

H101.2 Signs exempt from permits. The following signs are exempt from the requirements to obtain a permit before erection:

1. Painted nonilluminated signs.
2. Temporary signs announcing the sale or rent of property.
3. Signs erected by transportation authorities.
4. Projecting signs not exceeding 2.5 square feet (0.23 m²).
5. The changing of moveable parts of an approved sign that is designed for such changes, or the repainting or repositioning of display matter shall not be deemed an alteration.

SECTION H102 DEFINITIONS

H102.1 General. The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the *California Building Code* for general definitions.

COMBINATION SIGN. A sign incorporating any combination of the features of pole, projecting and roof signs.

DISPLAY SIGN. The area made available by the sign structure for the purpose of displaying the advertising message.

ELECTRIC SIGN. A sign containing electrical wiring, but not including signs illuminated by an exterior light source.

GROUND SIGN. A billboard or similar type of sign which is supported by one or more uprights, poles or braces in or upon the ground other than a combination sign or pole sign, as defined by this code.

POLE SIGN. A sign wholly supported by a sign structure in the ground.

PORTABLE DISPLAY SURFACE. A display surface temporarily fixed to a standardized advertising structure which is

regularly moved from structure to structure at periodic intervals.

PROJECTING SIGN. A sign other than a wall sign, which projects from and is supported by a wall of a building or structure.

ROOF SIGN. A sign erected upon or above a roof or parapet of a building or structure.

SIGN. Any letter, figure, character, mark, plane, point, marquee sign, design, poster, pictorial, picture, stroke, stripe, line, trademark, reading matter or illuminated service, which shall be constructed, placed, attached, painted, erected, fastened or manufactured in any manner whatsoever, so that the same shall be used for the attraction of the public to any place, subject, person, firm, corporation, public performance, article, machine or merchandise, whatsoever, which is displayed in any manner outdoors. Every sign shall be classified and conform to the requirements of that classification as set forth in this chapter.

SIGN STRUCTURE. Any structure which supports or is capable of supporting a sign as defined in this code. A sign structure is permitted to be a single pole and is not required to be an integral part of the building.

WALL SIGN. Any sign attached to or erected against the wall of a building or structure, with the exposed face of the sign in a plane parallel to the plane of said wall.

SECTION H103 LOCATION

H103.1 Location restrictions. Signs shall not be erected, constructed or maintained so as to obstruct any fire escape or any window or door or opening used as a means of egress or so as to prevent free passage from one part of a roof to any other part thereof. A sign shall not be attached in any form, shape or manner to a fire escape, nor be placed in such manner as to interfere with any opening required for ventilation.

SECTION H104 IDENTIFICATION

H104.1 Identification. Every outdoor advertising display sign hereafter erected, constructed or maintained, for which a permit is required shall be plainly marked with the name of the person, firm or corporation erecting and maintaining such sign and shall have affixed on the front thereof the permit number issued for said sign or other method of identification approved by the building official.

SECTION H105 DESIGN AND CONSTRUCTION

H105.1 General requirements. Signs shall be designed and constructed to comply with the provisions of this code for use of materials, loads and stresses.

H105.2 Permits, drawings and specifications. Where a permit is required, as provided in Chapter 1, construction documents shall be required. These documents shall show the dimensions, material and required details of construction, including loads, stresses and anchors.

H105.3 Wind load. Signs shall be designed and constructed to withstand wind pressure as provided for in Chapter 16.

H105.4 Seismic load. Signs designed to withstand wind pressures shall be considered capable of withstanding earthquake loads, except as provided for in Chapter 16.

H105.5 Working stresses. In outdoor advertising display signs, the allowable working stresses shall conform to the requirements of Chapter 16. The working stresses of wire rope and its fastenings shall not exceed 25 percent of the ultimate strength of the rope or fasteners.

Exceptions:

1. The allowable working stresses for steel and wood shall be in accordance with the provisions of Chapters 22 and 23.
2. The working strength of chains, cables, guys or steel rods shall not exceed one-fifth of the ultimate strength of such chains, cables, guys or steel.

H105.6 Attachment. Signs attached to masonry, concrete or steel shall be safely and securely fastened by means of metal anchors, bolts or approved expansion screws of sufficient size and anchorage to safely support the loads applied.

SECTION H106 ELECTRICAL

H106.1 Illumination. A sign shall not be illuminated by other than electrical means, and electrical devices and wiring shall be installed in accordance with the requirements of NFPA 70. Any open spark or flame shall not be used for display purposes unless specifically approved.

H106.1.1 Internally illuminated signs. Except as provided for in Sections 402.16 and 2611, where internally illuminated signs have facings of wood or approved plastic, the area of such facing section shall not be more than 120 square feet (11.16 m^2) and the wiring for electric lighting shall be entirely enclosed in the sign cabinet with a clearance of not less than 2 inches (51 mm) from the facing material. The dimensional limitation of 120 square feet (11.16 m^2) shall not apply to sign facing sections made from flame-resistant-coated fabric (ordinarily known as "flexible sign face plastic") that weighs less than 20 ounces per square yard (678 g/m^2) and that, when tested in accordance with NFPA 701, meets the fire propagation performance requirements of both Test 1 and Test 2 or that when tested in accordance with an approved test method, exhibits an average burn time of 2 seconds or less and a

burning extent of 5.9 inches (150 mm) or less for 10 specimens.

H106.2 Electrical service. Signs that require electrical service shall comply with NFPA 70.

SECTION H107 COMBUSTIBLE MATERIALS

H107.1 Use of combustibles. Wood, approved plastic or plastic veneer panels as provided for in Chapter 26, or other materials of combustible characteristics similar to wood, used for moldings, cappings, nailing blocks, letters and latticing, shall comply with Section H109.1, and shall not be used for other ornamental features of signs, unless approved.

H107.1.1 Plastic materials. Notwithstanding any other provisions of this code, plastic materials which burn at a rate no faster than 2.5 inches per minute (64 mm/s) when tested in accordance with ASTM D 635 shall be deemed approved plastics and can be used as the display surface material and for the letters, decorations and facings on signs and outdoor display structures.

H107.1.2 Electric sign faces. Individual plastic facings of electric signs shall not exceed 200 square feet (18.6 m^2) in area.

H107.1.3 Area limitation. If the area of a display surface exceeds 200 square feet (18.6 m^2), the area occupied or covered by approved plastics shall be limited to 200 square feet (18.6 m^2) plus 50 percent of the difference between 200 square feet (18.6 m^2) and the area of display surface. The area of plastic on a display surface shall not in any case exceed 1,100 square feet (102 m^2).

H107.1.4 Plastic appurtenances. Letters and decorations mounted on an approved plastic facing or display surface can be made of approved plastics.

SECTION H108 ANIMATED DEVICES

H108.1 Fail-safe device. Signs that contain moving sections or ornaments shall have fail-safe provisions to prevent the section or ornament from releasing and falling or shifting its center of gravity more than 15 inches (381 mm). The fail-safe device shall be in addition to the mechanism and the mechanism's housing which operate the movable section or ornament. The fail-safe device shall be capable of supporting the full dead weight of the section or ornament when the moving mechanism releases.

SECTION H109 GROUND SIGNS

H109.1 Height restrictions. The structural frame of ground signs shall not be erected of combustible materials to a height of more than 35 feet (10668 mm) above the ground. Ground signs constructed entirely of noncombustible material shall not be erected to a height of greater than 100 feet (30 480 mm) above the ground. Greater heights are permitted where

approved and located so as not to create a hazard or danger to the public.

H109.2 Required clearance. The bottom coping of every ground sign shall be not less than 3 feet (914 mm) above the ground or street level, which space can be filled with platform decorative trim or light wooden construction.

H109.3 Wood anchors and supports. Where wood anchors or supports are embedded in the soil, the wood shall be pressure treated with an approved preservative.

SECTION H110 ROOF SIGNS

H110.1 General. Roof signs shall be constructed entirely of metal or other approved noncombustible material except as provided for in Sections H106.1.1 and H107.1. Provisions shall be made for electric grounding of metallic parts. Where combustible materials are permitted in letters or other ornamental features, wiring and tubing shall be kept free and insulated therefrom. Roof signs shall be so constructed as to leave a clear space of not less than 6 feet (1829 mm) between the roof level and the lowest part of the sign and shall have at least 5 feet (1524 mm) clearance between the vertical supports thereof. No portion of any roof sign structure shall project beyond an exterior wall.

Exception: Signs on flat roofs with every part of the roof accessible.

H110.2 Bearing plates. The bearing plates of roof signs shall distribute the load directly to or upon masonry walls, steel roof girders, columns or beams. The building shall be designed to avoid overstress of these members.

H110.3 Height of solid signs. A roof sign having a solid surface shall not exceed, at any point, a height of 24 feet (7315 mm) measured from the roof surface.

H110.4 Height of open signs. Open roof signs in which the uniform open area is not less than 40 percent of total gross area shall not exceed a height of 75 feet (22 860 mm) on buildings of Type 1 or Type 2 construction. On buildings of other construction types, the height shall not exceed 40 feet (12 192 mm). Such signs shall be thoroughly secured to the building upon which they are installed, erected or constructed by iron, metal anchors, bolts, supports, chains, stranded cables, steel rods or braces and they shall be maintained in good condition.

H110.5 Height of closed signs. A closed roof sign shall not be erected to a height greater than 50 feet (15 240 mm) above the roof of buildings of Type 1 or Type 2 construction, nor more than 35 feet (10 668 mm) above the roof of buildings of Type 3, 4 or 5 construction.

SECTION H111 WALL SIGNS

H111.1 Materials. Wall signs which have an area exceeding 40 square feet (3.72 m^2) shall be constructed of metal or other approved noncombustible material, except for nailing rails and as provided for in Sections H106.1.1 and H107.1.

H111.2 Exterior wall mounting details. Wall signs attached to exterior walls of solid masonry, concrete or stone shall be safely and securely attached by means of metal anchors, bolts or expansion screws of not less than $\frac{3}{8}$ inch (9.5 mm) diameter and shall be embedded at least 5 inches (127 mm). Wood blocks shall not be used for anchorage, except in the case of wall signs attached to buildings with walls of wood. A wall sign shall not be supported by anchorages secured to an unbraced parapet wall.

H111.3 Extension. Wall signs shall not extend above the top of the wall, nor beyond the ends of the wall to which the signs are attached unless such signs conform to the requirements for roof signs, projecting signs or ground signs.

SECTION H112 PROJECTING SIGNS

H112.1 General. Projecting signs shall be constructed entirely of metal or other noncombustible material and securely attached to a building or structure by metal supports such as bolts, anchors, supports, chains, guys or steel rods. Staples or nails shall not be used to secure any projecting sign to any building or structure. The dead load of projecting signs not parallel to the building or structure and the load due to wind pressure shall be supported with chains, guys or steel rods having net cross-sectional dimension of not less than $\frac{3}{8}$ inch (9.5 mm) diameter. Such supports shall be erected or maintained at an angle of at least 45 percent (0.78 rad) with the horizontal to resist the dead load and at angle of 45 percent (0.78 rad) or more with the face of the sign to resist the specified wind pressure. If such projecting sign exceeds 30 square feet (2.8 m^2) in one facial area, there shall be provided at least two such supports on each side not more than 8 feet (2438 mm) apart to resist the wind pressure.

H112.2 Attachment of supports. Supports shall be secured to a bolt or expansion screw that will develop the strength of the supporting chains, guys or steel rods, with a minimum $\frac{5}{8}$ -inch (15.9 mm) bolt or lag screw, by an expansion shield. Turn buckles shall be placed in chains, guys or steel rods supporting projecting signs.

H112.3 Wall mounting details. Chains, cables, guys or steel rods used to support the live or dead load of projecting signs are permitted to be fastened to solid masonry walls with expansion bolts or by machine screws in iron supports, but such supports shall not be attached to an unbraced parapet wall. Where the supports must be fastened to walls made of wood, the supporting anchor bolts must go through the wall and be plated or fastened on the inside in a secure manner.

H112.4 Height limitation. A projecting sign shall not be erected on the wall of any building so as to project above the roof or cornice wall or above the roof level where there is no cornice wall; except that a sign erected at a right angle to the building, the horizontal width of which sign is perpendicular to such a wall and does not exceed 18 inches (457 mm), is permitted to be erected to a height not exceeding 2 feet (610 mm) above the roof or cornice wall or above the roof level where there is no cornice wall. A sign attached to a corner of a building and parallel to the vertical line of such corner shall be deemed to be erected at a right angle to the building wall.

H112.5 Additional loads. Projecting sign structures which will be used to support an individual on a ladder or other servicing device, whether or not specifically designed for the servicing device, shall be capable of supporting the anticipated additional load, but not less than a 100-pound (445 N) concentrated horizontal load and a 300-pound (1334 N) concentrated vertical load applied at the point of assumed or most eccentric loading. The building component to which the projecting sign is attached shall also be designed to support the additional loads.

SECTION H113 MARQUEE SIGNS

H113.1 Materials. Marquee signs shall be constructed entirely of metal or other approved noncombustible material except as provided for in Sections H106.1.1 and H107.1.

H113.2 Attachment. Marquee signs shall be attached to approved marquees that are constructed in accordance with Section 3106.

H113.3 Dimensions. Marquee signs, whether on the front or side, shall not project beyond the perimeter of the marquee.

H113.4 Height limitation. Marquee signs shall not extend more than 6 feet (1829 mm) above, nor 1 foot (305 mm) below such marquee, but under no circumstances shall the sign or signs have a vertical dimension greater than 8 feet (2438 mm).

SECTION H114 PORTABLE SIGNS

H114.1 General. Portable signs shall conform to requirements for ground, roof, projecting, flat and temporary signs where such signs are used in a similar capacity. The requirements of this section shall not be construed to require portable signs to have connections to surfaces, tie-downs or foundations where provisions are made by temporary means or configuration of the structure to provide stability for the expected duration of the installation.

TABLE 4-A
SIZE, THICKNESS AND TYPE OF GLASS PANELS IN SIGNS

| MAXIMUM SIZE OF EXPOSED PANEL | | MINIMUM THICKNESS OF GLASS (inches) | TYPE OF GLASS |
|-------------------------------|----------------------|-------------------------------------|-----------------------|
| Any dimension (inches) | Area (square inches) | | |
| 30 | 500 | 1/8 | Plain, plate or wired |
| 45 | 700 | 3/16 | Plain, plate or wired |
| 144 | 3,600 | 1/4 | Plain, plate or wired |
| > 144 | > 3,600 | 1/4 | Wired glass |

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm².

TABLE 4-B
THICKNESS OF PROJECTION SIGN

| PROJECTION (feet) | MAXIMUM THICKNESS (feet) |
|-------------------|--------------------------|
| 5 | 2 |
| 4 | 2.5 |
| 3 | 3 |
| 2 | 3.5 |
| 1 | 4 |

For SI: 1 foot = 304.8 mm.

SECTION H115 REFERENCED STANDARDS

| | | |
|---------------|--|----------------|
| ASTM D 635—03 | Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position | H107.1.1 |
| NFPA 70—08 | National Electrical Code | H106.1, H106.2 |
| NFPA 701—99 | Methods of Fire Test for Flame Propagation of Textiles and Films | H106.1.1 |

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

APPENDIX I – PATIO COVERS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| Adopt entire chapter | | | X | | | | | | | | | | | | | | | | | |
| Adopt entire chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | X | | | | | | | | | | | | | | | | | | |
| Chapter / Section | | | | | | | | | | | | | | | | | | | | |
| I101 | | X | | | | | | | | | | | | | | | | | | |
| I102 | | X | | | | | | | | | | | | | | | | | | |
| I103 | | X | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |



APPENDIX I

PATIO COVERS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION I101 GENERAL

I101.1 General. Patio covers shall be permitted to be detached from or attached to dwelling units. Patio covers shall be used only for recreational, outdoor living purposes and not as carports, garages, storage rooms or habitable rooms.

SECTION I102 DEFINITIONS

I102.1 General. The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the *California Building Code* for general definitions.

PATIO COVER. A structure with open or glazed walls which is used for recreational, outdoor living purposes associated with a dwelling unit.

SECTION I103 EXTERIOR WALLS AND OPENINGS

I103.1 Enclosure walls. Enclosure walls shall be permitted to be of any configuration, provided the open or glazed area of the longer wall and one additional wall is equal to at least 65 percent of the area below a minimum of 6 feet 8 inches (2032 mm) of each wall, measured from the floor. Openings shall be permitted to be enclosed with insect screening, approved translucent or transparent plastic not more than 0.125 inch (3.2 mm) in thickness, glass conforming to the provisions of Chapter 24 or any combination of the foregoing.

I103.2 Light, ventilation and emergency egress. Exterior openings of the dwelling unit required for light and ventilation shall be permitted to open into a patio structure. However, the patio structure shall be unenclosed if such openings are serving as emergency egress or rescue openings from sleeping rooms. Where such exterior openings serve as an exit from the dwelling unit, the patio structure, unless unenclosed, shall be provided with exits conforming to the provision of Chapter 10.

SECTION I104 HEIGHT

I104.1 Height. Patio covers shall be limited to one-story structures not exceeding 12 feet (3657 mm) in height.

SECTION I105 STRUCTURAL PROVISIONS

I105.1 Design loads. Patio covers shall be designed and constructed to sustain, within the stress limits of this code, all dead loads plus a minimum vertical live load of 10 pounds per square foot (0.48 kN/m^2) except that snow loads shall be used where such snow loads exceed this minimum. Such patio covers shall be designed to resist the minimum wind and seismic loads set forth in this code.

I105.2 Footings. In areas with a frost depth of zero, a patio cover shall be permitted to be supported on a concrete slab on grade without footings, provided the slab conforms to the provisions of Chapter 19 of this code, is not less than $3\frac{1}{2}$ inches (89 mm) thick and further provided that the columns do not support loads in excess of 750 pounds (3.36 kN) per column.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE

APPENDIX J – GRADING

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | X | | | | | | | | | X | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | X | X | | X | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | X | X | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| J101 | | | | | | | X | X | | | | | | | | | | | | |
| J102 | | | | | | | X | X | | | | | | | | | | | | |
| J104.4 | | | | | | | | | X | X | | X | | | | | | | | |
| J105 | | | | | | | X | X | | | | | | | | | | | | |
| J106.2 | | | | | | | X | X | X | X | | | X | | | | | | | |
| J107 | | | | | | | X | X | | | | | | | | | | | | |
| J107.5 | | | | | | | X | X | X | X | | | X | | | | | | | |
| J108 | | | | | | | X | X | | | | | | | | | | | | |
| J109 | | | | | | | X | X | | | | | | | | | | | | |
| J110 | | | | | | | X | X | | | | | | | | | | | | |
| J111 | | | | | | | X | X | | | | | | | | | | | | |
| J112 | | | | | | | X | X | X | X | | X | | | | | | | | |

APPENDIX J

GRADING

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION J101 GENERAL

J101.1 Scope. The provisions of this chapter apply to grading, excavation and earthwork construction, including fills and embankments. Where conflicts occur between the technical requirements of this chapter and the geotechnical report, the geotechnical report shall govern.

J101.2 Flood hazard areas. The provisions of this chapter shall not apply to grading, excavation and earthwork construction, including fills and embankments, in floodways within flood hazard areas established in Section 1612.3 or in flood hazard areas where design flood elevations are specified but floodways have not been designated, unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed work will not result in any increase in the level of the base flood.

SECTION J102 DEFINITIONS

J102.1 Definitions. The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the *California Building Code* for general definitions.

BENCH. A relatively level step excavated into earth material on which fill is to be placed.

COMPACTION. The densification of a fill by mechanical means.

CUT. See "Excavation."

DOWN DRAIN. A device for collecting water from a swale or ditch located on or above a slope, and safely delivering it to an approved drainage facility.

EROSION. The wearing away of the ground surface as a result of the movement of wind, water or ice.

EXCAVATION. The removal of earth material by artificial means, also referred to as a cut.

FILL. Deposition of earth materials by artificial means.

GRADE. The vertical location of the ground surface.

GRADE, EXISTING. The grade prior to grading.

GRADE, FINISHED. The grade of the site at the conclusion of all grading efforts.

GRADING. An excavation or fill or combination thereof.

KEY. A compacted fill placed in a trench excavated in earth material beneath the toe of a slope.

SLOPE. An inclined surface, the inclination of which is expressed as a ratio of horizontal distance to vertical distance.

TERRACE. A relatively level step constructed in the face of a graded slope for drainage and maintenance purposes.

SECTION J103 PERMITS REQUIRED

J103.1 Permits required. Except as exempted in Section J103.2, no grading shall be performed without first having obtained a permit therefor from the building official. A grading permit does not include the construction of retaining walls or other structures.

J103.2 Exemptions. A grading permit shall not be required for the following:

1. Grading in an isolated, self-contained area, provided there is no danger to the public, and that such grading will not adversely affect adjoining properties.
2. Excavation for construction of a structure permitted under this code.
3. Cemetery graves.
4. Refuse disposal sites controlled by other regulations.
5. Excavations for wells, or trenches for utilities.
6. Mining, quarrying, excavating, processing or stockpiling rock, sand, gravel, aggregate or clay controlled by other regulations, provided such operations do not affect the lateral support of, or significantly increase stresses in, soil on adjoining properties.
7. Exploratory excavations performed under the direction of a registered design professional.

Exemption from the permit requirements of this appendix shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this jurisdiction.

SECTION J104 PERMIT APPLICATION AND SUBMITTALS

J104.1 Submittal requirements. In addition to the provisions of Section 105.3, the applicant shall state the estimated quantities of excavation and fill.

J104.2 Site plan requirements. In addition to the provisions of Section 107, a grading plan shall show the existing grade and finished grade in contour intervals of sufficient clarity to indicate the nature and extent of the work and show in detail that it complies with the requirements of this code. The plans shall show the existing grade on adjoining properties in sufficient detail to identify how grade changes will conform to the requirements of this code.

J104.3 Geotechnical report. A geotechnical report prepared by a registered design professional shall be provided. The report shall contain at least the following:

1. The nature and distribution of existing soils;
2. Conclusions and recommendations for grading procedures;
3. Soil design criteria for any structures or embankments required to accomplish the proposed grading; and
4. Where necessary, slope stability studies, and recommendations and conclusions regarding site geology.

Exception: A geotechnical report is not required where the building code official determines that the nature of the work applied for is such that a report is not necessary.

J104.4 Liquefaction study. For sites with mapped maximum considered earthquake spectral response accelerations at short periods (S_g) greater than 0.5g as determined by Section 1613, a study of the liquefaction potential of the site shall be provided, and the recommendations incorporated in the plans.

Exceptions:

1. A liquefaction study is not required where the building official determines from established local data that the liquefaction potential is low.
2. [OSHPD 1, 2, & 4] Exception 1 not permitted by OSHPD.

SECTION J105 INSPECTIONS

J105.1 General. Inspections shall be governed by Section 110, Chapter 1, Division II of this code.

J105.2 Special inspections. The special inspection requirements of Section 1704.7 shall apply to work performed under a grading permit where required by the building official.

SECTION J106 EXCAVATIONS

J106.1 Maximum slope. The slope of cut surfaces shall be no steeper than is safe for the intended use, and shall be no steeper than two units horizontal to one unit vertical (50-percent slope) unless the owner or authorized agent furnishes a geotechnical report justifying a steeper slope.

Exceptions:

1. A cut surface shall be permitted to be at a slope of 1.5 units horizontal to one unit vertical (67-percent slope) provided that all of the following are met:
 - 1.1. It is not intended to support structures or surcharges.
 - 1.2. It is adequately protected against erosion.
 - 1.3. It is no more than 8 feet (2438 mm) in height.
 - 1.4. It is approved by the building code official.
 - 1.5. Ground water is not encountered.

2. A cut surface in bedrock shall be permitted to be at a slope of one unit horizontal to one unit vertical (100-percent slope).

J106.2 Earth retaining shoring. [OSHPD 1 & 4, DSA-SS & ||| DSA-SS/CC]

J106.2.1 General. The requirements of this section shall apply to temporary and permanent earth retaining shoring using soldier piles and lagging with or without tie-back anchors in soil or rock, only when existing or new DSA-SS, DSA-SS/CC or OSHPD 1 or 4 facilities are affected. Shoring used as construction means and methods only, which does not affect existing or new DSA-SS, DSA-SS/CC or OSHPD 1 or 4 facilities, are not regulated by DSA or OSHPD and shall satisfy the requirements of the authorities having jurisdiction.

Design, construction, testing and inspection shall satisfy the requirements of this code except as modified in Sections J106.2.2 through J106.2.8.

J106.2.2 Duration. Shoring shall be considered temporary when elements of the shoring will be exposed to site conditions for a period of less than one (1) year, and shall be considered permanent otherwise. Permanent shoring shall account for the increase in lateral soil pressure due to earthquake. At the end of the construction period, the existing and new structures shall not rely on the temporary shoring for support in any way. Wood components shall not be used for permanent shoring lasting more than two (2) years. Wood components of the temporary shoring that may affect the performance of permanent structure shall be removed after the shoring is no longer required.

All components of the shoring shall have corrosion protection or preservative treatment for their expected duration. Wood components of the temporary shoring that will not be removed shall be treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B and Section 5.2), and shall be identified in accordance with Section 2303.1.8.1.

J106.2.3 Surcharge. Surcharge pressure due to footings, traffic or other sources shall be considered in design. If the footing surcharge is located within the semicircular distribution or bulb of earth pressure (when shoring is located close to a footings), lagging shall be designed for lateral earth pressure due to footing surcharge. Soil arching effects may be considered in the design of lagging. Underpinning of the footing may be used in lieu of designing the shoring and lagging for surcharge pressure. Alternatively, continuously contacting drilled pier shafts near the footings shall be permitted. The lateral surcharge design pressure shall be derived using Boussinesq equations modified for the distribution of stresses in an elastic medium due to a uniform, concentrated or line surface load as appropriate and soil arching effects.

J106.2.4 Design and testing: Except for the modifications as set forth in Sections J106.2.4.1 and J106.2.4.2 below, all Prestressed Rock and Soil Tie-back Anchors shall be designed and tested in accordance with PTI Recommendations for Prestressed Rock and Soil Anchors (PTI-2004).

J106.2.4.1 Geotechnical requirements: The geotechnical report for the earth retaining shoring shall address the following:

1. Minimum diameter and minimum spacing for the anchors including consideration of group effects.
2. Maximum unbonded length and minimum bonded length of the tie-back anchors.
3. Maximum recommended anchor tension capacity based upon the soil or rock strength/grout bond and anchor depth/spacing.
4. Allowable bond stress at the ground/grout interface and applicable factor of safety for ultimate bond stress for the anchor. For permanent anchors, a minimum factor of safety of 2.0 shall be applied to ground soil interface as required by PTI-2004 Section 6.6.
5. Minimum grout pressure for installation and post-grout pressure for the anchor. The presumptive post grout pressure of 300 psi may be used for all soil type.
6. Class I corrosion protection is required for all permanent anchors. The geotechnical report shall specify the corrosion protection recommendations for temporary anchors.
7. Performance test for the anchors shall be at a minimum of two (2) times the design loads and shall not exceed 80 percent of the specified minimum tensile strength of the anchor rod. A creep test is required for all prestressed anchors that are performance tested. All production anchors shall be tested at 150 percent of design loads and shall not be greater than 70 percent of the specified minimum tensile strength of the anchor rod.
8. Earth pressure, surcharge pressure and the seismic increment of earth pressure loading, when applicable.
9. Maximum recommended lateral deformation at the top of the soldier pile, at the tie-back anchor locations, and the drilled pier concrete shafts at the lowest grade level.
10. Allowable vertical soil bearing pressure friction resistance, and lateral passive soil resistance for the drilled pier concrete shafts and associated factors of safety for these allowable capacities.
11. Soil-pier shaft/pile interaction assumptions and lateral soil stiffness to be used in design for drilled pier concrete shaft or pile lateral loads.
12. Acceptable drilling methods.
13. Geotechnical observation and monitoring recommendations.

J106.2.4.2 Structural requirements:

1. Tendons shall be thread-bar anchors conforming to ASTM A 722.

2. Anchor design loads shall be based upon the load combinations in Section 1605A.3.1 and shall not exceed 60 percent of the specified minimum tensile strength of the tendons.

3. The anchor shall be designed to fail in grout bond to the soil or rock before pullout of the soil wedge.
4. Design of shoring system shall account for as-built locations of soil anchors considering all specified construction tolerances in Section J106.2.8.
5. Design of shoring system shall account for both short and long-term deformation.

J106.2.4.3 Testing of tie-back anchors:

1. The geotechnical engineer shall keep a record at job site of all test loads, total anchor movement, and report their accuracy.
2. If a tie-back anchor initially fails the testing requirements, the anchor shall be permitted to be regROUTed and retested. If anchor continues to fail, the following steps shall be taken:
 - a. The contractor shall determine the cause of failure – variations of the soil conditions, installation methods, materials, etc.
 - b. The contractor shall propose a solution to remedy the problem. The proposed solution will need to be reviewed and approved by the geotechnical engineer, shoring design engineer and building official.
3. After a satisfactory test, each anchor shall be locked-off in accordance with Section 8.4 of PTI 2004.
4. The shoring design engineer shall specify design loads for each anchor.

J106.2.5 Construction. The construction procedure shall address the following:

1. Holes drilled for piles/tie-back anchors shall be done without detrimental loss of ground, sloughing or caving of materials and without endangering previously installed shoring members or existing foundations.
2. Drilling of earth anchor shafts for tie-backs shall occur when the drill bench reaches two to three feet below the level of the tie-back pockets.
3. Casing or other methods shall be used where necessary to prevent loss of ground and collapse of the hole.
4. The drill cuttings from earth anchor shaft shall be removed prior to anchor installation.
5. Unless tremie methods are used, all water and loose materials shall be removed from the holes prior to installing piles/tie-backs.
6. Tie-back anchor rods with attached centralizing devices shall be installed into the shaft or through

- the drill casing. Centralizing device shall not restrict movement of the grout.*
7. *After lagging installation, voids between lagging and soil shall be backfilled immediately to the full height of lagging.*
 8. *The soldier piles shall be placed within specified tolerances in the drilled hole and braced against displacement during grouting. Fill shafts with concrete up to top of footing elevation, rest of the shaft can generally be filled with lean concrete. Excavation for lagging shall not be started until concrete has achieved sufficient strength for all anticipated loads as determined by the shoring design engineer.*
 9. *Where boulders and/or cobbles have been identified in the geotechnical reports, contractor shall be prepared to address boulders and/or cobbles that may be encountered during the drilling of soldier piles and tie-back anchors.*
 10. *The grouting equipment shall produce grout free of lumps and indispensed cement. The grouting equipment shall be sized to enable the grout to be pumped in continuous operation. The mixer shall be capable of continuously agitating the grout.*
 11. *The quantity of grout and grout pressure shall be recorded. The grout pressure shall be controlled to prevent excessive heave in soils or fracturing rock formations.*
 12. *If post-grouting is required, post-grouting operation shall be performed after initial grout has set for 24 hours in the bond length only. Tie-backs shall be grouted over a sufficient length (anchor bond length) to transfer the maximum anchor force to the anchor grout.*
 13. *Testing of anchors may be performed after post-grouting operations, provided grout has reached strength of 3,000 psi as required by PTI-2004 Section 6.11.*
 14. *Anchor rods shall be tensioned straight and true. Excavation directly below the anchors shall not continue before those anchors are tested.*

J106.2.6 Inspection, survey monitoring and observation.

1. *The shoring design engineer or his designee shall make periodic inspections of the job site for the purpose of observing the installation of shoring system, testing of tie-back anchors and monitoring of survey.*
2. *Testing, inspection and observation shall be in accordance with testing, inspection and observation requirements approved by the building official. The following activities and materials shall be tested, inspected, or observed by the special inspector and geotechnical engineer:*
 - a. *Sampling and testing of concrete in soldier pile and tie-back anchor shafts.*
 - b. *Fabrication of tie-back anchor pockets on soldier beams*
 - c. *Installation and testing of tie-back anchors.*
 - d. *Survey monitoring of soldier pile and tie-back load cells.*
 - e. *Survey monitoring of existing buildings.*
3. *A complete and accurate record of all soldier pile locations, depths, concrete strengths, tie-back locations and lengths, tie-back grout strength, quantity of concrete per pile, quantity of grout per tie-back and applied tie-back loads shall be maintained by the special inspector and geotechnical engineer. The shoring design engineer shall be notified of any unusual conditions encountered during installation.*
4. *Calibration data for each test jack, pressure gauge and master pressure gauge shall be verified by the special inspector and geotechnical engineer. The calibration tests shall be performed by an independent testing laboratory and within 120 calendar days of the data submitted.*
5. *Monitoring points shall be established at the top and at the anchor heads of selected soldier piles and at intermediate intervals as considered appropriate by the geotechnical engineer.*
6. *Control points shall be established outside the area of influence of the shoring system to ensure the accuracy of the monitoring readings.*
7. *The periodic basis of shoring monitoring, as a minimum, shall be as follows:*
 - a. *Initial monitoring shall be performed prior to any excavation.*
 - b. *Once excavation has begun, the periodic readings shall be taken weekly until excavation reaches the estimated subgrade elevation and the permanent foundation is complete.*
 - c. *If performance of the shoring is within established guidelines, shoring design engineer may permit the periodic readings to be bi-weekly. Once initiated, bi-weekly readings shall continue until the building slab at ground floor level is completed and capable of transmitting lateral loads to the permanent structure. Thereafter, readings can be monthly.*
 - d. *Where the building has been designed to resist lateral earth pressures, the periodic monitoring of the soldier piles and adjacent structure can be discontinued once the ground floor diaphragm and subterranean portion of the structure is capable of resisting lateral soil loads and approved by the shoring design engineer, geotechnical engineer and building official.*
 - e. *Additional readings shall be taken when requested by the special inspector, shoring*

- design engineer, geotechnical engineer or building official.*
8. *Monitoring reading shall be submitted to the shoring design engineer, engineer in responsible charge, and building official within three working days after they are conducted. Monitoring readings shall be accurate to within 0.01 feet. Results are to be submitted in tabular form showing at least the initial date of monitoring and reading, current monitoring date and reading and difference between the two readings.*
 9. *If the total cumulative horizontal or vertical movement (from start of construction) of the existing buildings reaches $\frac{1}{2}$ inch or soldier piles reaches 1 inch all excavation activities shall be suspended. The geotechnical and shoring design engineer shall determine the cause of movement, if any, and recommend corrective measures, if necessary, before excavation continues.*
 10. *If the total cumulative horizontal or vertical movement (from start of construction) of the existing buildings reaches $\frac{3}{4}$ inch or soldier piles reaches $1\frac{1}{2}$ inches all excavation activities shall be suspended until the causes, if any, can be determined. Supplemental shoring shall be devised to eliminate further movement and the building official shall review and approve the supplemental shoring before excavation continues.*
 11. *Monitoring of tie-back anchor loads:*
 - a. *Load cells shall be installed at the tie-back heads adjacent to buildings at maximum interval of 50 feet, with a minimum of one load cells per wall.*
 - b. *Load cell readings shall be taken once a day during excavation and once a week during the remainder of construction.*
 - c. *Load cell readings shall be submitted to the geotechnical engineer, shoring design engineer, engineer in responsible charge and building official.*
 - d. *Load cell readings can be terminated once the temporary shoring no longer provides support for the buildings.*
- J106.2.7 Monitoring of existing DSA-SS, DSA-SS/CC, and OSHPD 1 and 4 structures**
1. *The contractor shall complete a written and photographic log of all existing DSA-SS, DSA-SS/CC, and OSHPD 1 & 4 structures within 100 ft or three times depth of shoring, prior to construction. A licensed surveyor shall document all existing substantial cracks in adjacent existing structures.*
 2. *The contractor shall document existing condition of wall cracks adjacent to shoring walls prior to start of construction.*
3. *The contractor shall monitor existing walls for movement or cracking that may result from adjacent shoring.*
 4. *If excessive movement or visible cracking occurs, the contractor shall stop work and shore/reinforce excavation and contact the shoring design engineer and building official.*
 5. *Monitoring of the existing structure shall be at reasonable intervals as required by the registered design professional subject to approval of the building official. Monitoring shall be performed by a licensed surveyor and shall consist of vertical and lateral movement of the existing structures. Prior to starting shoring installation a preconstruction meeting shall take place between the contractor, shoring design engineer, surveyor, geotechnical engineer and building official to identify monitoring locations on existing buildings.*
 6. *If in the opinion of the building official or shoring design engineer, monitoring data indicate excessive movement or other distress, all excavation shall cease until the geotechnical engineer and shoring design engineer investigate the situation and make recommendations for remediation or continuing.*
 7. *All reading and measurements shall be submitted to the building official and shoring design engineer.*
- J106.2.8 Tolerances.** *The following tolerances shall be specified on the construction documents.*
1. *Soldier piles:*
 - i. *Horizontal and vertical construction tolerances for the soldier pile locations.*
 - ii. *Soldier pile plumbness requirements (angle with vertical line).*
 2. *Tie-back anchors:*
 - i. *Allowable deviation of anchor projected angle from specified vertical and horizontal design projected angle.*
 - ii. *Anchor clearance to the existing/new utilities and structures.*

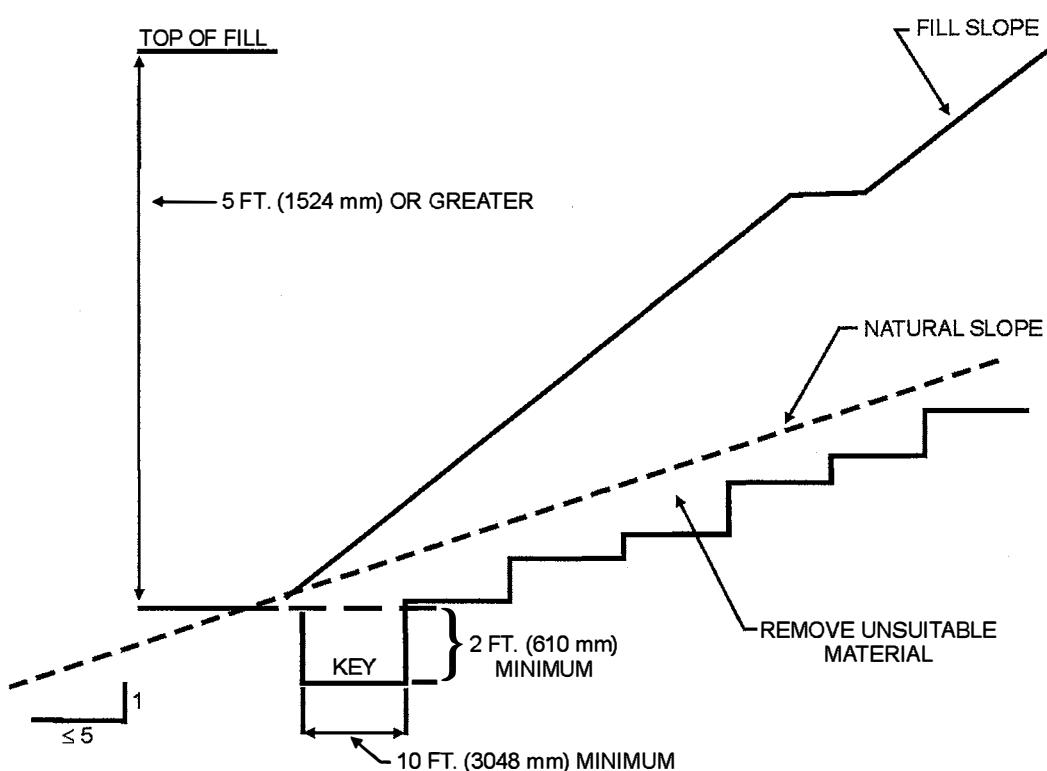
SECTION J107 FILLS

J107.1 General. Unless otherwise recommended in the geotechnical report, fills shall comply with the provisions of this section.

J107.2 Surface preparation. The ground surface shall be prepared to receive fill by removing vegetation, topsoil and other unsuitable materials, and scarifying the ground to provide a bond with the fill material.

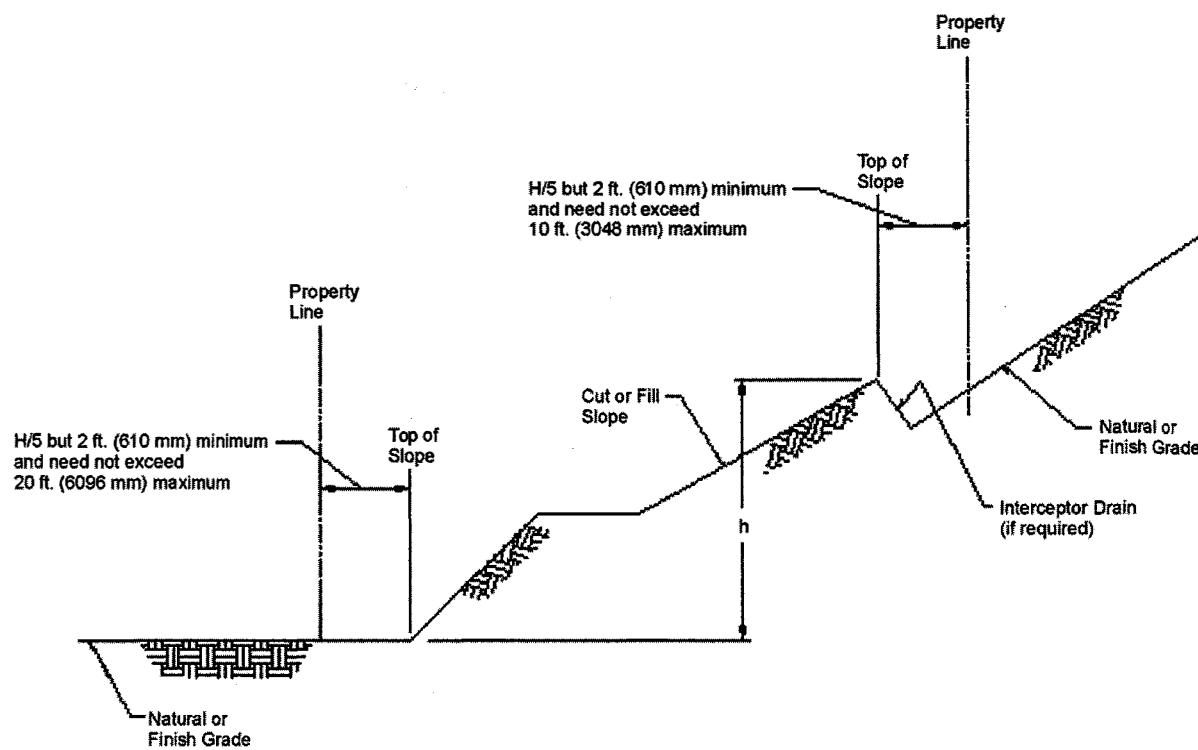
J107.3 Benching. Where existing grade is at a slope steeper than five units horizontal to one unit vertical (20-percent slope) and the depth of the fill exceeds 5 feet (1524 mm) benching shall be provided in accordance with Figure J107.3. A key shall be provided which is at least 10 feet (3048 mm) in width and 2 feet (610 mm) in depth.

APPENDIX J



For SI: 1 foot = 304.8 mm.

**FIGURE J107.3
BENCHING DETAILS**



For SI: 1 foot = 304.8 mm.

**FIGURE J108.1
DRAINAGE DIMENSIONS**

J107.4 Fill material. Fill material shall not include organic, frozen or other deleterious materials. No rock or similar irreducible material greater than 12 inches (305 mm) in any dimension shall be included in fills.

J107.5 Compaction. All fill material shall be compacted to 90 percent of maximum density as determined by ASTM D 1557, Modified Proctor, in lifts not exceeding 12 inches (305 mm) in depth.

|| *[OSHPD 1, 2, & 4, DSA-SS & DSA-SS/CC] This section establishes minimum requirements only.*

J107.6 Maximum slope. The slope of fill surfaces shall be no steeper than is safe for the intended use. Fill slopes steeper than two units horizontal to one unit vertical (50-percent slope) shall be justified by a geotechnical report or engineering data.

SECTION J108 SETBACKS

J108.1 General. Cut and fill slopes shall be set back from the property lines in accordance with this section. Setback dimensions shall be measured perpendicular to the property line and shall be as shown in Figure J108.1, unless substantiating data is submitted justifying reduced setbacks.

J108.2 Top of slope. The setback at the top of a cut slope shall not be less than that shown in Figure J108.1, or than is required to accommodate any required interceptor drains, whichever is greater.

J108.3 Slope protection. Where required to protect adjacent properties at the toe of a slope from adverse effects of the grading, additional protection, approved by the *building official*, shall be included. Such protection may include but shall not be limited to:

1. Setbacks greater than those required by Figure J108.1.
2. Provisions for retaining walls or similar construction.
3. Erosion protection of the fill slopes.
4. Provision for the control of surface waters.

SECTION J109 DRAINAGE AND TERRACING

J109.1 General. Unless otherwise recommended by a registered design professional, drainage facilities and terracing shall be provided in accordance with the requirements of this section.

Exception: Drainage facilities and terracing need not be provided where the ground slope is not steeper than 3 horizontal to 1 vertical (33 percent).

J109.2 Terraces. Terraces at least 6 feet (1829 mm) in width shall be established at not more than 30-foot (9144 mm) vertical intervals on all cut or fill slopes to control surface drainage and debris. Suitable access shall be provided to allow for cleaning and maintenance.

Where more than two terraces are required, one terrace, located at approximately mid-height, shall be at least 12 feet (3658 mm) in width.

Swales or ditches shall be provided on terraces. They shall have a minimum gradient of 20 horizontal to 1 vertical (5 percent) and shall be paved with concrete not less than 3 inches (76 mm) in thickness, or with other materials suitable to the application. They shall have a minimum depth of 12 inches (305 mm) and a minimum width of 5 feet (1524 mm).

A single run of swale or ditch shall not collect runoff from a tributary area exceeding 13,500 square feet (1256 m²) (projected) without discharging into a down drain.

J109.3 Interceptor drains. Interceptor drains shall be installed along the top of cut slopes receiving drainage from a tributary width greater than 40 feet (12 192 mm), measured horizontally. They shall have a minimum depth of 1 foot (305 mm) and a minimum width of 3 feet (915 mm). The slope shall be approved by the building official, but shall not be less than 50 horizontal to 1 vertical (2 percent). The drain shall be paved with concrete not less than 3 inches (76 mm) in thickness, or by other materials suitable to the application. Discharge from the drain shall be accomplished in a manner to prevent erosion and shall be approved by the building official.

J109.4 Drainage across property lines. Drainage across property lines shall not exceed that which existed prior to grading. Excess or concentrated drainage shall be contained on site or directed to an approved drainage facility. Erosion of the ground in the area of discharge shall be prevented by installation of nonerosive down drains or other devices.

SECTION J110 EROSION CONTROL

J110.1 General. The faces of cut and fill slopes shall be prepared and maintained to control erosion. This control shall be permitted to consist of effective planting.

Exception: Erosion control measures need not be provided on cut slopes not subject to erosion due to the erosion-resistant character of the materials.

Erosion control for the slopes shall be installed as soon as practicable and prior to calling for final inspection.

J110.2 Other devices. Where necessary, check dams, cribbing, riprap or other devices or methods shall be employed to control erosion and provide safety.

SECTION J111 REFERENCED STANDARDS

ASTM D
1557-e01

Test Method for Laboratory
Compaction Characteristics of
Soil Using Modified Effort
[56,000 ft-lb/ft³ (2,700kN-m/m³)].

J107.6

SECTION J112
VIBRO STONE COLUMNS
FOR GROUND IMPROVEMENT
[OSHPD 1, 2 & 4, DSA-SS & DSA-SS/CC]

J112.1 General. This section shall apply to vibro stone columns (VSCs) for ground improvement using unbounded aggregate materials. Vibro stone column provisions in this section are intended to increase bearing capacity, reduce settlements and mitigate liquefaction for shallow foundations. These requirements shall not be used for grouted or bonded stone columns, ground improvement for deep foundation elements, or changing site class. VSCs shall not be considered a deep foundation element. Ground improvement shall be installed under the entire building/structure footprint and not under isolated foundation elements only. Design, construction, testing and inspection shall satisfy the requirements of this code except as modified in Sections J112.2 through J112.5.

J112.2 Geotechnical report. The geotechnical report shall specify vibro stone column requirements to ensure uniformity in total and differential immediate settlement, long term settlement and earthquake induced settlement.

1. Soil compaction shall be in accordance with California Geological Survey (CGS) Special Publication 117A (SP-117A): Guidelines for Evaluating and Mitigating Seismic Hazard in California.
2. Area replacement ratio for the compaction elements and the basis of its determination shall be explained. Minimum factor of safety for soil compaction shall be in accordance with SP-117A.
3. Depth of soil compaction elements and extent beyond the footprint of structures/foundation shall be defined. Extent beyond the foundation shall be half the depth of the VSCs with a minimum of 10 ft or an approved alternative.
4. Minimum diameter and maximum spacing of soil compaction elements shall be specified. VSCs shall not be less than 2 feet in diameter, and center to center spacing shall not exceed 8 feet.
5. The modulus of subgrade reactions for shallow foundations shall account for the presence of compaction elements.
6. The modulus of subgrade reactions, long-term settlement and post-earthquake settlement shall be specified along with expected total and differential settlements for design.
7. The acceptance criteria for the cone penetration test (CPT) in accordance with ASTM D 3441 complemented by the standard penetration test (SPT) in accor-

dance with ASTM D 1586, if necessary, to verify soil improvement shall be specified.

8. The requirements for special inspection and observation by the geotechnical engineer shall be specified.
9. A final verified report (FVR) documenting the installation of the ground improvement system and confirming that the ground improvement acceptance criteria have been met shall be prepared by the geotechnical engineer and submitted to the enforcement agency for review and approval.

J112.3 Shallow foundations. VSCs under the shallow foundation shall be located symmetrically around the centroid of the footing or load.

1. There shall be a minimum of four stone columns under each isolated or continuous/combined footing or approved equivalent.
2. The VSCs or deep foundation elements shall not be used to resist tension or overturning uplift from the shallow foundations.
3. The foundation design for the shallow foundation shall consider the increased vertical stiffness of the VSCs as point supports for analysis, unless it is substantiated that the installation of the VSCs result in improvement of the surrounding soils such that the modulus of sub-grade reaction, long term settlement, and post-earthquake settlement can be considered uniform throughout.

J112.4 Installation. VSCs shall be installed with vibratory probes. Vertical columns of compacted unbounded aggregate shall be formed through the soils to be improved by adding gravel near the tip of the vibrator and progressively raising and repenetrating the vibrator which will results in the gravel being pushed into the surrounding soil. Gravel aggregate for VSCs shall be well graded with a maximum size of 6 inches and not more than 10 percent smaller than $\frac{3}{8}$ inch after compaction.

J112.5 Construction documents. Construction documents for VSCs, as a minimum, shall include the following:

1. Size, depth and location of VSCs.
2. Extent of soil improvements along with building/structure foundation outlines.
3. Field verification requirements and acceptance criteria using CPT/SPT.
4. The locations where CPT/SPT shall be performed.
5. The testing, inspection and observation (TIO) program shall indicate the inspection and observation required for the VSCs.

APPENDIX K

GROUP R-3 AND GROUP R-3.1 OCCUPANCIES PROTECTED BY THE FACILITIES OF THE CENTRAL VALLEY FLOOD PROTECTION PLAN

Note: The effective date of these standards shall be March 1, 2012 or ninety (90) days after the corresponding maps are completed and become readily available to the general public, whichever is the later date.

SECTION K101 SCOPE

K101.1 General. The provisions of this section shall apply to new construction, changes of use and to substantial improvement and restoration of substantial damage as defined in Section 1612, of Group R-3 and R-3.1 Occupancies in areas protected by the facilities of the Central Valley Flood Protection Plan where flood levels are anticipated to exceed three feet for the 200-year flood event. Except as specifically required by this section, buildings and structures shall meet applicable provisions of this code.

Exception: Changes of use of Group R-3 to Group R-3.1 Occupancies, including any substantial improvement done under the same permit.

K101.1.1 Construction documents. If the land on which the proposed work is to be constructed is located in an area protected by the facilities of the Central Valley Flood Protection Plan, the construction documents shall include the WSEL200 and the elevation(s) of the floor(s), and, as applicable, the elevation(s) and slopes of roofs, of the building or structure.

SECTION K102 DEFINITIONS

K102.1 General. The following words and terms shall, for the purposes of this section, have the meanings shown.

AREAS PROTECTED BY THE FACILITIES OF THE CENTRAL VALLEY FLOOD PROTECTION PLAN WHERE FLOOD LEVELS ARE ANTICIPATED TO EXCEED THREE FEET FOR THE 200-YEAR FLOOD EVENT. Geographical areas identified by the state as "Areas Protected by the Facilities of the Central Valley Flood Protection Plan where Flood Levels are Anticipated to Exceed Three Feet for the 200-Year Flood Event" in accordance with Health and Safety Code Section 50465. Published data from the California Department of Water Resources can be obtained online at the following website: www.water.ca.gov/BuildingCodes.

Note: The facilities of the Central Valley Flood Protection Plan are identified in the following counties: Butte, Colusa, Fresno, Glenn, Lake, Madera, Merced, Plumas, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, Tehama, Yolo and Yuba. Determination of additional facilities is ongoing.

CENTRAL VALLEY. Any lands in the bed or along or near the banks of the Sacramento River and the San Joaquin River, and any of their tributaries or connected therewith, or upon any land adjacent thereto, or within any of the overflow basins thereof, or upon any land susceptible to overflow therefrom. The following counties and the incorporated municipalities within these counties, in whole or in part, are in the Central Valley: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Fresno, Glenn, Lake, Lassen, Madera, Mariposa, Merced, Modoc, Napa, Nevada, Placer, Plumas, Sacramento, San Benito, San Joaquin, Shasta, Sierra, Siskiyou, Solano, Stanislaus, Sutter, Tehama, Tuolumne, Yolo and Yuba. A map that delineates the Central Valley can be obtained online at the following website: www.water.ca.gov/BuildingCodes.

EVACUATION LOCATION. A location no less than one (1) foot (0.30 meter) above the WSEL200 where occupants are expected to congregate pending evacuation and from which occupants may be evacuated during conditions of flooding, such as a space within the building that has an exit door or operable window; a deck, balcony, porch, rooftop platform or rooftop area, or combinations thereof.

FACILITIES OF THE CENTRAL VALLEY FLOOD PROTECTION PLAN. The facilities referenced herein include the facilities of State Plan of Flood Control and other flood management facilities in the Central Valley evaluated under the Central Valley Flood Protection Plan, which will be completed in 2012 and updated every 5 years thereafter. The facilities of State Plan of Flood Control include the state and federal flood control works (levees, weirs, channels and other features) of the Sacramento River Flood Control Project described in Water Code Section 8350, and flood control projects in the Sacramento River and San Joaquin River watersheds authorized pursuant to Article 2 (commencing with Water Code section 12648) of Chapter 2 of Part 6 of Division 6 for which the Central Valley Flood Protection Board or the Department of Water Resources has provided the assurances of nonfederal cooperation to the United States, and those facilities identified in Water Code Section 8361.

ROUTE TO THE EVACUATION LOCATION. The path through and along which occupants move from the habitable areas of a building or structure that are below the WSEL200 to the evacuation location.

WSEL200. The water surface elevation (WSEL) of the 200-year flood event that is identified by the state when it identifies areas that receive protection from the facilities of the Central Valley Flood Protection Plan.

SECTION K103 STRUCTURAL STABILITY

K103.1 General. Portions of buildings and structures supporting evacuation locations shall be designed, constructed, connected and anchored to resist flotation, collapse or permanent lateral movement resulting from the hydrostatic loads anticipated during conditions of flooding anticipated for the 200-year flood event.

K103.2 Determination of loads. Hydrostatic loads, based on the depth of water determined by the WSEL200, shall be determined in accordance with Chapter 5 of ASCE 7. Reduction of hydrostatic loads may be accomplished by allowing for the automatic entry and exit of floodwaters to minimize unbalanced loads. Such means shall be designed by a registered design professional and include, but are not limited to, openings, valves, and panels designed to yield under load.

Exception: When two flood vents are installed on opposite sides of the building or structure, one on each side, that comply with Figure K103.1.

SECTION K104 EVACUATION LOCATIONS

K104.1 General. An evacuation location and a route to the evacuation location shall be provided for Group R-3 and R-3.1 Occupancies.

K104.2 Route to evacuation location. A route shall be allowed through any number of intervening rooms or spaces. Doors along the route shall be openable without the use of a key or lock, special knowledge or effort.

Exception: Doors in individual dwelling or sleeping units having an occupant load of 10 or less are permitted to be equipped with a night latch, dead bolt or security chain, provided such devices are openable from the inside without the use of a key or tool.

K104.2.1 Group R-3.1 Occupancies. The route to an evacuation location shall meet the accessibility requirements of Chapter 11A or 11B as applicable.

K104.3 Minimum size requirements. Evacuation locations shall provide a minimum gross floor area of 7 square feet (0.65 m²) per occupant, based on the occupant load of the portions of the building that are below the WSEL200. The area provided shall be adequate to accommodate the occupant load of the upper levels as well as the anticipated occupant load from the area below the WSEL200.

SECTION K105 SPACE WITHIN THE BUILDING

K105.1 General. If the evacuation location is a space within a building, the evacuation location shall be provided with a means for occupants to be evacuated out of the building specified in Sections K105.1.1, K105.1.2 or K105.1.3.

K105.1.1 Windows, minimum size and dimensions. A minimum of one window shall be provided that meets the minimum size, minimum dimensions and operational constraints of Section 1026. The number of such windows shall be appropriate for the occupancy or occupancies of the portions of the building that are below the WSEL200.

Note: It is the intent of this section that windows are of sufficient number, sizes and dimensions to reasonably accommodate the needs and limitations of the occupants of the building. Reasonable judgment in the application of this requirement must be exercised by the building official.

K105.1.2 Exterior doors to decks, balconies and porches. Exterior doors to decks, balconies and porches shall be sized in accordance with Section 1008.

Exception: In Group R-3.1 Occupancies that are subject to the requirements of Chapters 11A or 11B, doors to decks, balconies or porches shall comply with Section 1132A.1.

K105.1.3 Means of escape to rooftops from spaces within a building. The means of escape to rooftops shall be permitted to be provided by a stairway, ramp, alternating tread device, fixed ladder or other means approved by the building official.

Exception: In Group R-3.1 occupancies that are subject to the requirements of Chapter 11A or 11B, such accessibility requirements shall apply to the means of escape to rooftops.

SECTION K106 DECKS AND BALCONIES THAT ARE EVACUATION LOCATIONS

K106.1 General. Decks and balconies that have finish floors no less than one (1) foot (0.30 meter) above the WSEL200 shall be permitted to be evacuation locations. When a deck or balcony used as an evacuation location is not at the same level as a floor within the building, it shall be permitted to be accessed by a stairway, ramp, alternating tread device, fixed ladder or other means approved by the building official.

K106.2 Live load. Decks and balconies that are evacuation locations shall be designed for the live load required for the occupancy as required in Table 1607.2.

K106.3 Evacuation route. Evacuation routes to decks and balconies that are evacuation locations shall be permitted to be provided by a stairway, ramp, alternating tread device, fixed ladder or other means approved by the building official.

Exception: In Group R-3.1 Occupancies that are subject to the requirements of Chapter 11A or 11B, such requirements shall apply to the evacuation routes to decks and balconies.

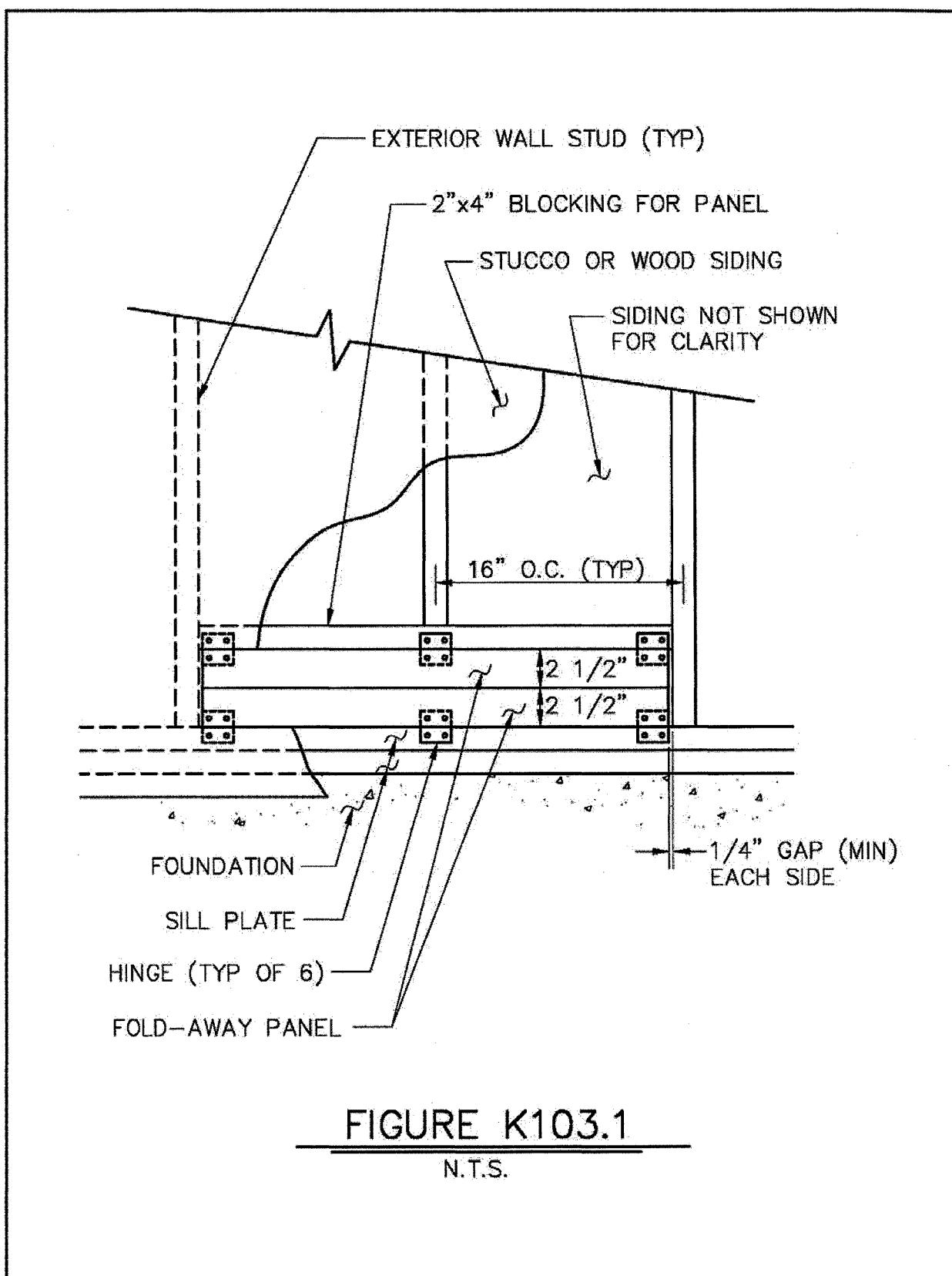


FIGURE K103.1

N.T.S.

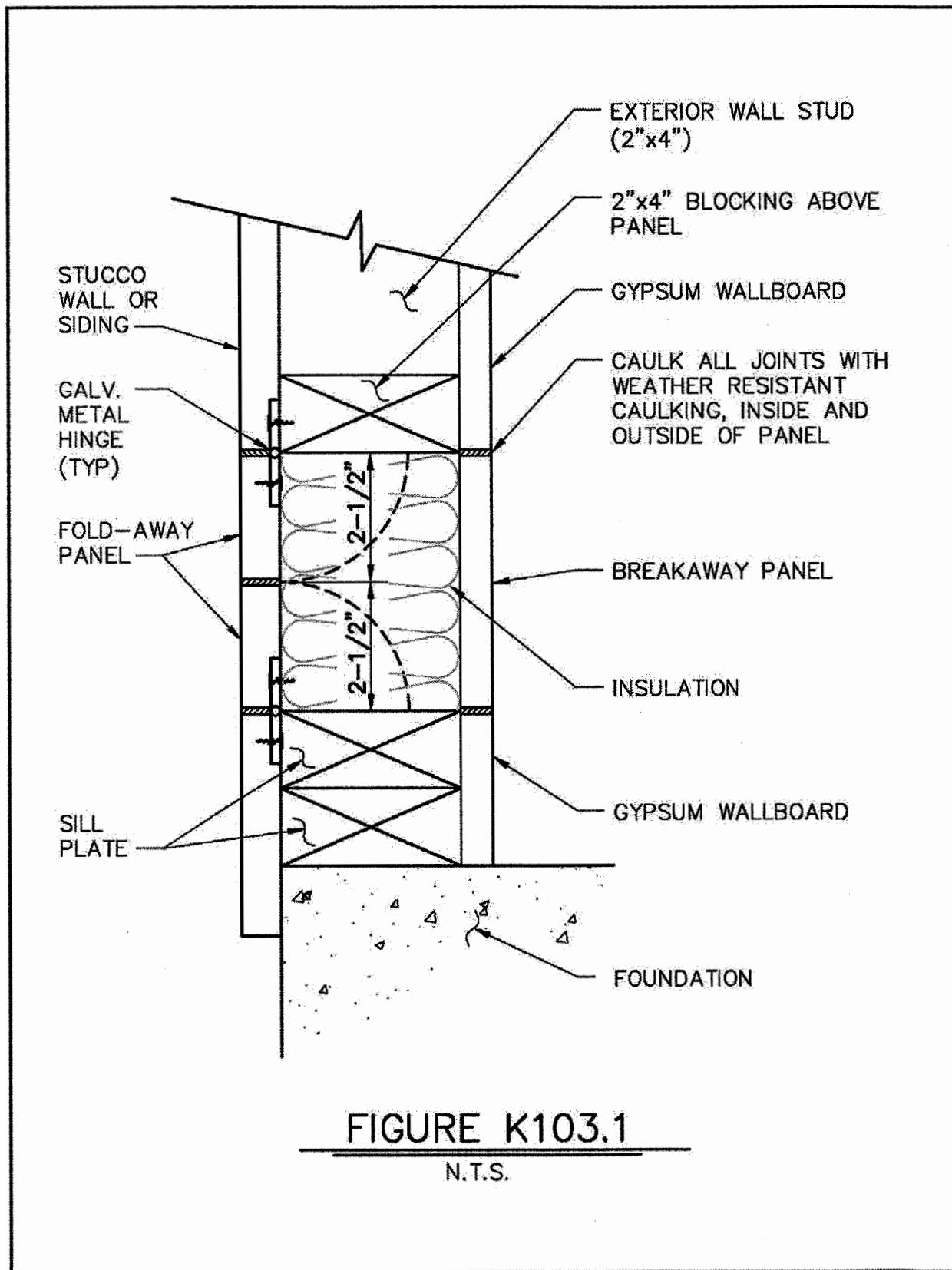


FIGURE K103.1

N.T.S.

SECTION K107 ROOFTOP EVACUATION LOCATIONS

K107.1 General. Rooftop evacuation locations shall be permitted to include rooftop platforms and rooftop areas provided that they are no less than one (1) foot (0.30 meter) above the WSEL200. A minimum horizontal distance of three (3) feet (0.91 meter) shall be provided between the lower edge of the rooftop evacuation location access point and the evacuation location lower perimeter.

K107.2 Rooftop platforms required. A rooftop platform shall be provided if the roof covering materials are:

1. Clay tile, concrete tile, slate shingles, wood shingles or wood shakes, and the roof slope is three units vertical in 12 units horizontal (25 percent slope) or greater.
2. Metal roof panels or metal roof shingles, and the roof slope is one unit vertical in 12 units horizontal (8.33 percent slope) or greater.

K107.3 Roof live loads. Roof areas that are rooftop evacuation locations and roofs that support rooftop platforms that are evacuation locations shall be designed for the roof live load required for the occupancy as required in Table 1607.2.

K107.4 Evacuation routes to rooftop evacuation locations. Evacuation routes to rooftop evacuation locations shall be permitted to be provided by a stairway, ramp, alternating tread device, fixed ladder or other means approved by the building official.

Exception: In Group R-3.1 occupancies that are subject to the requirements of Chapter 11A or 11B, such requirements shall apply to the evacuation routes to rooftops.

K107.5 Perimeter protection. For Group R-3 and R-3.1 occupancies, the perimeter of rooftop evacuation locations shall be protected by:

1. Guards per Section 1013 if a rooftop platform is provided; or
2. A railing that is 12 inches (305 mm) in height if a sloped roof is provided.

K107.6 Utility/equipment buffer zone. A separation of 48 inches shall be provided between a rooftop evacuation location and any mechanical equipment, photovoltaic system, utility service drop or other utility line. Electrical service lines shall not pass over evacuation locations.

SECTION K108 ATTICS THAT ARE EVACUATION LOCATIONS

K108.1 General. Attics that have finish floors no less than one (1) foot (0.30 meter) above the WSEL200 shall be permitted to be evacuation locations.

K108.2 Headroom. When an attic is used as an evacuation location, the minimum headroom of the required area shall be 30 inches (762 mm) with 50 percent of the required area having a headroom of 60 inches (1524 mm).

K108.3 Attic flooring. The required area of the evacuation location shall be solidly sheathed.

K108.4 Attic live loads. Attic areas that are used as evacuation locations shall be designed for the floor live load required for the occupancy as required in Table 1607.2.

K108.5 Evacuation routes to attic evacuation locations. Evacuation routes to attic evacuation locations shall be permitted to be provided by a stairway, ramp, alternating tread device, fixed ladder or other means approved by the building official.

Exception: In Group R-3.1 occupancies that are subject to the requirements of Chapter 11A or 11B, such requirements shall apply to the evacuation routes to attics.

K108.6 Means of escape from attics. The means of escape from attics shall comply with Section K105.

SECTION K109 ALTERNATE MEANS OF PROTECTION

K109.1 Request for approval of alternate means of protection. Requests for approval to use an alternative means of protection shall be made in writing to the building official by the owner or the owner's authorized representative. The request shall be accompanied by a full statement of the conditions and sufficient evidence that the proposed alternate means of protection provides reasonable protection to occupants. The building official shall require the owner to obtain a written statement from the applicable emergency management authority regarding plans and processes related to notification of anticipated conditions of flooding, warnings, evacuations and other pertinent conditions relative to the proximity of nearby levees. The building official shall also require the owner to obtain a written statement and findings from the entity that has jurisdiction over the management, maintenance, monitoring and control of flood protection works in the vicinity of the location of the owner's property; such statement shall comment on the viability of the proposed alternate means of protection. The building official may request written statements from the Central Valley Flood Protection Board, the California Department of Water Resources, and the California Emergency Management Agency.

Approval of a request for use of an alternative means of protection made pursuant to these provisions shall be limited to the particular case covered by the request and shall not be construed as establishing any precedent for any future request except in substantially equivalent situations.

Note: Contact information for the California Department of Water Resources and the Department's Directory of Flood Officials, which includes levee and reclamation district boundary maps, is available on-line at the following web site: www.water.ca.gov/BuildingCodes. The Department of Water Resources Building Code Project Engineer can be contacted at 916-574-1451. The Central Valley Flood Control Board Chief Engineer can be contacted at 916-574-0609. The California Emergency Management Agency Inland Region Program Manager can be contacted at 916-845-8488.

K109.2 Appeals. When a request for an alternate means of protection has been denied by the building official, the applicant may file a written appeal with the board of appeals. In considering such appeal, the board of appeals may provide additional information to, and request additional written statements from, the Central Valley Flood Protection Board, the California Department of Water Resources, and the California Emergency Management Agency. If such additional written statements are provided, the board of appeals shall consider those statements.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX L – EARTHQUAKE RECORDING INSTRUMENTATION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.

See Chapter 1 for state agency authority and building applications.)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | X | | X | X | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| L101 | | | | | | | | | X | | X | X | | | | | | | | |
| L102 | | | | | | | | | X | | X | X | | | | | | | | |
| L103 | | | | | | | | | X | | | | | | | | | | | |



APPENDIX L

EARTHQUAKE RECORDING INSTRUMENTATION

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION L101 GENERAL

L101.1 General. Every structure located where the 1-second spectral response acceleration, S_1 , in accordance with Section 1613.3 is greater than 0.40 that either 1) exceeds six stories in height with an aggregate floor area of 60,000 square feet (5574 m^2) or more, or 2) exceeds ten stories in height regardless of floor area, shall be equipped with not less than three approved recording accelerographs. The accelerographs shall be interconnected for common start and common timing.

[OSHPD 1, 3 & 4] There shall be a sufficient number of instruments to characterize the response of the building during an earthquake and shall include at least one tri-axial free field instrument or equivalent.

L101.2 Location. As a minimum, instruments shall be located at the lowest level, mid-height, and near the top of the structure. Each instrument shall be located so that access is maintained at all times and is unobstructed by room contents. A sign stating "MAINTAIN CLEAR ACCESS TO THIS INSTRUMENT" in 1-inch block letters shall be posted in a conspicuous location.

[OSHPD 1, 3 & 4] A proposal for instrumentation and equipment specifications shall be forwarded to the enforcement agency for review and approval.

L101.3 Maintenance. Maintenance and service of the instrumentation shall be provided by the owner of the structure. Data produced by the instrument shall be made available to the building official on request.

Maintenance and service of the instruments shall be performed annually by an approved testing agency. The owner shall file with the building official a written report from an approved testing agency certifying that each instrument has been serviced and is in proper working condition. This report shall be submitted when the instruments are installed and annually thereafter. Each instrument shall have affixed to it an externally visible tag specifying the date of the last maintenance or service and the printed name and address of the testing agency.

[OSHPD 1] The owner of the building shall be responsible for the implementation of the instrumentation program. Maintenance of the instrumentation and removal/processing of the records shall be the responsibility of the enforcement agency.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX M – TSUNAMI-GENERATED FLOOD HAZARD

(Not adopted by state agencies)

| Adopting agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CEC | CA | SL | SLC |
|--|-----|-----|-----|---|------|-----|----|-------|-------|---|---|---|------|-----|-----|-----|-----|----|----|-----|
| | | | 1 | 2 | 1/AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | | |
| <i>Adopt entire chapter</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt entire chapter as amended (amended sections listed below)</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Adopt only those sections that are listed below</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Chapter / Section</i> | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

APPENDIX M

TSUNAMI-GENERATED FLOOD HAZARD

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

SECTION M101

TSUNAMI-GENERATED FLOOD HAZARD

M101.1 General. The purpose of this appendix is to provide tsunami regulatory criteria for those communities that have a tsunami hazard and have elected to develop and adopt a map of their tsunami hazard inundation zone.

M101.2 Definitions. The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the *California Building Code* for general definitions.

TSUNAMI HAZARD ZONE. The area vulnerable to being flooded or inundated by a design event tsunami as identified on a community's Tsunami Hazard Zone Map.

TSUNAMI HAZARD ZONE MAP. A map adopted by the community that designates the extent of inundation by a design event tsunami. This map shall be based on the tsunami inundation map which is developed and provided to a community by either the applicable State agency or the National Atmospheric and Oceanic Administration (NOAA) under the National Tsunami Hazard Mitigation Program, but shall be permitted to utilize a different probability or hazard level.

M101.3 Establishment of Tsunami Hazard Zone. Where applicable, if a community has adopted a Tsunami Hazard Zone Map, that map shall be used to establish a community's Tsunami Hazard Zone.

M101.4 Construction within the Tsunami Hazard Zone. Construction of structures designated Risk Category III and IV as specified under Section 1604.5 shall be prohibited within a Tsunami Hazard Zone.

Exceptions:

1. A vertical evacuation tsunami refuge shall be permitted to be located in a Tsunami Hazard Zone provided it is constructed in accordance with FEMA P646.
2. Community critical facilities shall be permitted to be located within the Tsunami Hazard Zone when such a location is necessary to fulfill their function, providing suitable structural and emergency evacuation measures have been incorporated.

SECTION M102

REFERENCED STANDARDS

FEMA P646—08 Guidelines for Design of Structures for Vertical Evacuation from Tsunamis

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HISTORY NOTE APPENDIX

**California Building Code
Title 24, Part 2, California Code of Regulations (CCR)**

For prior code history, see the History Note Appendix to the *California Building Code (CBC)*, 2010 Triennial Edition effective January 1, 2011.

1. BSC 03/12, SFM 02/12, OSHPD 03/12 & 04/12, DSA-SS 02/12, HCD 06/12, HCD 08/12, DSA-AC 01/12, BSCC 01/12, CDPH 01/12, SLC 01/12 — Adoption of the 2012 edition of the *International Building Code* published by the International Code Council, for incorporation into the 2013 *California Building Code*, CCR Title 24, Part 2 with amendments for State regulated occupancies effective on January 1, 2014.
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