2016 CALIFORNIA BUILDING CODE

CALIFORNIA CODE OF REGULATIONS
TITLE 24, PART 2, VOLUME 2 OF 2

Based on the 2015 International Building Code®

2016 California Historical Building Code, Title 24, Part 8
2016 California Existing Building Code, Title 24, Part 10
Based on the 2015 International Existing Building Code®

California Building Standards Commission

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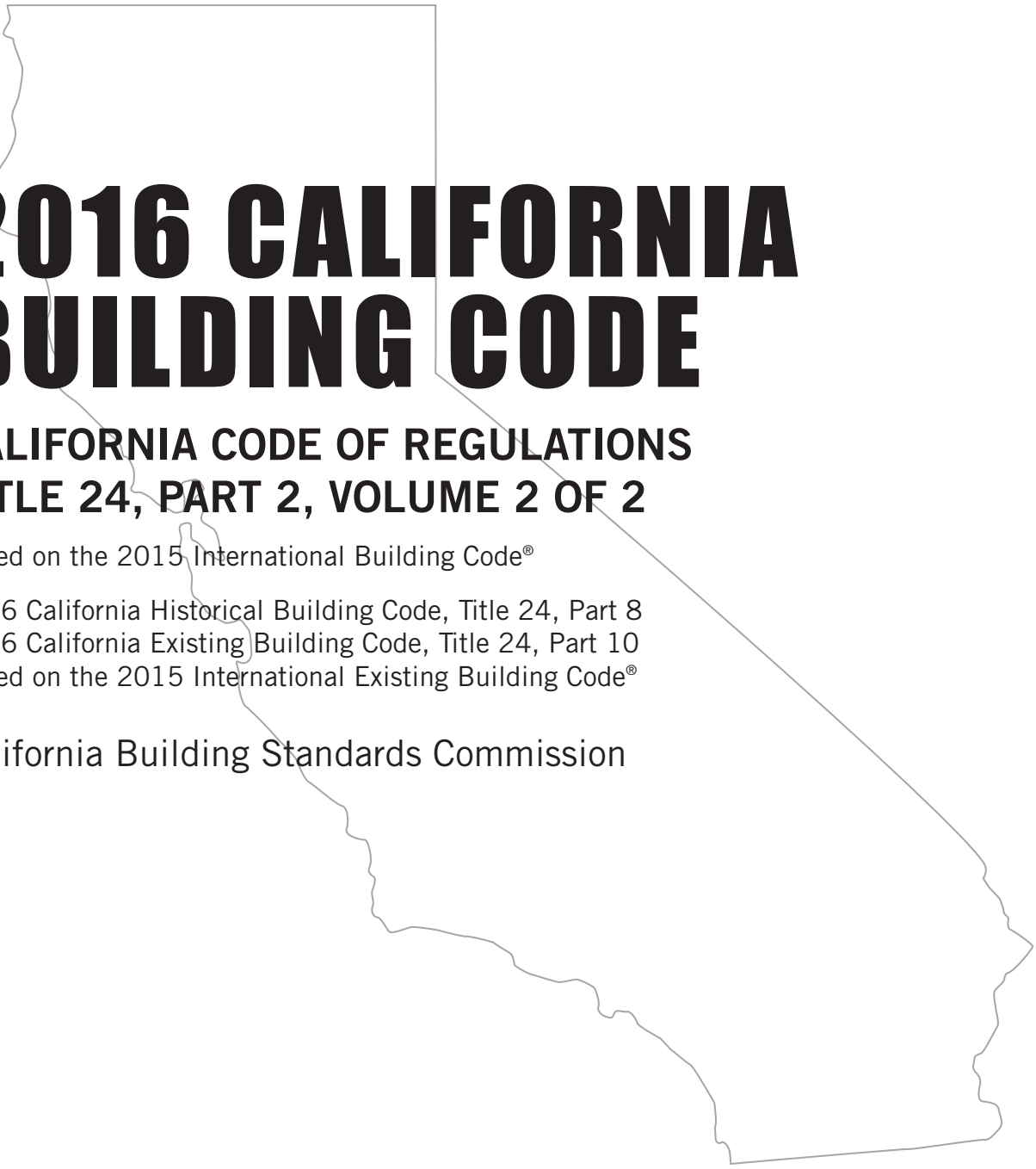

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Effective January 1, 2017

For Errata and Supplement effective dates see the History Note Appendix

2016 California Building Code
California Code of Regulations, Title 24, Volume 2 of Part 2

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PREFACE

This document is Part 2 of thirteen 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:

California Building Standards Commission
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833–2936

Phone: (916) 263–0916
Email: cbsc@dgs.ca.gov

Web page: www.bsc.ca.gov

ACKNOWLEDGEMENTS

The 2016 *California Building Standards Code* (Code) was developed through the outstanding collaborative efforts of the Department of Housing and Community Development, Division of State Architect, Office of the State Fire Marshal, Office of Statewide Health Planning and Development, California Energy Commission, California Department of Public Health, California State Lands Commission, Board of State and Community Corrections, and the California Building Standards Commission (Commission).

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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Peter Santillan

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Michael L. Nearman – Deputy Executive Director

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

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) 653-5217

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 ..... (800) 952-5210

Barber and Beauty Shop,
and College Standards

Bureau of Electronic and Appliance Repair,
Home Furnishings and Thermal Insulation
www.bearhfti.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) 515-5220

Veterinary Hospital Standards

Department of Food and Agriculture

www.cdfa.ca.gov

Meat & Poultry Packing Plant Standards
Rendering & Collection Standards ..... (916) 900-5004

Dairy Standards ..... (916) 900-5008

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

Fire and Life Safety

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 (916) 654-3362

Office of the State Fire Marshal

osfm.fire.ca.gov .....(916) 445-8200

Code Development and Analysis
Fire Safety Standards

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 italics.

***[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	*California Building Standards Commission (see Section 1.2.1)*
BSC-CG	*California Building Standards Commission-CALGreen (see Section 1.2.2)*
BSCC	*Board of State and Community Corrections (see Section 1.3)*
SFM	*Office of the State Fire Marshal (see Section 1.11)*
HCD 1	*Department of Housing and Community Development (see Section 1.8.2.1.1)*
HCD 2	*Department of Housing and Community Development (see Section 1.8.2.1.3)*
HCD 1/AC	*Department of Housing and Community Development (see Section 1.8.2.1.2)*
DSA-AC	*Division of the State Architect-Access Compliance (see Section 1.9.1)*
DSA-SS	*Division of the State Architect-Structural Safety (see Section 1.9.2)*
DSA-SS/CC	*Division of the State Architect-Structural Safety/Community Colleges (see Section 1.9.2.2)*
OSHPD 1	*Office of Statewide Health Planning and Development (see Section 1.10.1)*
OSHPD 2	*Office of Statewide Health Planning and Development (see Section 1.10.2)*
OSHPD 3	*Office of Statewide Health Planning and Development (see Section 1.10.3)*
OSHPD 4	*Office of Statewide Health Planning and Development (see Section 1.10.4)*
DPH	*Department of Public Health (see Section 1.7)*
AGR	*Department of Food and Agriculture (see Section 1.6)*
CEC	*California Energy Commission (see Section 100 in Part 2, the California Energy Code)*
CA	*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*
SL	*State Library (see Section 1.12)*
SLC	*State Lands Commission (see Section 1.14)*
DWR	*Department of Water Resources (see Section 1.12 of Chapter 1 of the California Plumbing Code in Part 2 of Title 24)*

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 vi and vii. 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 applications.)

CHAPTER 2 – DEFINITIONS AND ABBREVIATIONS

Adopting agency	BSC	BSC-CG	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								S	A	M	P	L	E								
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	BSC-CG	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																		
Adopt only those sections that are listed below								S	A	M	P	L	E								
Chapter 1																					
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	BSC-CG	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														

Marginal Markings

| 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.

Solid vertical lines in the margins within the body of the code indicate a technical change from the requirements of the 2012 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:

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 2015 edition of the *International Building Code*.

2015 LOCATION	2012 LOCATION
712.1.13.2	711.3.2
903.3.8 through 903.3.8.5	903.3.5.1.1
915	908.7
1006	1014.3, 1015, 1021
1007	1015.2, 1021.3
1019.3	1009.3
1504.2	1711.2
2111.2	2101.3.1
Table 2308.5.11	Table 2304.6
2514	1911
2902.3.6	1210.4
3002.9	3004.4
3006	713.14.1 and 713.14.1.1

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

In each code development cycle, code change proposals to this code are considered at the Code Development Hearings by 11 different code development committees. Four of these committees have primary responsibility for designated chapters and appendices as follows:

IBC – Fire Safety
Code Development Committee [BF]: Chapters 7, 8, 9, 14, 26

IBC – General
Code Development Committee [BG]: Chapters 2, 3, 4, 5, 6, 12, 27, 28, 29, 30, 31, 32, 33, Appendices A, B, C, D, K

IBC – Means of Egress
Code Development Committee [BE]: Chapters 10, 11, Appendix E

IBC – Structural
Code Development Committee [BS]: Chapters 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, Appendices F, G, H, I, J, L, M

Code change proposals to sections of the code that are preceded by a bracketed letter designation, such as [A], will be considered by a committee other than the building code committee listed for the chapter or appendix above. For example, proposed code changes to Section [F] 307.1.1 will be considered by the International Fire Code Development Committee during the Committee Action Hearing in the 2016 (Group B) code development cycle.

Another example is Section [BF] 1505.2. While code change proposals to Chapter 15 are primarily the responsibility of the IBC – Structural Code Development Committee, which considers code change proposals during the 2016 (Group B) code development cycle, Section 1505.2 is the responsibility of the IBC – Fire Safety Code Development Committee, which considers code change proposals during the 2015 (Group A) code development cycle.

The bracketed letter designations for committees responsible for portions of this code are as follows:

[A] = Administrative Code Development Committee;

[BE] = IBC – Means of Egress Code Development Committee;

[BF] = IBC – Fire Safety Code Development Committee;

[BG] = IBC – General Code Development Committee;

[BS] = IBC – Structural 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.

For the development of the 2018 edition of the I-Codes, there will be three groups of code development committees and they will meet in separate years. Note that these are tentative groupings.

EFFECTIVE USE OF THE INTERNATIONAL BUILDING CODE

The *International Building Code*® (IBC®) is a model code that provides minimum requirements to safeguard the public health, safety and general welfare of the occupants of new and existing buildings and structures. The IBC is fully compatible with the ICC family of codes, including: *International Energy Conservation Code*® (IECC®), *International Existing Building Code*® (IEBC®), *International Fire Code*® (IFC®), *International Fuel Gas Code*® (IFGC®), *International Green Construction Code*® (IgCC®), *International Mechanical Code*® (IMC®), ICC *Performance Code*® (ICCPC®), *International Plumbing Code*® (IPC®), *International Private Sewage Disposal Code*® (IPSDC®), *International Property Maintenance Code*® (IPMC®), *International Residential Code*® (IRC®), *International Swimming Pool and Spa Code*™ (ISPSC™), *International Wildland-Urban Interface Code*® (IWUIC®) and *International Zoning Code*® (IZC®).

The IBC addresses structural strength, means of egress, sanitation, adequate lighting and ventilation, accessibility, energy conservation and life safety in regard to new and existing buildings, facilities and systems. The codes are promulgated on a 3-year cycle to allow for new construction methods and technologies to be incorporated into the codes. Alternative materials, designs and methods not specifically addressed in the code can be approved by the code official where the proposed materials, designs or methods comply with the intent of the provisions of the code (see Section 104.11).

The IBC applies to all occupancies, including one- and two-family dwellings and townhouses that are not within the scope of the IRC. The IRC is referenced for coverage of detached one- and two-family dwellings and townhouses as defined in the exception to Section 101.2 and the definition for "Townhouse" in Chapter 2. The IRC can also be used for the construction of Live/Work units (as defined in Section 419) and small bed and breakfast-style hotels where there are five or fewer guest rooms and the hotel is owner occupied. The IBC applies to all types of buildings and structures unless exempted. Work exempted from permits is listed in Section 105.2.

Arrangement and Format of the 2015 IBC

Before applying the requirements of the IBC, it is beneficial to understand its arrangement and format. The IBC, like other codes published by ICC, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection.

Chapters	Subjects
1-2	Administration and definitions
3	Use and occupancy classifications
4, 31	Special requirements for specific occupancies or elements
5-6	Height and area limitations based on type of construction
7-9	Fire resistance and protection requirements
10	Requirements for evacuation
11	Specific requirements to allow use and access to a building for persons with disabilities
12-13, 27-30	Building systems, such as lighting, HVAC, plumbing fixtures, elevators
14-26	Structural components—performance and stability
32	Encroachment outside of property lines
33	Safeguards during construction
35	Referenced standards
Appendices A-M	Appendices

The IBC requirements for hazardous materials, fire-resistance-rated construction, interior finish, fire protection systems, means of egress, emergency and standby power, and temporary structures are directly correlated with the requirements of the IFC. The following chapters/sections of the IBC are correlated to the IFC:

IBC Chapter/Section	IFC Chapter/Section	Subject
Sections 307, 414, 415	Chapters 50-67	Hazardous materials and Group H requirements
Chapter 7	Chapter 7	Fire-resistance-rated construction (Fire and smoke protection features in the IFC)
Chapter 8	Chapter 8	Interior finish, decorative materials and furnishings
Chapter 9	Chapter 9	Fire protection systems
Chapter 10	Chapter 10	Means of egress
Chapter 27	Section 604	Standby and emergency power
Section 3103	Chapter 31	Temporary structures

The IBC requirements for smoke control systems, and smoke and fire dampers are directly correlated to the requirements of the IMC. IBC Chapter 28 is a reference to the IMC and the IFGC for chimneys, fireplaces and barbecues, and all aspects of mechanical systems. The following chapters/sections of the IBC are correlated with the IMC:

IBC Chapter/Section	IMC Chapter/Section	Subject
Section 717	Section 607	Smoke and fire dampers
Section 909	Section 513	Smoke control

The IBC requirements for plumbing fixtures and toilet rooms are directly correlated to the requirements of the IPC. The following chapters/sections of the IBC are correlated with the IPC:

IBC Chapter/Section	IPC Chapter/Section	Subject
Chapter 29	Chapters 3 & 4	Plumbing fixtures and facilities

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the *International Building Code*.

Chapter 1 Scope and Administration. Chapter 1 establishes the limits of applicability of the code and describes how the code is to be applied and enforced. Chapter 1 is in two parts, Part 1—Scope and Application (Sections 101-102) and Part 2—Administration and Enforcement (Sections 103-116). Section 101 identifies which buildings and structures come under its purview and references other ICC codes as applicable. Standards and codes are scoped to the extent referenced (see Section 102.4).

The building code is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 1 establish the authority and duties of the code official appointed by the jurisdiction having authority and also establish the rights and privileges of the design professional, contractor and property owner.

Chapter 2 Definitions. An alphabetical listing of all defined terms is located in Chapter 2. Defined terms that are pertinent to a specific chapter or section are also found in that chapter or section with a reference back to Chapter 2 for the definition. While a defined term may be listed in one chapter or another, the meaning is applicable throughout the code.

Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. The code often uses terms that have a unique

meaning in the code and the code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code. Where understanding of a term's definition is especially key to or necessary for understanding a particular code provision, the term is shown in *italics* wherever it appears in the code.

The user of the code should be familiar with and consult this chapter because the definitions are essential to the correct interpretation of the code. Where a term is not defined, such terms shall have the ordinarily accepted meaning.

Chapter 3 Use and Occupancy Classification. Chapter 3 provides for the classification of buildings, structures and parts thereof based on the purpose or purposes for which they are used. Section 302 identifies the groups into which all buildings, structures and parts thereof must be classified. Sections 303 through 312 identify the occupancy characteristics of each group classification. In some sections, specific group classifications having requirements in common are collectively organized such that one term applies to all. For example, Groups A-1, A-2, A-3, A-4 and A-5 are individual groups for assembly-type buildings. The general term "Group A," however, includes each of these individual groups. Other groups include Business (B), Educational (E), Factory (F-1, F-2), High Hazard (H-1, H-2, H-3, H-4, H-5), Institutional (I-1, I-2, I-3, I-4), Mercantile (M), Residential (R-1, R-2, R-3, R-4), Storage (S-1, S-2) and Utility (U). In some occupancies, the smaller number means a higher hazard, but that is not always the case.

Defining the use of the buildings is very important as it sets the tone for the remaining chapters of the code. Occupancy works with the height, area and construction type requirements in Chapters 5 and 6, as well as the special provisions in Chapter 4, to determine "equivalent risk," or providing a reasonable level of protection or life safety for building occupants. The determination of equivalent risk involves three interdependent considerations: (1) the level of fire hazard associated with the specific occupancy of the facility; (2) the reduction of fire hazard by limiting the floor area and the height of the building based on the fuel load (combustible contents and burnable building components); and (3) the level of overall fire resistance provided by the type of construction used for the building. The greater the potential fire hazards indicated as a function of the group, the lesser the height and area allowances for a particular construction type.

Occupancy classification also plays a key part in organizing and prescribing the appropriate protection measures. As such, threshold requirements for fire protection and means of egress systems are based on occupancy classification (see Chapters 9 and 10). Other sections of the code also contain requirements respective to the classification of building groups. For example, Section 706 specifies requirements for fire wall fire-resistance ratings that are tied to the occupancy classification of a building and Section 803.11 contains interior finish requirements that are dependent upon the occupancy classification. The use of the space, rather than the occupancy of the building, is utilized for determining occupant loading (Section 1004) and live loading (Section 1607).

Over the useful life of a building, the activities in the building will evolve and change. Where the provisions of the code address uses differently, moving from one activity to another or from one level of activity to another is, by definition, a change of occupancy. The new occupancy must be in compliance with the applicable provisions.

Chapter 4 Special Detailed Requirements Based On Use and Occupancy. Chapter 4 contains the requirements for protecting special uses and occupancies, which are supplemental to the remainder of the code. Chapter 4 contains provisions that may alter requirements found elsewhere in the code; however, the general requirements of the code still apply unless modified within the chapter. For example, the height and area limitations established in Chapter 5 apply to all special occupancies unless Chapter 4 contains height and area limitations. In this case, the limitations in Chapter 4 supersede those in other sections. An example of this is the height and area limitations for open parking garages given in Section 406.5.4, which supersede the limitations given in Sections 504 and 506.

In some instances, it may not be necessary to apply the provisions of Chapter 4. For example, if a covered mall building complies with the provisions of the code for Group M, Section 402 does not apply; however, other sections that address a use, process or operation must be applied to that specific occupancy, such as stages and platforms, special amusement buildings and hazardous materials (Sections 410, 411 and 414).

The chapter includes requirements for buildings and conditions that apply to one or more groups, such as high-rise buildings, underground buildings or atriums. Special uses may also imply specific occupancies and operations, such as for Group H, hazardous materials, application of flam-

mable finishes, drying rooms, organic coatings and combustible storage or hydrogen fuel gas rooms, all of which are coordinated with the IFC. Unique consideration is taken for special use areas, such as covered mall buildings, motor-vehicle-related occupancies, special amusement buildings and aircraft-related occupancies. Special facilities within other occupancies are considered, such as stages and platforms, motion picture projection rooms, children's play structures and storm shelters. Finally, in order that the overall package of protection features can be easily understood, unique considerations for specific occupancies are addressed: Groups I-1, I-2, I-3, R-1, R-2, R-3, R-4, ambulatory care facilities and live/work units.

Chapter 5 General Building Heights and Areas. Chapter 5 contains the provisions that regulate the minimum type of construction for area limits and height limits based on the occupancy of the building. Height and area increases (including allowances for basements, mezzanines and equipment platforms) are permitted based on open frontage for fire department access, and the type of sprinkler protection provided and separation (Sections 503-506, 510). These thresholds are reduced for buildings over three stories in height in accordance with Sections 506.2.3 and 506.2.4. Provisions include the protection and/or separation of incidental uses (Table 509), accessory occupancies (Section 508.2) and mixed uses in the same building (Sections 506.2.2, 506.2.4, 508.3, 508.4 and 510). Unlimited area buildings are permitted in certain occupancies when they meet special provisions (Section 507).

Tables 504.3, 504.4 and 506.2 are the keystones in setting thresholds for building size based on the building's use and the materials with which it is constructed. If one then looks at Tables 504.3, 504.4 and 506.2, the relationship among group classification, allowable heights and areas and types of construction becomes apparent. Respective to each group classification, the greater the fire-resistance rating of structural elements, as represented by the type of construction, the greater the floor area and height allowances. The greater the potential fire hazards indicated as a function of the group, the lesser the height and area allowances for a particular construction type. In the 2015 edition, the table that once contained both height and area has been separated and these three new tables address the topics individually. In addition, the tables list criteria for buildings containing automatic sprinkler systems and those that do not.

Chapter 6 Types of Construction. The interdependence of these fire safety considerations can be seen by first looking at Tables 601 and 602, which show the fire-resistance ratings of the principal structural elements comprising a building in relation to the five classifications for types of construction. Type I construction is the classification that generally requires the highest fire-resistance ratings for structural elements, whereas Type V construction, which is designated as a combustible type of construction, generally requires the least amount of fire-resistance-rated structural elements. The greater the potential fire hazards indicated as a function of the group, the lesser the height and area allowances for a particular construction type. Section 603 includes a list of combustible elements that can be part of a noncombustible building (Types I and II construction).

Chapter 7 Fire and Smoke Protection Features. The provisions of Chapter 7 present the fundamental concepts of fire performance that all buildings are expected to achieve in some form. This chapter identifies the acceptable materials, techniques and methods by which proposed construction can be designed and evaluated against to determine a building's ability to limit the impact of fire. The fire-resistance-rated construction requirements within Chapter 7 provide passive resistance to the spread and effects of fire. Types of separations addressed include fire walls, fire barriers, fire partitions, horizontal assemblies, smoke barriers and smoke partitions. A fire produces heat that can weaken structural components and smoke products that cause property damage and place occupants at risk. The requirements of Chapter 7 work in unison with height and area requirements (Chapter 5), active fire detection and suppression systems (Chapter 9) and occupant egress requirements (Chapter 10) to contain a fire should it occur while helping ensure occupants are able to safely exit.

Chapter 8 Interior Finishes. This chapter contains the performance requirements for controlling fire growth within buildings by restricting interior finish and decorative materials. Past fire experience has shown that interior finish and decorative materials are key elements in the development and spread of fire. The provisions of Chapter 8 require materials used as interior finishes and decorations to meet certain flame-spread index or flame-propagation criteria based on the relative fire hazard associated with the occupancy. As smoke is also a hazard associated with fire, this chapter contains limits on the smoke development characteristics of interior finishes. The performance of the material is evaluated based on test standards.

Chapter 9 Fire Protection Systems. Chapter 9 prescribes the minimum requirements for active systems of fire protection equipment to perform the following functions: detect a fire; alert the occupants or fire department of a fire emergency; and control smoke and control or extinguish the fire. Generally, the requirements are based on the occupancy, the height and the area of the building, because these are the factors that most affect fire-fighting capabilities and the relative hazard of a specific building or portion thereof. This chapter parallels and is substantially duplicated in Chapter 9 of the *International Fire Code* (IFC); however, the IFC Chapter 9 also contains periodic testing criteria that are not contained in the IBC. In addition, the special fire protection system requirements based on use and occupancy found in IBC Chapter 4 are duplicated in IFC Chapter 9 as a user convenience.

Chapter 10 Means of Egress. The general criteria set forth in Chapter 10 regulating the design of the means of egress are established as the primary method for protection of people in buildings by allowing timely relocation or evacuation of building occupants. Both prescriptive and performance language is utilized in this chapter to provide for a basic approach in the determination of a safe exiting system for all occupancies. It addresses all portions of the egress system (i.e., exit access, exits and exit discharge) and includes design requirements as well as provisions regulating individual components. The requirements detail the size, arrangement, number and protection of means of egress components. Functional and operational characteristics also are specified for the components that will permit their safe use without special knowledge or effort. The means of egress protection requirements work in coordination with other sections of the code, such as protection of vertical openings (see Chapter 7), interior finish (see Chapter 8), fire suppression and detection systems (see Chapter 9) and numerous others, all having an impact on life safety. Chapter 10 of the IBC is duplicated in Chapter 10 of the IFC; however, the IFC contains one additional section on the means of egress system in existing buildings.

Chapter 11 Accessibility. Chapter 11 contains provisions that set forth requirements for accessibility of buildings and their associated sites and facilities for people with physical disabilities. The fundamental philosophy of the code on the subject of accessibility is that everything is required to be accessible. This is reflected in the basic applicability requirement (see Section 1103.1). The code's scoping requirements then address the conditions under which accessibility is not required in terms of exceptions to this general mandate. While the IBC contains scoping provisions for accessibility (e.g., what, where and how many), ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities*, is the referenced standard for the technical provisions (i.e., how).

There are many accessibility issues that not only benefit people with disabilities, but also provide a tangible benefit to people without disabilities. This type of requirement can be set forth in the code as generally applicable without necessarily identifying it specifically as an accessibility-related issue. Such a requirement would then be considered as having been "mainstreamed." For example, visible alarms are located in Chapter 9 and accessible means of egress and ramp requirements are addressed in Chapter 10.

Accessibility criteria for existing buildings are addressed in the *International Existing Building Code* (IEBC).

Appendix E is supplemental information included in the code to address accessibility for items in the 2010 *ADA Standards for Accessible Design* that were not typically enforceable through the standard traditional building code enforcement approach system (e.g., beds, room signage). The *International Residential Code* (IRC) references Chapter 11 for accessibility provisions; therefore, this chapter may be applicable to housing covered under the IRC.

Chapter 12 Interior Environment. Chapter 12 provides minimum standards for the interior environment of a building. The standards address the minimum sizes of spaces, minimum temperature levels, and minimum light and ventilation levels. The collection of requirements addresses limiting sound transmission through walls, ventilation of attic spaces and under floor spaces (crawl spaces). Finally, the chapter provides minimum standards for toilet and bathroom construction, including privacy shielding and standards for walls, partitions and floors to resist water intrusion and damage.

Chapter 13 Energy Efficiency. The purpose of Chapter 13 is to provide minimum design requirements that will promote efficient utilization of energy in buildings. The requirements are directed toward the design of building envelopes with adequate thermal resistance and low air leakage, and toward the design and selection of mechanical, water heating, electrical and illumina-

tion systems that promote effective use of depletable energy resources. For the specifics of these criteria, Chapter 13 requires design and construction in compliance with the *International Energy Conservation Code* (IECC).

Chapter 14 Exterior Walls. This chapter addresses requirements for exterior walls of buildings. Minimum standards for wall covering materials, installation of wall coverings and the ability of the wall to provide weather protection are provided. This chapter also requires exterior walls that are close to lot lines, or that are bearing walls for certain types of construction, to comply with the minimum fire-resistance ratings specified in Chapters 6 and 7. The installation of each type of wall covering, be it wood, masonry, vinyl, metal composite material or an exterior insulation and finish system, is critical to its long-term performance in protecting the interior of the building from the elements and the spread of fire. Limitations on the use of combustible materials on exterior building elements such as balconies, eaves, decks and architectural trim are also addressed in this chapter.

Chapter 15 Roof Assemblies and Rooftop Structures. Chapter 15 provides standards for both roof assemblies as well as structures that sit on top of the roof of buildings. The criteria address roof construction and covering which includes the weather-protective barrier at the roof and, in most circumstances, a fire-resistant barrier. The chapter is prescriptive in nature and is based on decades of experience with various traditional materials, but it also addresses newer products such as photovoltaic shingles. These prescriptive rules are very important for satisfying performance of one type of roof covering or another. Section 1510 addresses rooftop structures, including penthouses, tanks, towers and spires. Rooftop penthouses larger than prescribed in this chapter must be treated as a story under Chapter 5.

Chapter 16 Structural Design. Chapter 16 prescribes minimum structural loading requirements for use in the design and construction of buildings and structural components. It includes minimum design loads, assignment of risk categories, as well as permitted design methodologies. Standards are provided for minimum design loads (live, dead, snow, wind, rain, flood, ice and earthquake as well as the required load combinations). The application of these loads and adherence to the serviceability criteria will enhance the protection of life and property. The chapter references and relies on many nationally recognized design standards. A key standard is the American Society of Civil Engineer's *Minimum Design Loads for Buildings and Other Structures* (ASCE 7). Structural design needs to address the conditions of the site and location. Therefore, maps are provided of rainfall, seismic, snow and wind criteria in different regions.

Chapter 17 Special Inspections and Tests. Chapter 17 provides a variety of procedures and criteria for testing materials and assemblies, labeling materials and assemblies and special inspection of structural assemblies. This chapter expands on the inspections of Chapter 1 by requiring special inspection where indicated and, in some cases, structural observation. It also spells out additional responsibilities for the owner, contractor, design professionals and special inspectors. Proper assembly of structural components, proper quality of materials used and proper application of materials are essential to ensuring that a building, once constructed, complies with the structural and fire-resistance minimums of the code and the approved design. To determine this compliance often requires continuous or frequent inspection and testing. Chapter 17 establishes standards for special inspection, testing and reporting of the work to the building official.

Chapter 18 Soils and Foundations. Chapter 18 provides criteria for geotechnical and structural considerations in the selection, design and installation of foundation systems to support the loads from the structure above. The chapter includes requirements for soils investigation and site preparation for receiving a foundation, including the allowed load-bearing values for soils and for protecting the foundation from water intrusion. Section 1808 addresses the basic requirements for all foundation types. Later sections address foundation requirements that are specific to shallow foundations and deep foundations. Due care must be exercised in the planning and design of foundation systems based on obtaining sufficient soils information, the use of accepted engineering procedures, experience and good technical judgment.

Chapter 19 Concrete. This chapter provides minimum accepted practices for the design and construction of buildings and structural components using concrete—both plain and reinforced. Chapter 19 relies primarily on the reference to American Concrete Institute (ACI) 318, *Building Code Requirements for Structural Concrete*. The chapter also includes references to additional standards. Structural concrete must be designed and constructed to comply with this code and all listed stan-

dards. There are specific sections of the chapter addressing concrete slabs, anchorage to concrete and shotcrete. Because of the variable properties of material and numerous design and construction options available in the uses of concrete, due care and control throughout the construction process is necessary.

Chapter 20 Aluminum. Chapter 20 contains standards for the use of aluminum in building construction. Only the structural applications of aluminum are addressed. The chapter does not address the use of aluminum in specialty products such as storefront or window framing or architectural hardware. The use of aluminum in heating, ventilating or air-conditioning systems is addressed in the *International Mechanical Code* (IMC). The chapter references national standards from the Aluminum Association for use of aluminum in building construction, AA ASM 35, *Aluminum Sheet Metal Work in Building Construction*, and AA ADM 1, *Aluminum Design Manual*. By utilizing the standards set forth, a proper application of this material can be obtained.

Chapter 21 Masonry. This chapter provides comprehensive and practical requirements for masonry construction. The provisions of Chapter 21 require minimum accepted practices and the use of standards for the design and construction of masonry structures. The provisions address: material specifications and test methods; types of wall construction; criteria for engineered and empirical designs; and required details of construction, including the execution of construction. Masonry design methodologies including allowable stress design, strength design and empirical design are covered by provisions of the chapter. Also addressed are masonry fireplaces and chimneys, masonry heaters and glass unit masonry. Fire-resistant construction using masonry is also required to comply with Chapter 7. Masonry foundations are also subject to the requirements of Chapter 18.

Chapter 22 Steel. Chapter 22 provides the requirements necessary for the design and construction of structural steel (including composite construction), cold-formed steel, steel joists, steel cable structures and steel storage racks. The chapter specifies appropriate design and construction standards for these types of structures. It also provides a road map of the applicable technical requirements for steel structures. Because steel is a noncombustible building material, it is commonly associated with Types I and II construction; however, it is permitted to be used in all types of construction. Chapter 22 requires that the design and use of steel materials be in accordance with the specifications and standards of the American Institute of Steel Construction, the American Iron and Steel Institute, the Steel Joist Institute and the American Society of Civil Engineers.

Chapter 23 Wood. This chapter provides minimum requirements for the design of buildings and structures that use wood and wood-based products. The chapter is organized around three design methodologies: allowable stress design (ASD), load and resistance factor design (LRFD) and conventional light-frame construction. Included in the chapter are references to design and manufacturing standards for various wood and wood-based products; general construction requirements; design criteria for lateral force-resisting systems and specific requirements for the application of the three design methods. In general, only Type III, IV or V buildings may be constructed of wood.

Chapter 24 Glass and Glazing. This chapter establishes regulations for glass and glazing used in buildings and structures that, when installed, are subjected to wind, snow and dead loads. Engineering and design requirements are included in the chapter. Additional structural requirements are found in Chapter 16. Another concern of this chapter is glass and glazing used in areas where it is likely to be impacted by the occupants. Section 2406 identifies hazardous locations where glazing installed must either be safety glazing or blocked to prevent human impact. Safety glazing must meet stringent standards and be appropriately marked or identified. Additional requirements are provided for glass and glazing in guards, handrails, elevator hoistways and elevator cars, as well as in athletic facilities.

Chapter 25 Gypsum Board, Gypsum Panel Products and Plaster. Chapter 25 contains the provisions and referenced standards that regulate the design, construction and quality of gypsum board, gypsum panel products and plaster. It also addresses reinforced gypsum concrete. These represent the most common interior and exterior finish materials in the building industry. This chapter primarily addresses quality-control-related issues with regard to material specifications and installation requirements. Most products are manufactured under the control of industry standards. The building official or inspector primarily needs to verify that the appropriate product is used and properly installed for the intended use and location. While often simply used as wall and ceiling coverings, proper design and application are necessary to provide weather resistance and

required fire protection for both structural and nonstructural building components.

Chapter 26 Plastic. The use of plastics in building construction and components is addressed in Chapter 26. This chapter provides standards addressing foam plastic insulation, foam plastics used as interior finish and trim, and other plastic veneers used on the inside or outside of a building. Plastic siding is regulated by Chapter 14. Sections 2606 through 2611 address the use of light-transmitting plastics in various configurations such as walls, roof panels, skylights, signs and as glazing. Requirements for the use of fiber-reinforced polymers, fiberglass-reinforced polymers and reflective plastic core insulation are also contained in this chapter. Additionally, requirements specific to the use of wood-plastic composites and plastic lumber are contained in this chapter. Some plastics exhibit rapid flame spread and heavy smoke density characteristics when exposed to fire. Exposure to the heat generated by a fire can cause some plastics to deform, which can affect their performance. The requirements and limitations of this chapter are necessary to control the use of plastic and foam plastic products such that they do not compromise the safety of building occupants.

Chapter 27 Electrical. Since electrical systems and components are an integral part of almost all structures, it is necessary for the code to address the installation of such systems. For this purpose, Chapter 27 references the *National Electrical Code* (NEC). In addition, Section 2702 addresses emergency and standby power requirements. Such systems must comply with the *International Fire Code* (IFC) and referenced standards. This section also provides references to the various code sections requiring emergency and standby power, such as high-rise buildings and buildings containing hazardous materials.

Chapter 28 Mechanical Systems. Nearly all buildings will include mechanical systems. This chapter provides references to the *International Mechanical Code* (IMC) and the *International Fuel Gas Code* (IFGC) for the design and installation of mechanical systems. In addition, Chapter 21 of this code is referenced for masonry chimneys, fireplaces and barbecues.

Chapter 29 Plumbing Systems. Chapter 29 regulates the minimum number of plumbing fixtures that must be provided for every type of building. This chapter also regulates the location of the required fixtures in various types of buildings. This section requires separate facilities for males and females except for certain types of small occupancies. The regulations in this chapter come directly from Chapters 3 and 4 of the *International Plumbing Code* (IPC).

Chapter 30 Elevators and Conveying Systems. Chapter 30 provides standards for the installation of elevators into buildings. Referenced standards provide the requirements for the elevator system and mechanisms. Detailed standards are provided in the chapter for hoistway enclosures, machine rooms and requirements for sizing of elevators. Beginning in the 2015 edition, the elevator lobby requirements were moved from Chapter 7 to Chapter 30 to pull all the elevator-related construction requirements together. New provisions were added in the 2009 edition of the *International Building Code* for Fire Service Access Elevators required in high-rise buildings and for the optional choice of Occupant Evacuation Elevators (see Section 403).

Chapter 31 Special Construction. Chapter 31 contains a collection of regulations for a variety of unique structures and architectural features. Pedestrian walkways and tunnels connecting two buildings are addressed in Section 3104. Membrane and air-supported structures are addressed by Section 3102. Safeguards for swimming pool safety are found in Section 3109. Standards for temporary structures, including permit requirements are provided in Section 3103. Structures as varied as awnings, marquees, signs, telecommunication and broadcast towers and automatic vehicular gates are also addressed (see Sections 3105 through 3108 and 3110).

Chapter 32 Encroachments into the Public Right-of-way. Buildings and structures from time to time are designed to extend over a property line and into the public right-of-way. Local regulations outside of the building code usually set limits to such encroachments, and such regulations take precedence over the provisions of this chapter. Standards are provided for encroachments below grade for structural support, vaults and areaways. Encroachments above grade are divided into below 8 feet, 8 feet to 15 feet, and above 15 feet, because of headroom and vehicular height issues. This includes steps, columns, awnings, canopies, marquees, signs, windows and balconies. Similar architectural features above grade are also addressed. Pedestrian walkways must also comply with Chapter 31.

Chapter 33 Safeguards During Construction. Chapter 33 provides safety requirements during construction and demolition of buildings and structures. These requirements are intended to protect the public from injury and adjoining property from damage. In addition the chapter provides for the progressive installation and operation of exit stairways and standpipe systems during construction.

Chapter 34 Reserved. During the last code change cycle the membership voted to delete Chapter 34, Existing Structures, from the IBC and reference the IEBC. The provisions that were in Chapter 34 will appear in the *International Existing Building Code* (IEBC). Sections 3402 through 3411 are repeated as IEBC Chapter 4 and Section 3412 as Chapter 14.

Chapter 35 Referenced Standards. The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 35 contains a comprehensive list of all standards that are referenced in the code, including the appendices. The standards are part of the code to the extent of the reference to the standard (see Section 102.4). Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the building code official, contractor, designer and owner.

Chapter 35 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency's standards are then listed in either alphabetical or numeric order based upon the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

Appendices. Appendices are provided in the IBC to offer optional or supplemental criteria to the provisions in the main chapters of the code. Appendices provide additional information for administration of the Department of Building Safety as well as standards not typically administered by all building departments. Appendices have the same force and effect as the first 35 chapters of the IBC only when explicitly adopted by the jurisdiction.

Appendix A Employee Qualifications. Effective administration and enforcement of the family of *International Codes* depends on the training and expertise of the personnel employed by the jurisdiction and his or her knowledge of the codes. Section 103 of the code establishes the Department of Building Safety and calls for the appointment of a building official and deputies such as plans examiners and inspectors. Appendix A provides standards for experience, training and certification for the building official and the other staff mentioned in Chapter 1.

Appendix B Board of Appeals. Section 113 of Chapter 1 requires the establishment of a board of appeals to hear appeals regarding determinations made by the building official. Appendix B provides qualification standards for members of the board as well as operational procedures of such board.

Appendix C Group U—Agricultural Buildings. Appendix C provides a more liberal set of standards for the construction of agricultural buildings, rather than strictly following the Utility building provision, reflective of their specific usage and limited occupant load. The provisions of the appendix, when adopted, allow reasonable heights and areas commensurate with the risk of agricultural buildings.

Appendix D Fire Districts. Fire districts have been a tool used to limit conflagration hazards in areas of a city with intense and concentrated development. More frequently used under the model codes that preceded the *International Building Code* (IBC), the appendix is provided to allow jurisdictions to continue the designation and use of fire districts. Fire district standards restrict certain occupancies within the district, as well as setting higher minimum construction standards.

Appendix E Supplementary Accessibility Requirements. The Architectural and Transportation Barriers Compliance Board (U.S. Access Board) has revised and updated its accessibility guidelines for buildings and facilities covered by the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA). Appendix E includes scoping requirements contained in the *2010*

ADA Standards for Accessible Design that are not in Chapter 11 and not otherwise mentioned or mainstreamed throughout the code. Items in the appendix address subjects not typically addressed in building codes (e.g., beds, room signage, transportation facilities).

Appendix F Rodentproofing. The provisions of this appendix are minimum mechanical methods to prevent the entry of rodents into a building. These standards, when used in conjunction with cleanliness and maintenance programs, can significantly reduce the potential of rodents invading a building.

Appendix G Flood-resistant Construction. Appendix G is intended to fulfill the flood-plain management and administrative requirements of the National Flood Insurance Program (NFIP) that are not included in the code. Communities that adopt the *International Building Code* (IBC) and Appendix G will meet the minimum requirements of NFIP as set forth in Title 44 of the Code of Federal Regulations.

Appendix H Signs. Appendix H gathers in one place the various code standards that regulate the construction and protection of outdoor signs. Whenever possible, the appendix provides standards in performance language, thus allowing the widest possible application.

Appendix I Patio Covers. Appendix I provides standards applicable to the construction and use of patio covers. It is limited in application to patio covers accessory to dwelling units. Covers of patios and other outdoor areas associated with restaurants, mercantile buildings, offices, nursing homes or other nondwelling occupancies would be subject to standards in the main code and not this appendix.

Appendix J Grading. Appendix J provides standards for the grading of properties. The appendix also provides standards for administration and enforcement of a grading program including permit and inspection requirements. Appendix J was originally developed in the 1960s and used for many years in jurisdictions throughout the western states. It is intended to provide consistent and uniform code requirements anywhere grading is considered an issue.

Appendix K Administrative Provisions. Appendix K primarily provides administrative provisions for jurisdictions adopting and enforcing NFPA 70—the *National Electrical Code* (NEC). The provisions contained in this appendix are compatible with administrative and enforcement provisions contained in Chapter 1 of the IBC and the other *International Codes*. Annex H of NFPA 70 also contains administrative provisions for the NEC; however, some of its provisions are not compatible with IBC Chapter 1. Section K110 also contains technical provisions that are unique to this appendix and are in addition to technical standards of NFPA 70.

Appendix L Earthquake Recording Instrumentation. The purpose of this appendix is to foster the collection of ground motion data, particularly from strong-motion earthquakes. When this ground motion data is synthesized, it may be useful in developing future improvements to the earthquake provisions of the code.

Appendix M Tsunami-Generated Flood Hazard. Addressing a tsunami risk for all types of construction in a tsunami hazard zone through building code requirements would typically not be cost effective, making tsunami-resistant construction impractical at an individual building level. However, this appendix does allow the adoption and enforcement of requirements for tsunami hazard zones that regulate the presence of high risk or high hazard structures.

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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	BSC-CG	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**										
Adopt only those sections that are listed below						**X**	**X**													**X**	
Chapter / Section																					
1601.1.1									X												
1601.1.2									X												
1601.1.3									X												
1601.1.4									X												
1601.2									X		X										
1602.1																					
1603.1											X										
1607.1, Table 1607.1											X										
> 1607.8						X															
> 1607.8.2						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																					
1613.3.5											X										
1613.3.5.1											X										
1613.3.5.2											X										
1613.5	X										X										
> 1613.5.1											X										
> 1613.5.2											X										
1613.6	X																				
1616									X												

The state agency does not adopt sections identified with 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 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 Registered Design Professional (RDP), 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.

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 1609.3(1), 1609.3(2), 1609.3(3) 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 1603.1.8 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/m^2), 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_s.
4. Thermal factor, C_t.
5. Drift surcharge load(s), P_d, where the sum of P_d and P_f exceeds 20 psf (0.96 kN/m^2).
6. Width of snow drift(s), w.

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. Applicable wind direction if more than one wind exposure is utilized.
4. Applicable internal pressure coefficient.
5. Design wind pressures to be used for exterior component and cladding materials not specifically designed by the registered design professional responsible for the design of the structure, psf (kN/m^2).

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_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.

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. Flood design class assigned according to ASCE 24.
2. In flood hazard areas other than coastal high hazard areas or coastal A zones, the elevation of the proposed lowest floor, including the basement.
3. In flood hazard areas other than coastal high hazard areas or coastal A zones, the elevation to which any nonresidential building will be dry floodproofed.

4. In coastal high hazard areas and coastal A zones, 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.

1603.1.8.1 Photovoltaic panel systems. The dead load of rooftop-mounted photovoltaic panel systems, including rack support systems, shall be indicated on the construction documents.

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.

TABLE 1604.3
DEFLECTION LIMITS[a, b, c, h, i]

CONSTRUCTION	*L*	*E, S* or *W*[f]	*D* + *L*[d, g]
Roof members:[c]			
Supporting plaster or stucco ceiling	*l*/360	*l*/360	*l*/240
Supporting nonplaster ceiling	*l*/240	*l*/240	*l*/180
Not supporting ceiling	*l*/180	*l*/180	*l*/120
Floor members	*l*/360	—	*l*/240
Exterior walls:			
With plaster or stucco finishes	—	*l*/360	—
With other brittle finishes	—	*l*/240	—
With flexible finishes	—	*l*/120	—
Interior partitions:[b]			
With plaster or stucco finishes	*l*/360	—	—
With other brittle finishes	*l*/240	—	—
With flexible finishes	*l*/120	—	—
Farm buildings	—	—	*l*/180
Greenhouses	—	—	*l*/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 *l*/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed *l*/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed *l*/90. For roofs, this exception only applies when the metal sheets have no roof covering.

b. 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. The deflection limit for the *D*+*L* load combination only applies to the deflection due to the creep component of long-term dead load deflection plus the short-term live load deflection. For wood structural members that are dry at time of installation and used under dry conditions in accordance with the AWC NDS, the creep component of the long-term deflection shall be permitted to be estimated as the immediate dead load deflection resulting from 0.5*D*. For wood structural members at all other moisture conditions, the creep component of the long-term deflection is permitted to be estimated as the immediate dead load deflection resulting from *D*. The value of 0.5*D* shall not be used in combination with AWC NDS provisions for long-term loading.

e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to ensure adequate drainage shall be investigated for ponding. See Section 1611 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. Where members support glass in accordance with Section 2403 using the deflection limit therein, the wind load shall be no less than 0.6 times the "component and cladding" loads for the purpose of determining deflection.

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 *l*/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed *l*/175 for each glass lite or *l*/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 *l*/120.

i. For cantilever members, *l* shall be taken as twice the length of the cantilever.

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, SJI JG, SJI K or SJI LH/DLH, as applicable.

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. A diaphragm is rigid for the purpose of distribution of story shear and torsional moment when the lateral deformation of the diaphragm is less than or equal to two times the average story drift. Where required by ASCE 7, 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. Where a referenced standard specifies that the assignment of a risk category be in accordance with ASCE 7, Table 1.5-1, Table 1604.5 shall be used in lieu of ASCE 7, Table 1.5-1.

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 1.4.5 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 with-

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: • 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: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing Group E occupancies with an occupant load greater than 250. • Buildings and other structures containing educational occupancies for students above the 12th grade 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, wastewater 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: 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 *California Fire Code*; 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: • 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: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *California Fire Code*; 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.

drawal. 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.

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:

$1.4(D + F)$ **(Equation 16-1)**

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

$1.2(D + F) + 1.6(L_r \text{ or } S \text{ or } R) + 1.6H + (f_1 L \text{ or } 0.5W)$ **(Equation 16-3)**

$1.2(D + F) + 1.0W + f_1 L + 1.6H + 0.5(L_r \text{ or } S \text{ or } R)$ **(Equation 16-4)**

$1.2(D + F) + 1.0E + f_1 L + 1.6H + f_2 S$ **(Equation 16-5)**

$0.9D + 1.0W + 1.6H$ **(Equation 16-6)**

$0.9(D + F) + 1.0E + 1.6H$ **(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:

$D + F$ **(Equation 16-8)**

$D + H + F + L$ **(Equation 16-9)**

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

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

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

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

$D + H + F + 0.75\,(0.7\,E) + 0.75\,L + 0.75\,S$ **(Equation 16-14)**

$0.6D + 0.6W + H$ **(Equation 16-15)**

$0.6(D + F) + 0.7E + H$ **(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 that have been increased or load combinations that 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.

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

$D + L + 0.6\,\omega W$ **(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/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.

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.

TABLE 1607.1
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		
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 and control 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	100	
On single-family dwellings only	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, except one- and two-family dwellings	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

(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.)
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]	
Ice skating rink	250[m]	—
Reviewing stands, grandstands and bleachers	100[c, m]	
Roller skating rink	100[m]	
Stadiums and arenas with fixed seats (fastened to floor)	60[c, m]	
25. Residential		
One- and two-family dwellings		
Uninhabitable attics without storage[i]	10	
Uninhabitable attics with storage[i, j, k]	20	
Habitable attics and sleeping areas[k]	30	
Canopies, including marquees	20	—
All other areas	40	
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, except one- and two-family dwellings	20	
Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	
Primary roof members exposed to a work floor:		
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manufacturing, storage warehouses, and repair garages		2,000
All other primary roof members		300
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 driveways and yards, subject to trucking	250[d, m]	8,000[e]

(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.)
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	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 mm^2, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kN/m^2, 1 pound = 0.004448 kN, 1 pound per cubic foot = 16 kg/m^3.

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 this Table 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 $4^1/_2$ inches by $4^1/_2$ 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 book stack 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 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

(continued)

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

   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 pounds per square foot.

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 1607.12.3.

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

n. [OSHPD 2] 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/m^3) 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/m^3) per total volume of the rack or cabinet, whichever is less.

Other media:

20 pounds per cubic foot (311 N/m^3) or 20 pounds per square foot (958 Pa), whichever is less, but not less than actual loads.

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, 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 $2^1/_2$ feet by $2^1/_2$ feet (762 mm by 762 mm) and shall be located so as to produce the maximum load effects in the structural members.

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 is 80 psf (3.83 kN/m^2) or greater. The partition load shall be not less than a uniformly distributed live load of 15 psf (0.72 kN/m^2).

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/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.

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/m^2). 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 in accordance with 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 vehicles allowed into or on a garage or other structure shall be posted by the owner or the owner's authorized agent 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 for 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 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 seats 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, 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.

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.

1607.9.3 Elements supporting hoists for façade access equipment. In addition to any other applicable live loads, structural elements that support hoists for façade access equipment shall be designed for a live load consisting of the larger of the rated load of the hoist times 2.5 and the stall load of the hoist.

1607.9.4 Lifeline anchorages for façade access equipment. In addition to any other applicable live loads, lifeline anchorages and structural elements that support lifeline anchorages shall be designed for a live load of at least 3,100 pounds (13.8 kN) for each attached lifeline, in every direction that a fall arrest load may be applied.

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:

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

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, *AT*, 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.

$R = 0.08(A - 150)$ **(Equation 16-24)**

For SI: $R = 0.861(A - 13.94)$

Such reduction shall not exceed the smallest of:

1. 40 percent for members supporting one floor.
2. 60 percent for members supporting two or more floors.
3. R as determined by the following equation:

$R = 23.1(1 + D/L_o)$ **(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).

$L_r = L_o R_1 R_2$ **(Equation 16-26)**

where: $12 \le L_r \le 20$

For SI: $L_r = L_o R_1 R_2$

where: $0.58 \le L_r \le 0.96$

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:

$R_1 = 1$ for $A_t \le 200$ square feet (18.58 m^2) **(Equation 16-27)**

$R_1 = 1.2 - 0.001A_t$ for 200 square feet $< A_t <$ 600 square feet **(Equation 16-28)**

For SI: $1.2 - 0.011A_t$ for 18.58 square meters $< A_t <$ 55.74 square meters

$R_1 = 0.6$ for $A_t \ge 600$ square feet (55.74 m^2) **(Equation 16-29)**

where:

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

$R_2 = 1$ for $F \le 4$ **(Equation 16-30)**

$R_2 = 1.2 - 0.05F$ for $4 < F < 12$ **(Equation 16-31)**

$R_2 = 0.6$ for $F \geq 12$ **(Equation 16-32)**

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.

1607.12.3 Occupiable roofs. Areas of roofs that are occupiable, such as vegetative roofs, 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 Vegetative and landscaped roofs. The weight of all landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil as determined in accordance with ASTM E2397. The uniform design live load in unoccupied landscaped areas on roofs shall be 20 psf (0.958 kN/m^2). The uniform design live load for occupied landscaped areas on roofs shall be determined in accordance with Table 1607.1.

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.

1607.12.5 Photovoltaic panel systems. Roof structures that provide support for photovoltaic panel systems shall be designed in accordance with Sections 1607.12.5.1 through 1607.12.5.4, as applicable.

1607.12.5.1 Roof live load. Roof surfaces to be covered by solar photovoltaic panels or modules shall be designed for the roof live load, L_r, assuming that the photovoltaic panels or modules are not present. The roof photovoltaic live load in areas covered by solar photovoltaic panels or modules shall be in addition to the panel loading unless the area covered by each solar photovoltaic panel or module is inaccessible. Areas where the clear space between the panels and the rooftop is not more than 24 inches (610 mm) shall be considered inaccessible. Roof surfaces not covered by photovoltaic panels shall be designed for the roof live load.

1607.12.5.2 Photovoltaic panels or modules. The structure of a roof that supports solar photovoltaic panels or modules shall be designed to accommodate the full solar photovoltaic panels or modules and ballast dead load, including concentrated loads from support frames in combination with the loads from Section 1607.12.5.1 and other applicable loads. Where applicable, snow drift loads created by the photovoltaic panels or modules shall be included.

1607.12.5.3 Photovoltaic panels or modules installed as an independent structure. Solar photovoltaic panels or modules that are independent structures and do not have accessible/occupied space underneath are not required to accommodate a roof photovoltaic live load, provided the area under the structure is restricted to keep the public away. All other loads and combinations in accordance with Section 1605 shall be accommodated.

Solar photovoltaic panels or modules that are designed to be the roof, span to structural supports and have accessible/occupied space underneath shall have the panels or modules and all supporting structures designed to support a roof photovoltaic live load, as defined in Section 1607.12.5.1 in combination with other applicable loads. Solar photovoltaic panels or modules in this application are not permitted to be classified as "not accessible" in accordance with Section 1607.12.5.1.

1607.12.5.4 Ballasted photovoltaic panel systems. Roof structures that provide support for ballasted photovoltaic panel systems shall be designed, or analyzed, in accordance with Section 1604.4; checked in accordance with Section 1604.3.6 for deflections; and checked in accordance with Section 1611 for ponding.

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-geared 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-geared 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 and stiffness to resist the loads to which they are subjected but not less than a horizontal load of 5 psf (0.240 kN/m^2).

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

1. The horizontal distributed load need only be 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 mm^2)] 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.

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 AWC 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.

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/m^2.

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 ASCE 49 and Sections 31.4 and 31.5 of ASCE 7.

The wind speeds in Figures 1609.3(1), 1609.3(2) and 1609.3(3) 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 4 and 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, AWC 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 E1996 and ASTM E1886 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 E1996.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the small missile test of ASTM E1996.

Exceptions:

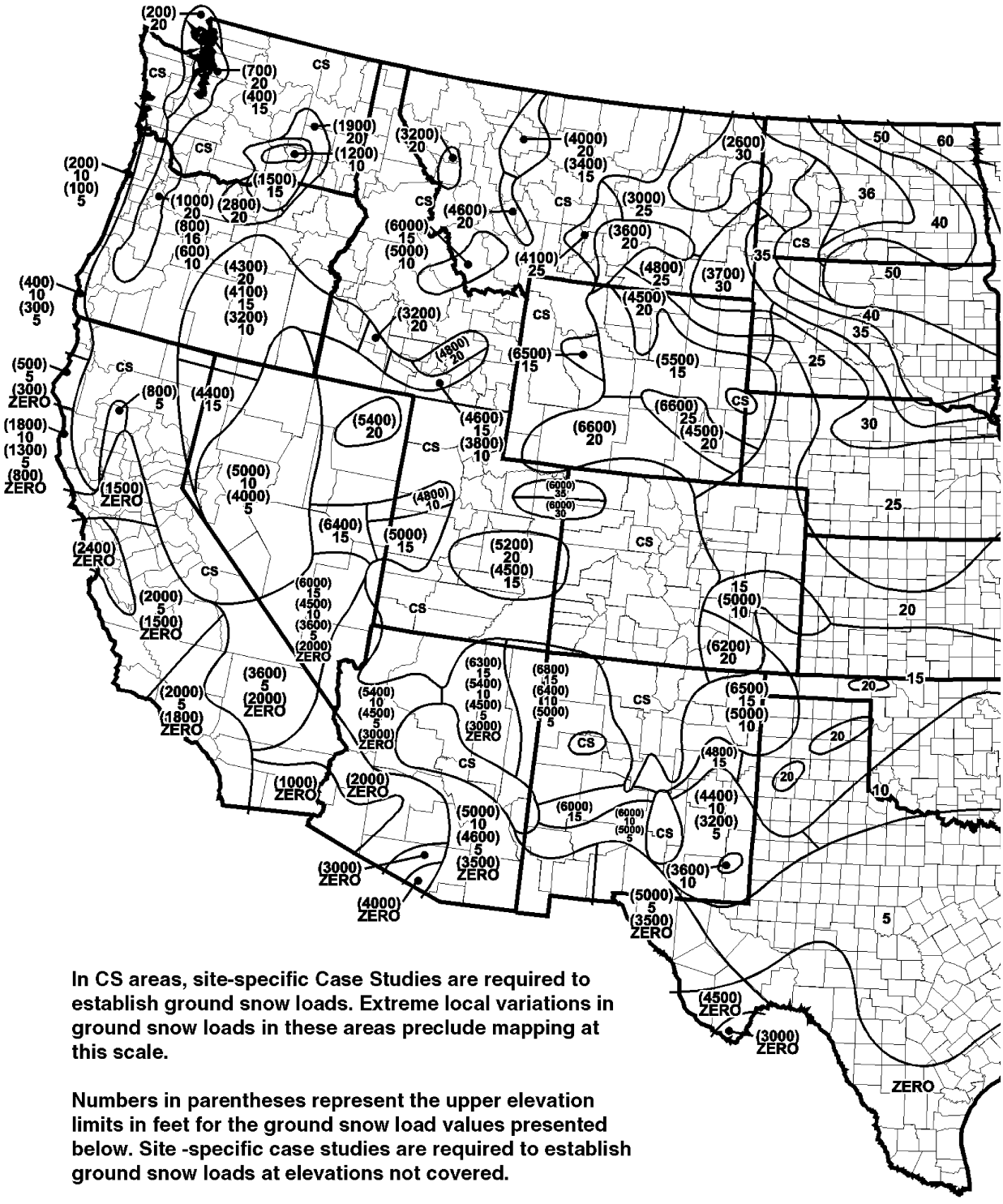
1. Wood structural panels with a minimum thickness of $^{7}/_{16}$ inch (11.1 mm) and maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in buildings with a mean roof height of 33 feet (10 058 mm) or less that are classified as a Group R-3 or R-4 occupancy. Panels shall 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, 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.

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
$^{1}/_{4}$-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 $2^{1}/_{2}$ 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.



In CS areas, site-specific Case Studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.

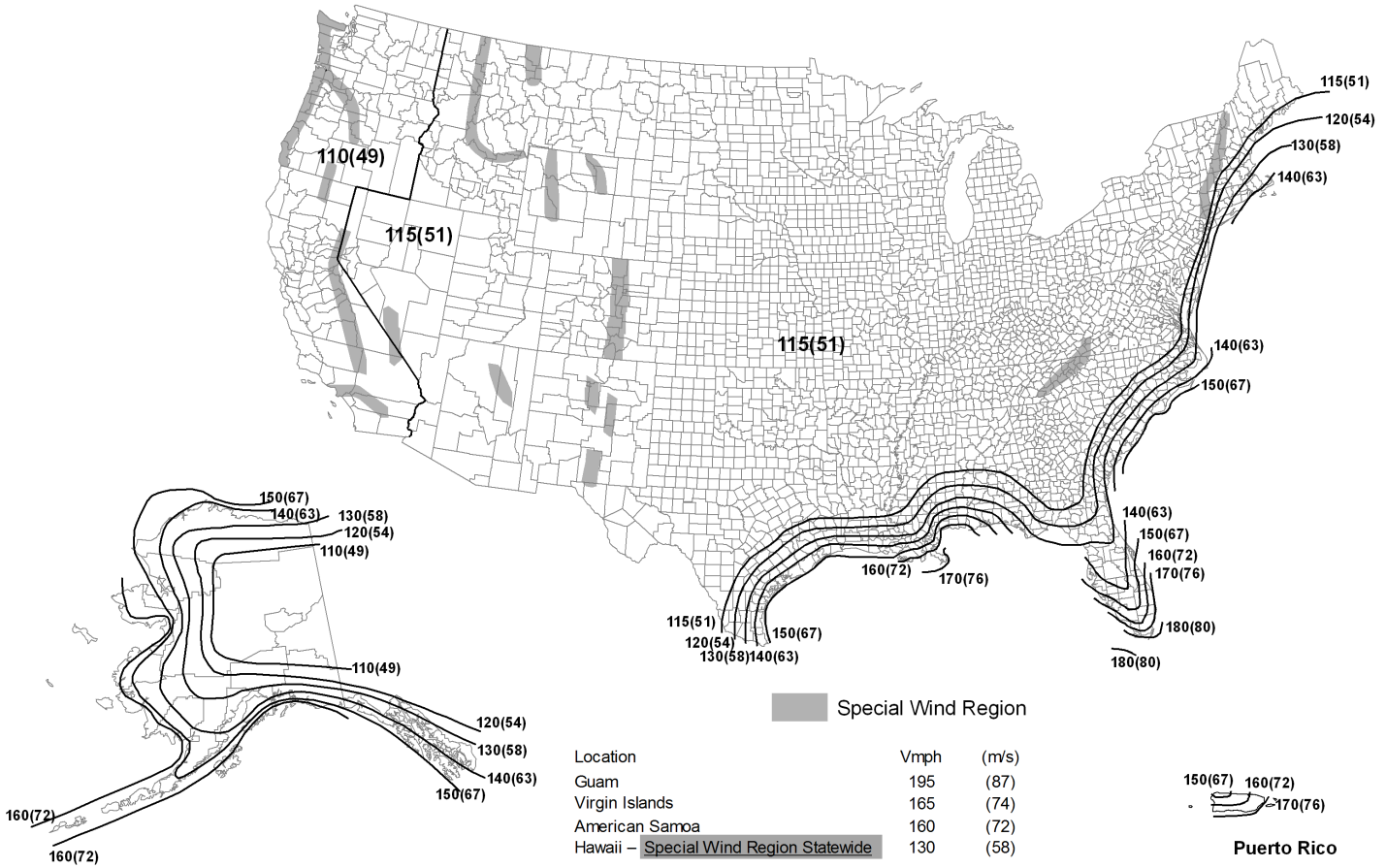
Numbers in parentheses represent the upper elevation limits in feet for the ground snow load values presented below. Site -specific case studies are required to establish ground snow loads at elevations not covered.

To convert lb/sq ft to kNm^2 , multiply by 0.0479.

To convert feet to meters, multiply by 0.3048.

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

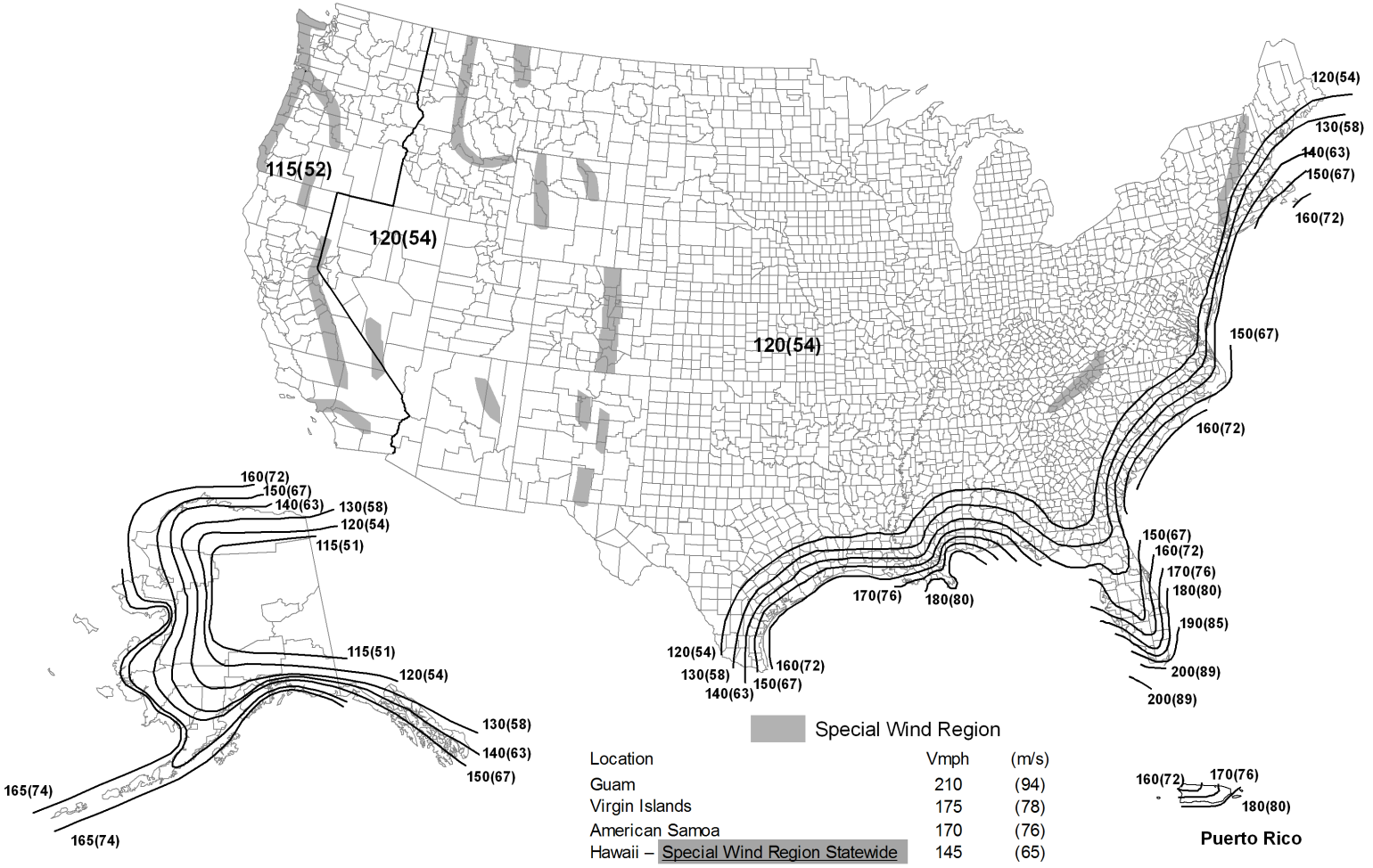
FIGURE 1608.2—continued
GROUND SNOW LOADS, p_g, FOR THE UNITED STATES (psf)



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 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

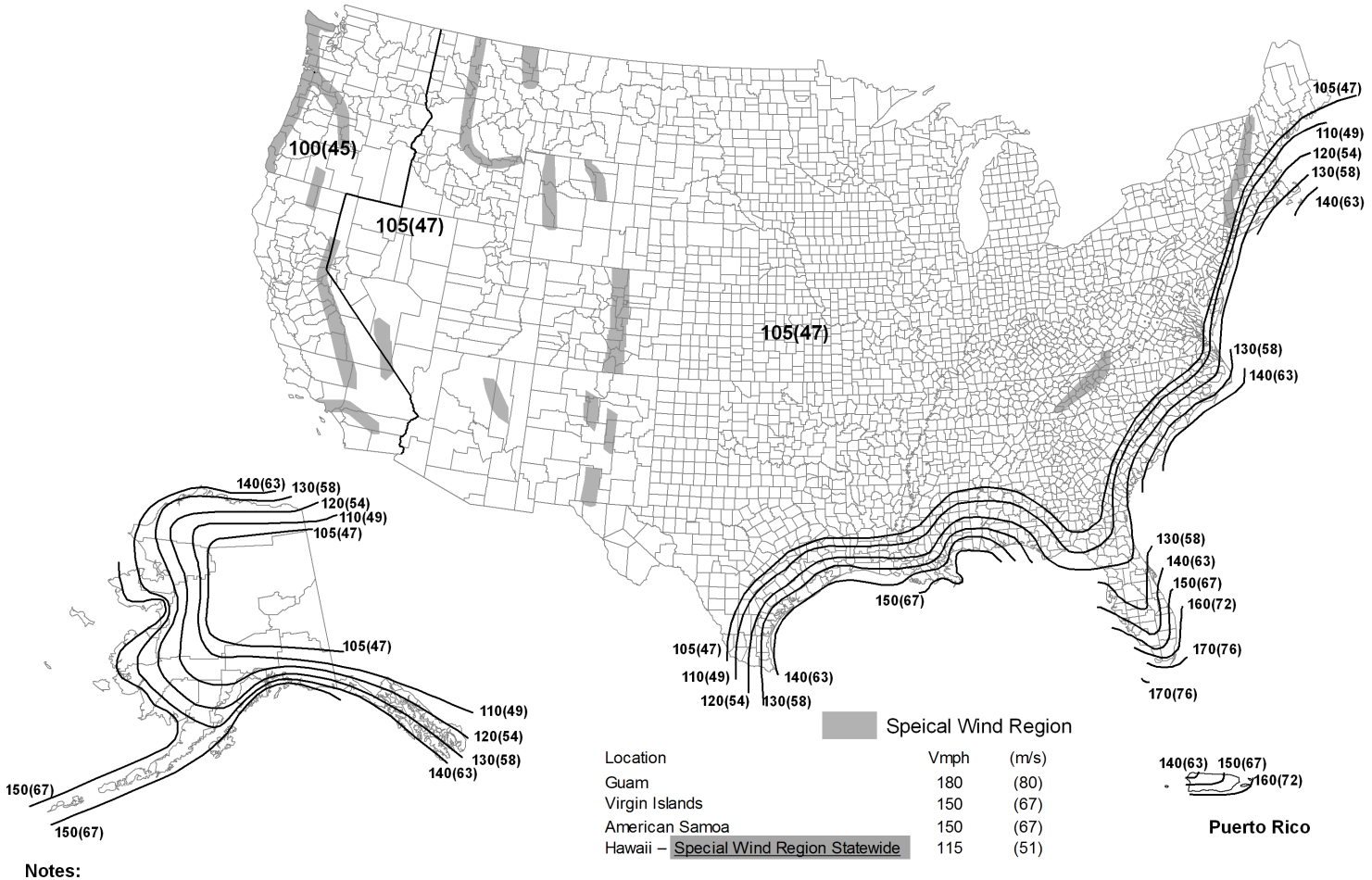
FIGURE 1609.3(1)
ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES



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 1609.3(2)
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 1609.3(3)
ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES

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.

1609.1.2.2. Application of ASTM E1996. The text of Section 6.2.2 of ASTM E1996 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} ≤ 160 mph (63 m/s), or 140 mph (54 m/s) ≤ ultimate design wind speed, V_{ult} ≤ 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 Ultimate design wind speed. The ultimate design wind speed, V_{ult}, in mph, for the determination of the wind loads shall be determined by Figures 1609.3(1), 1609.3(2) and 1609.3(3). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609.3(1). 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 1609.3(2). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609.3(3). 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 1609.3(1), 1609.3(2) and 1609.3(3) shall be converted to nominal design wind speeds, V_{asd}, using Table 1609.3.1 or Equation 16-33.

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

where:

V_{asd} = Nominal design wind speed applicable to methods specified in Exceptions 4 and 5 of Section 1609.1.1.

V_{ult} = Ultimate design wind speeds determined from Figures 1609.3(1), 1609.3(2) or 1609.3(3).

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

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 Figure 1609.3(1), 1609.3(2) or 1609.3(3).

(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 Exposure B or D does 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 1504.1.1.

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

$$M_a = q_h C_L b L L_a [1.0 - GC_p] \qquad \textbf{(Equation 16-34)}$$

For SI:

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

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, feet-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 build-

ings, or other structures that are regularly shaped, that 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.

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

Design wind forces for the MWFRS shall be not 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 be not 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 wind force-resisting systems. The MWFRS shall be investigated for the torsional effects identified in ASCE 7 Figure 27.4-8.

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_{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.

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.

TABLE 1609.6.2
NET PRESSURE COEFFICIENTS, C_{net} [a, b]

STRUCTURE OR PART THEREOF	DESCRIPTION		C_{net} FACTOR			
			Enclosed		Partially enclosed	
	Walls:		+ Internal pressure	- Internal pressure	+ Internal pressure	- Internal pressure
	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
1. Main windforce-resisting frames and systems	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 1609.6.2—continued
NET PRESSURE COEFFICIENTS, C_{net} [a, b]

STRUCTURE OR PART THEREOF	DESCRIPTION		C_{net} FACTOR	
2. Components and cladding not in areas of discontinuity—roofs and overhangs	**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
3. Components and cladding in areas of discontinuities—roofs and overhangs (continued)	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	
3. Components and cladding in areas of discontinuities—roofs and overhangs	**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
4. Components and cladding not in areas of discontinuity—walls and parapets (continued)	Wall Elements: $h \leq 60$ 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 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
	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	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
	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
	Negative		-2.45	-2.76

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929m^2, 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 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.

$R = 5.2(d_s + d_h)$ **(Equation 16-36)**

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/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.

SECTION 1612
FLOOD LOADS

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.

COASTAL A ZONE.

COASTAL HIGH HAZARD AREA.

DESIGN FLOOD.

DESIGN FLOOD ELEVATION.

DRY FLOODPROOFING.

EXISTING CONSTRUCTION.

EXISTING STRUCTURE.

FLOOD or FLOODING.

FLOOD DAMAGE-RESISTANT MATERIALS.

FLOOD HAZARD AREA.

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.

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.

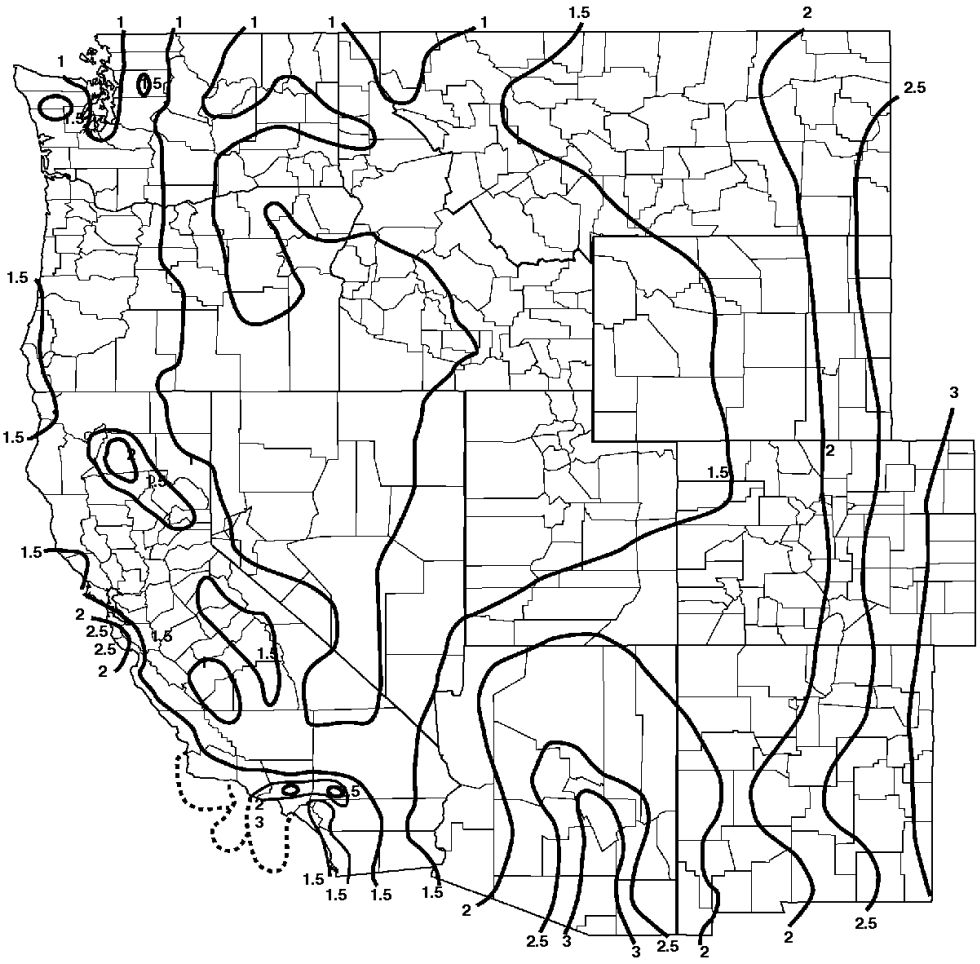
b. Unsuitable as backfill material.

c. The definition and classification of soil materials shall be in accordance with ASTM D2487.

1612.4 Design and construction. The design and construction of buildings and structures located in flood hazard areas, including coastal high hazard areas and coastal A zones, shall be in accordance with Chapter 5 of ASCE 7 and 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 other than coastal high hazard areas or coastal A zones:
   - 1.1. The elevation of the lowest floor, including the basement, as required by the lowest floor elevation inspection in Section 110.3.3 and for the final inspection in Section 110.3.10.1.
   - 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 coastal high hazard areas and coastal A zones:
   - 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 and for the final inspection in Section 110.3.10.1.
   - 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/m^2) determined using



[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.

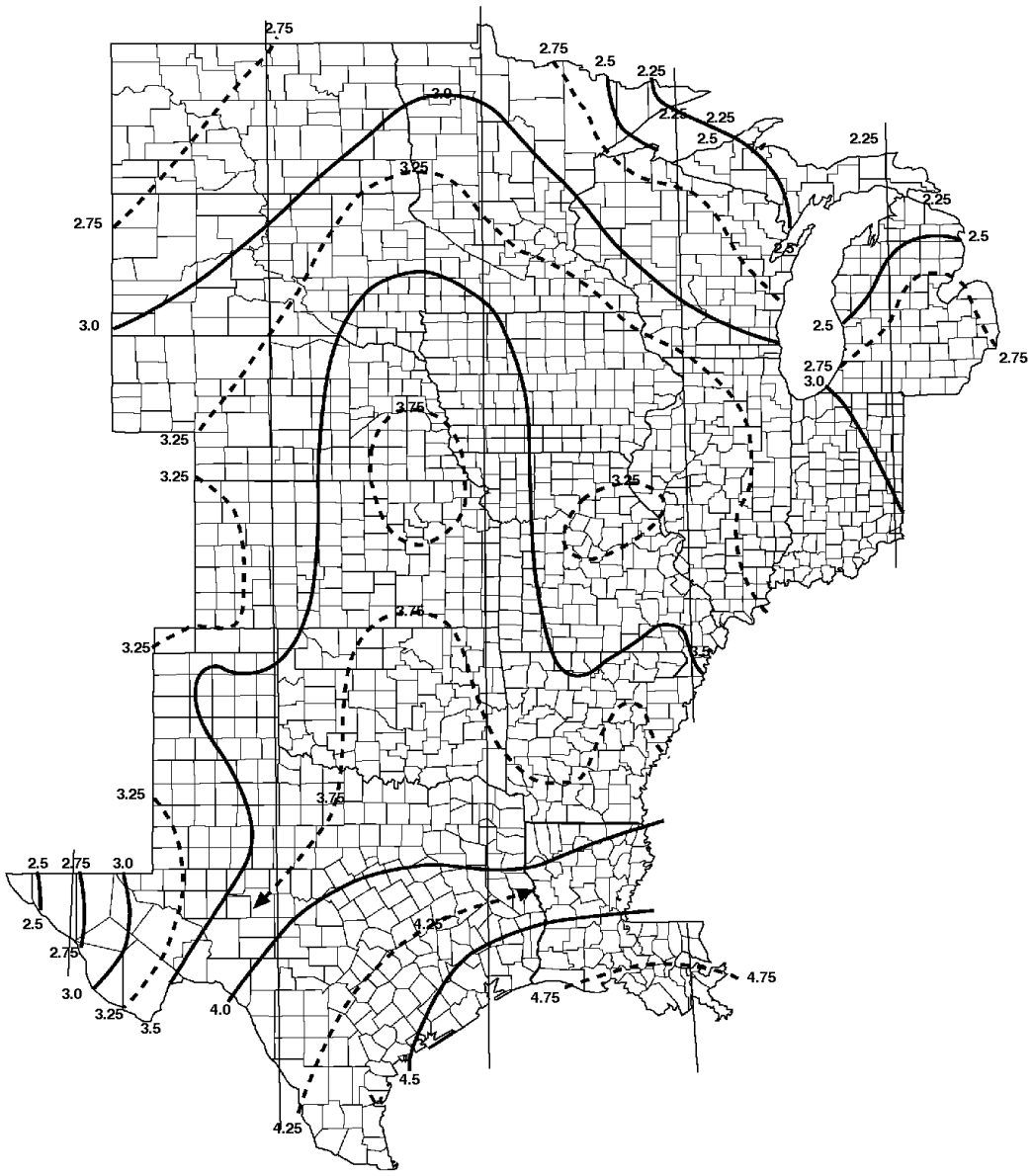
allowable stress design, construction documents shall include a statement that the breakaway wall is designed in accordance with ASCE 24.

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.*



[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.

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. [BSC]** 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*

[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.

area or 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. [BSC] *Additions, alterations, repairs or change of occupancy category of existing buildings shall be in accordance with the California Existing Building Code, Part 10.*

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.

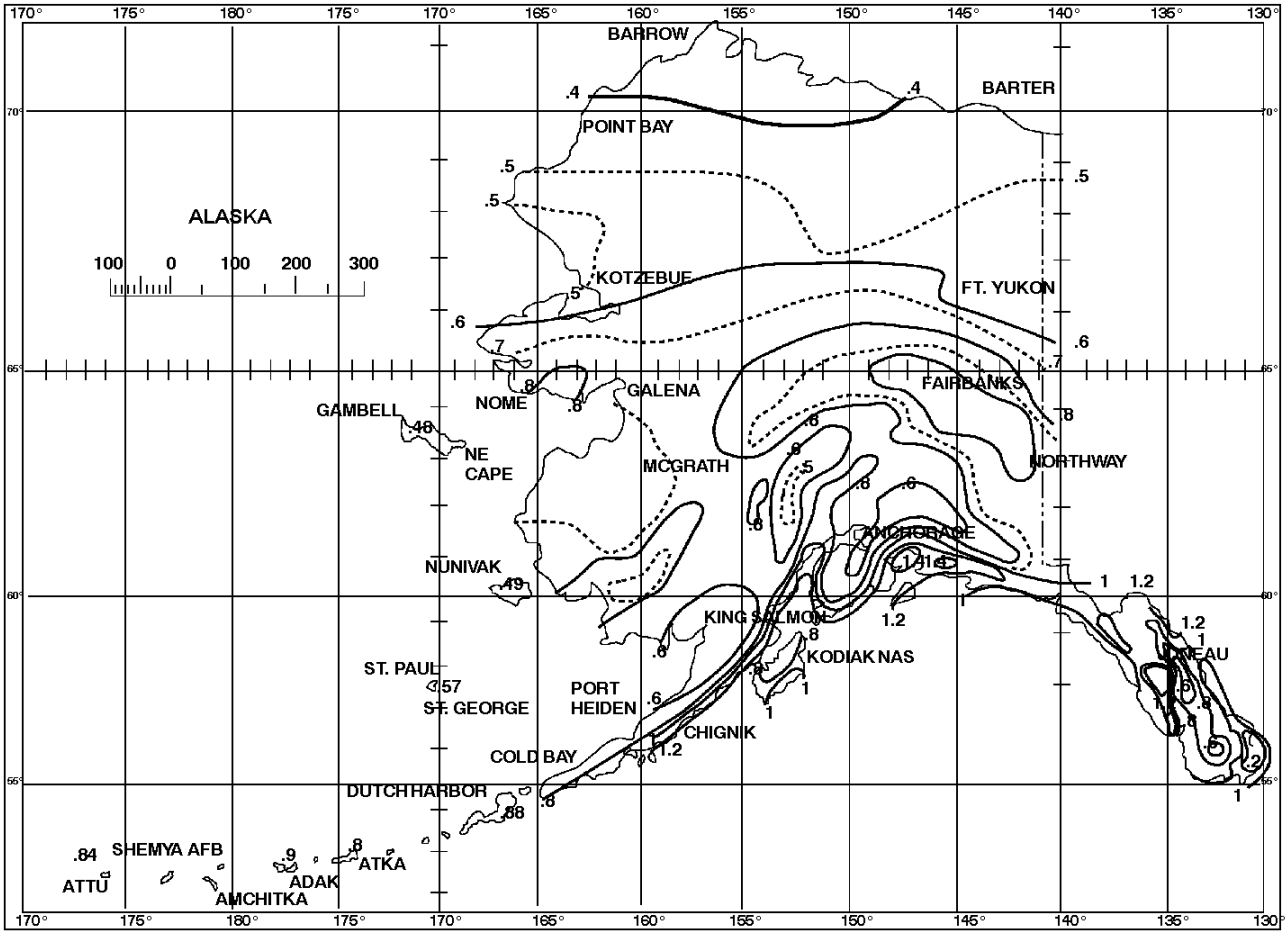
1613.3 Seismic ground motion values. Seismic ground motion values shall be determined in accordance with this section.

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(8). 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 Seismic Design Category A.

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

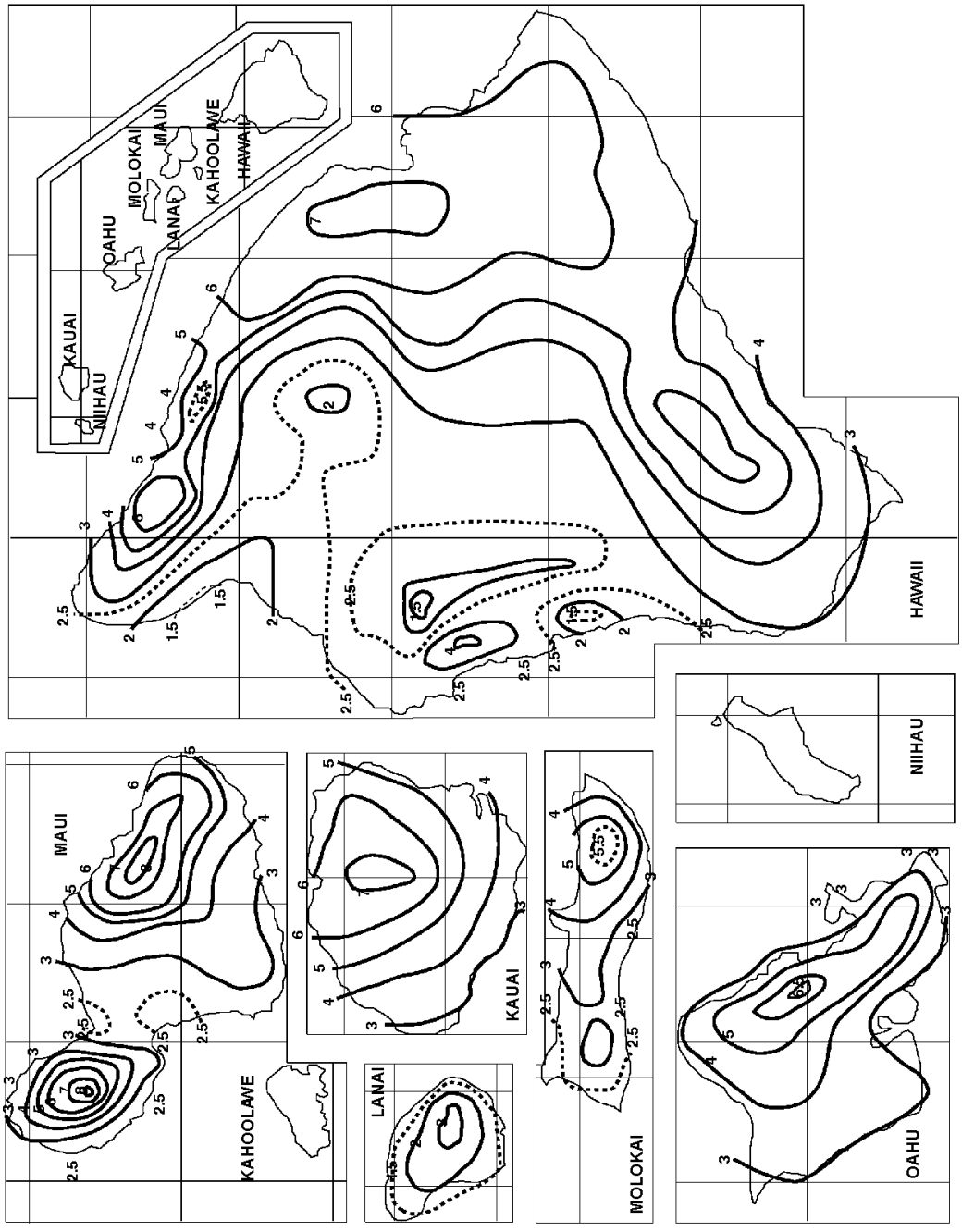
1613.3.2 Site class definitions. Based on the site soil properties, the site shall be classified as Site Class A, B, C, D, E or F in accordance with Chapter 20 of ASCE 7.

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.



[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.

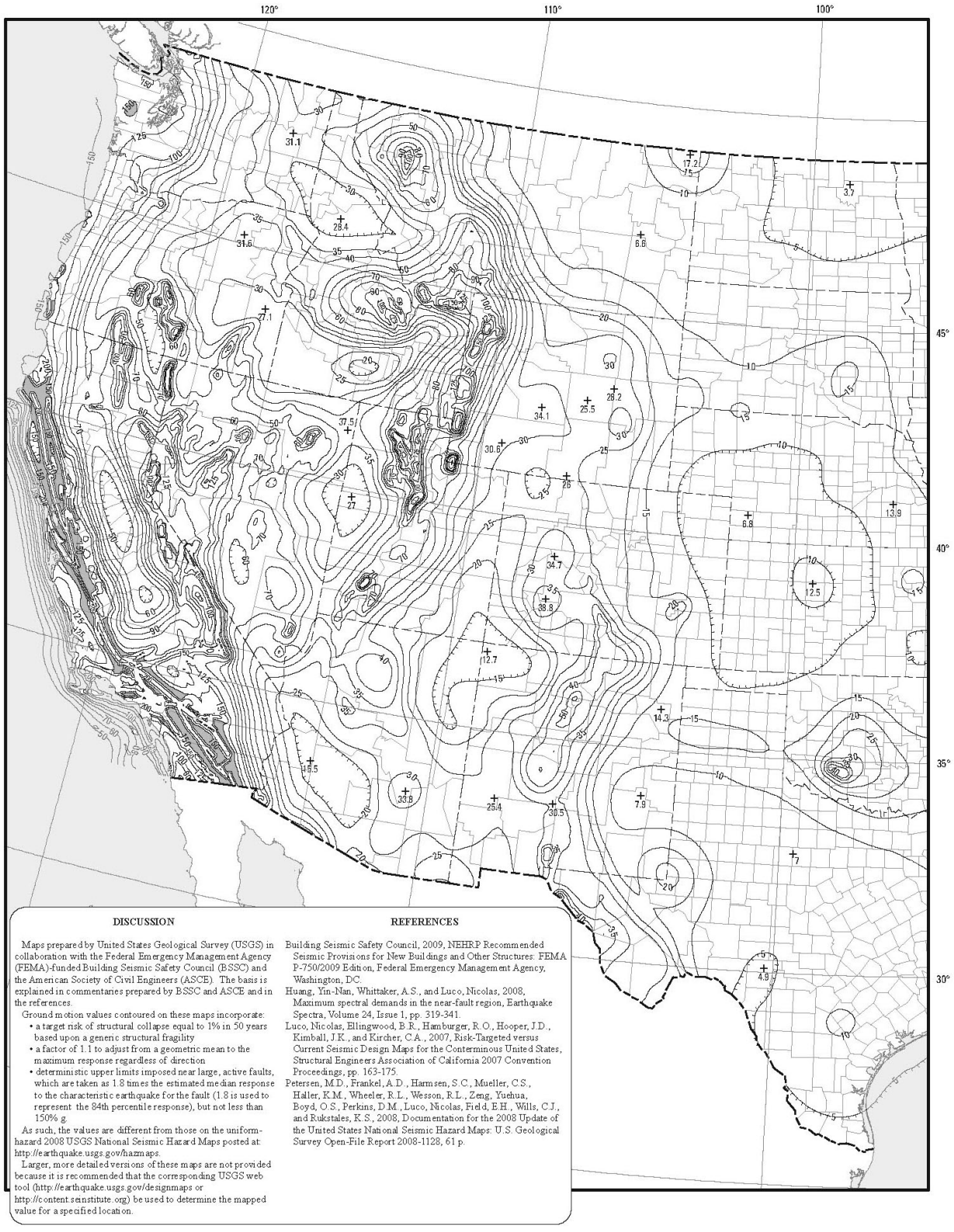


FIGURE 1613.3.1(1)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B
(continued)

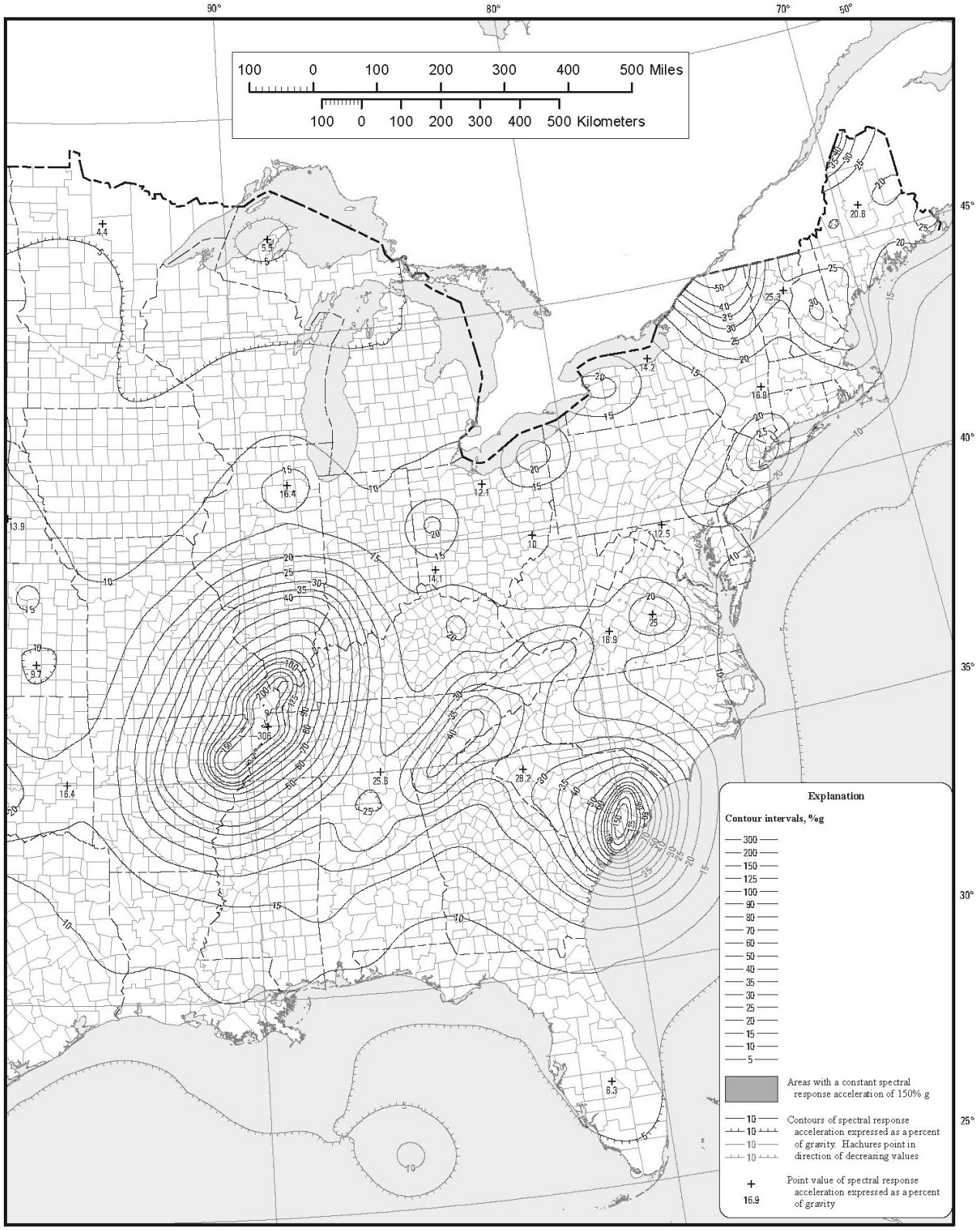


FIGURE 1613.3.1(1)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

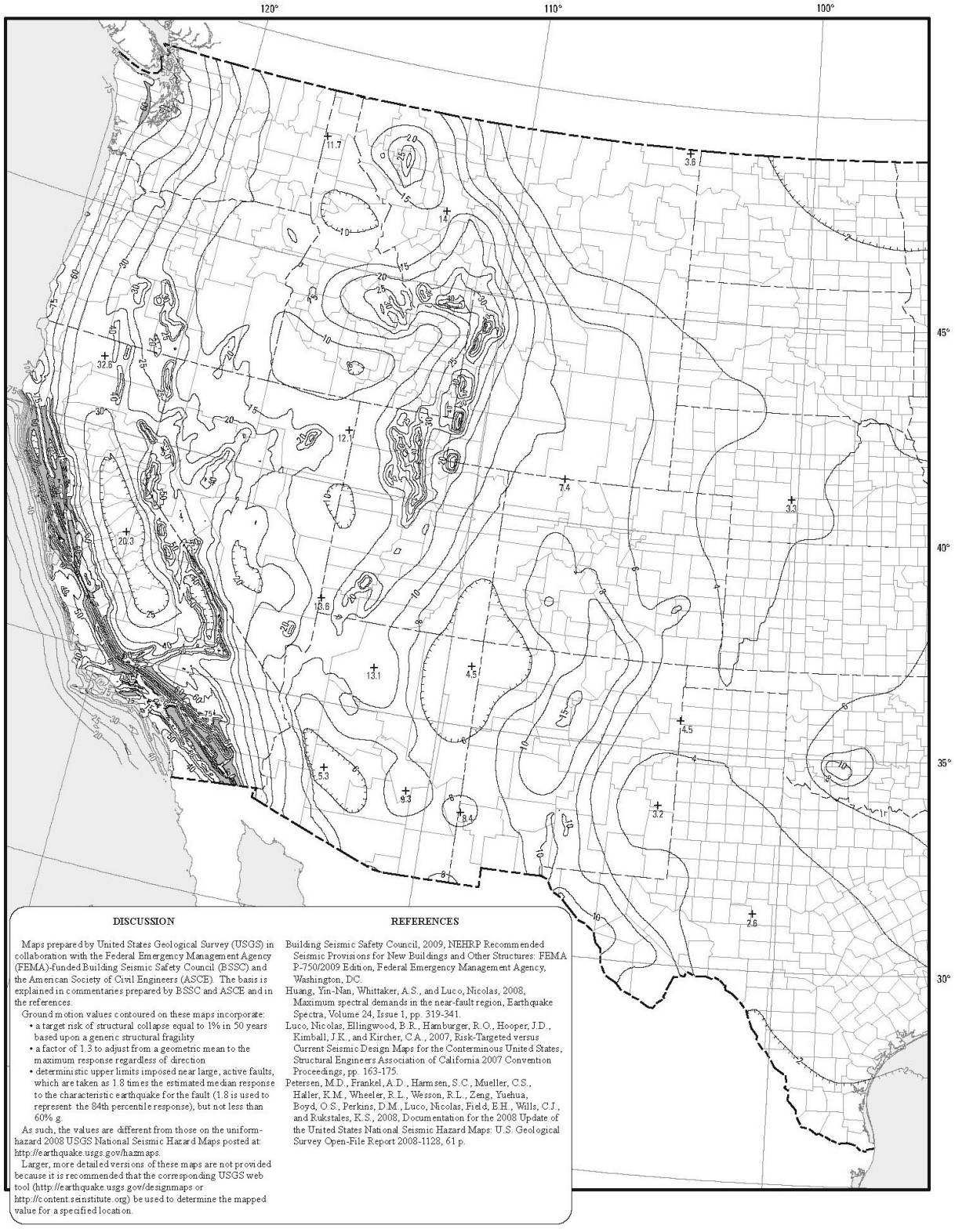


FIGURE 1613.3.1(2)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

(continued)

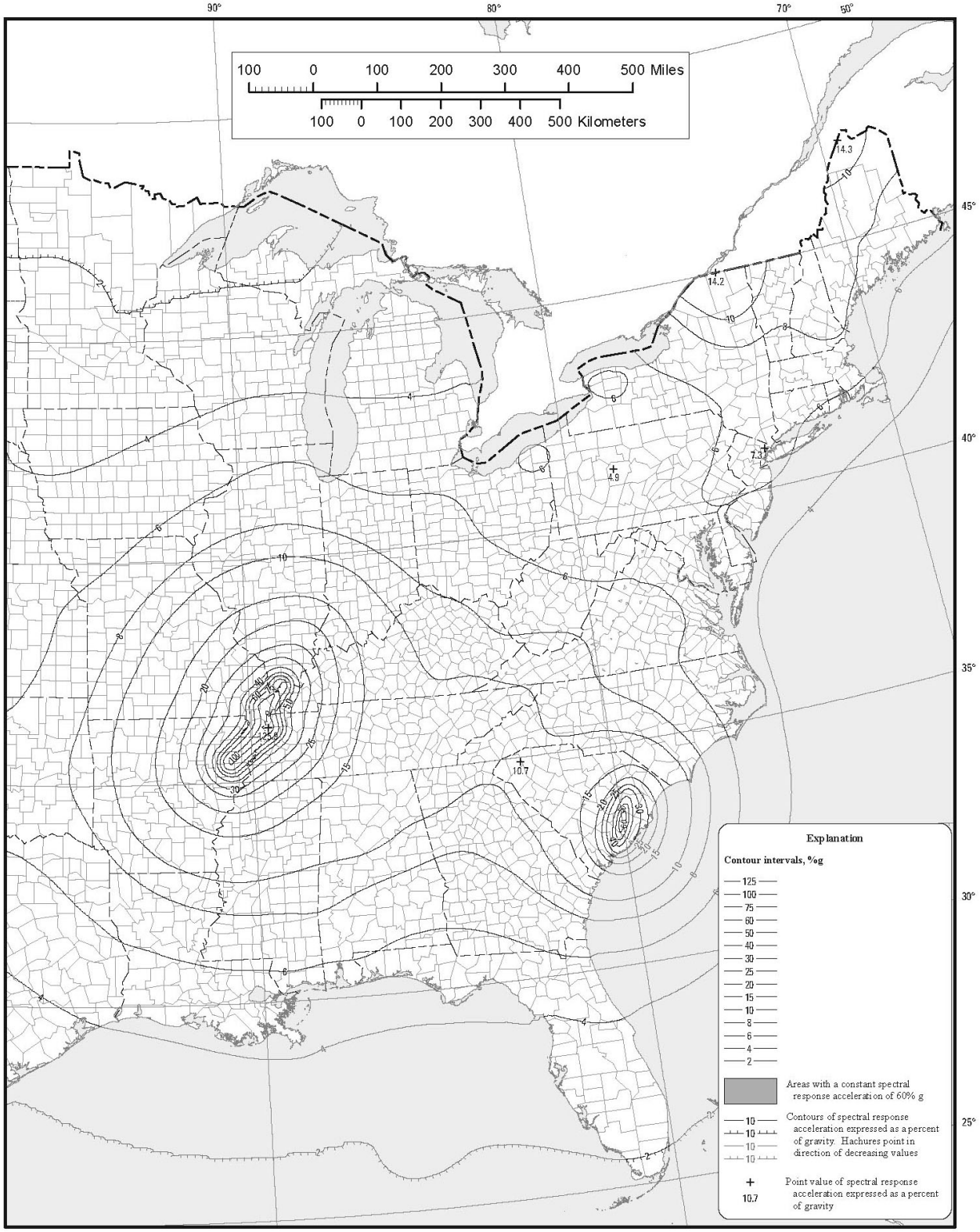
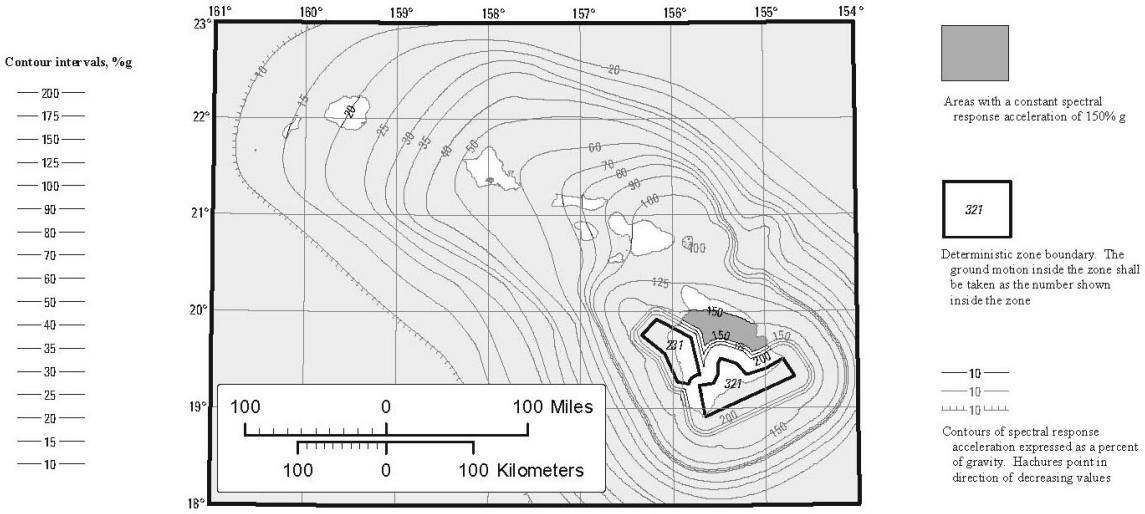
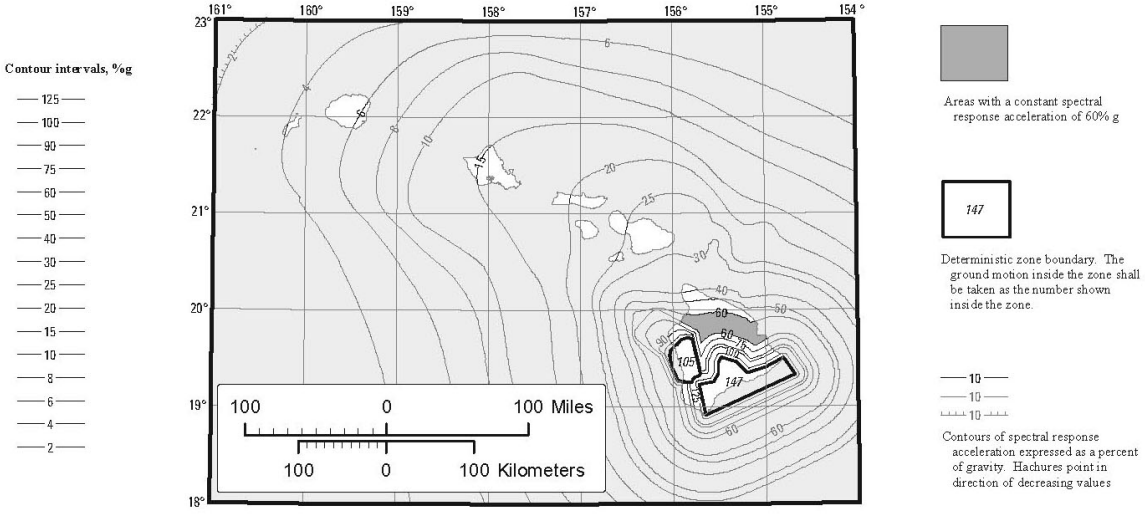


FIGURE 1613.3.1(2)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B



0.2 Second Spectral Response Acceleration (5% of Critical Damping)



1.0 Second Spectral Response Acceleration (5% of Critical Damping)

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.seinstitute.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 Conterminous 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

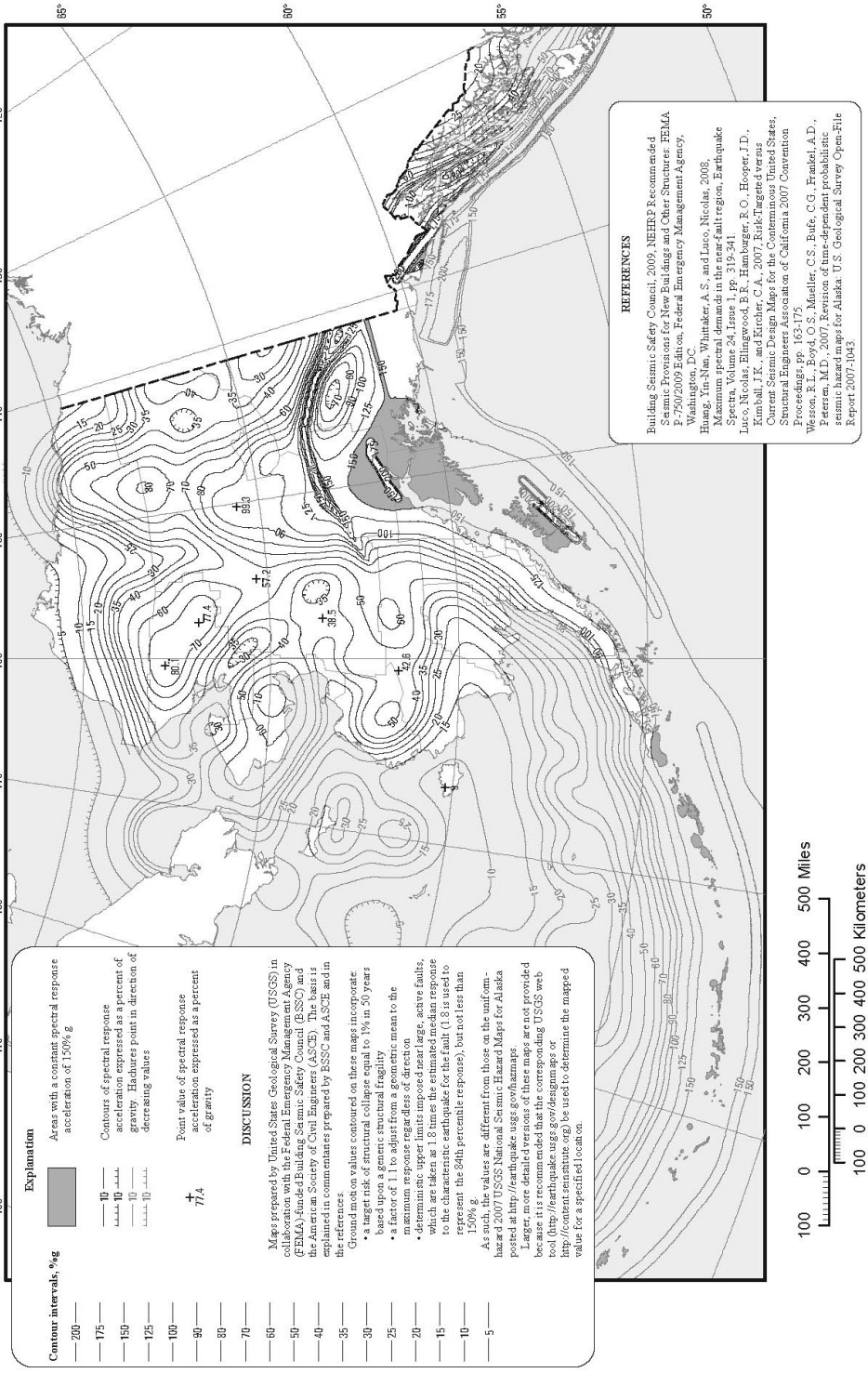


FIGURE 1613.3.1(4)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR ALASKA OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

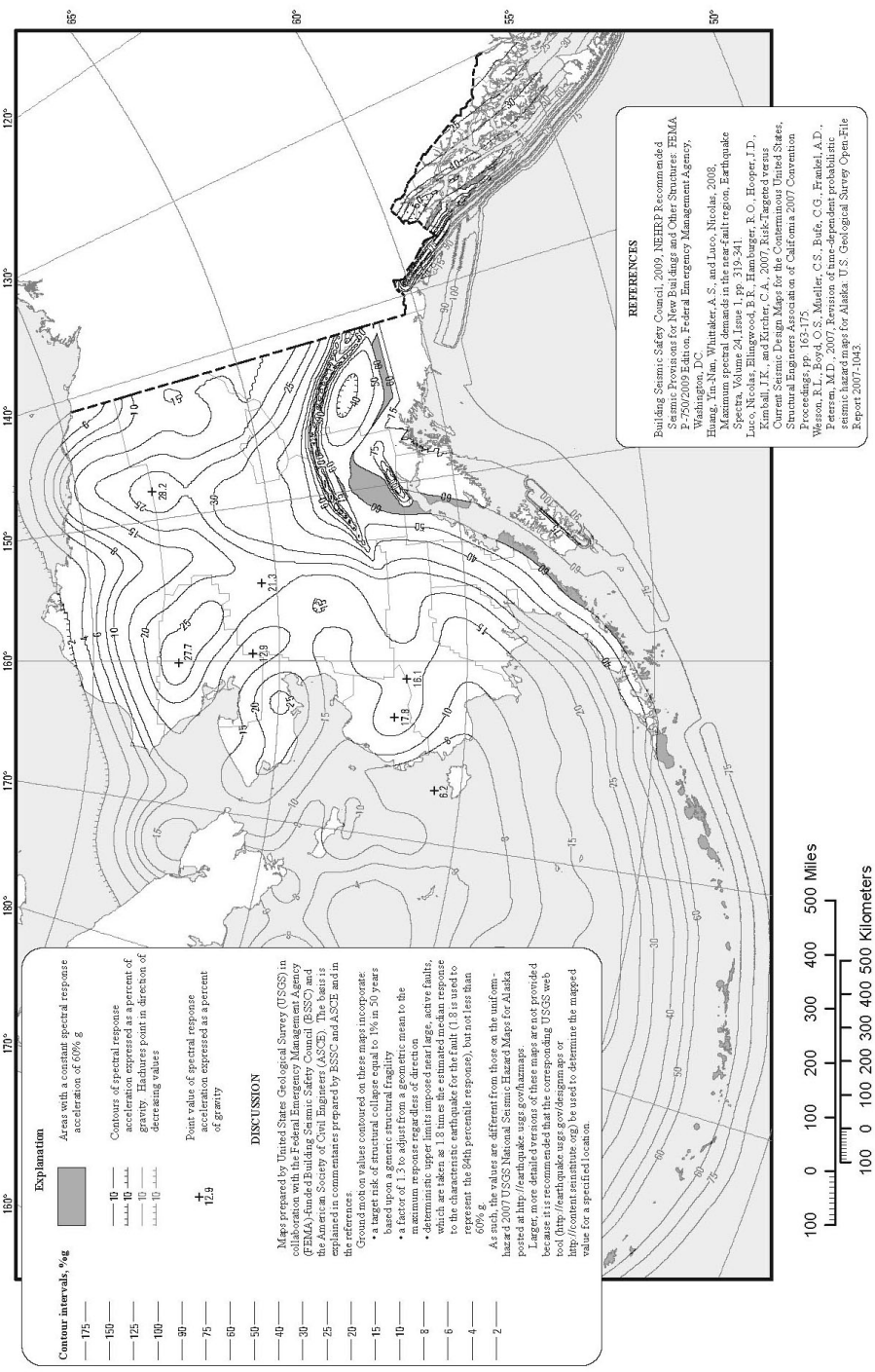
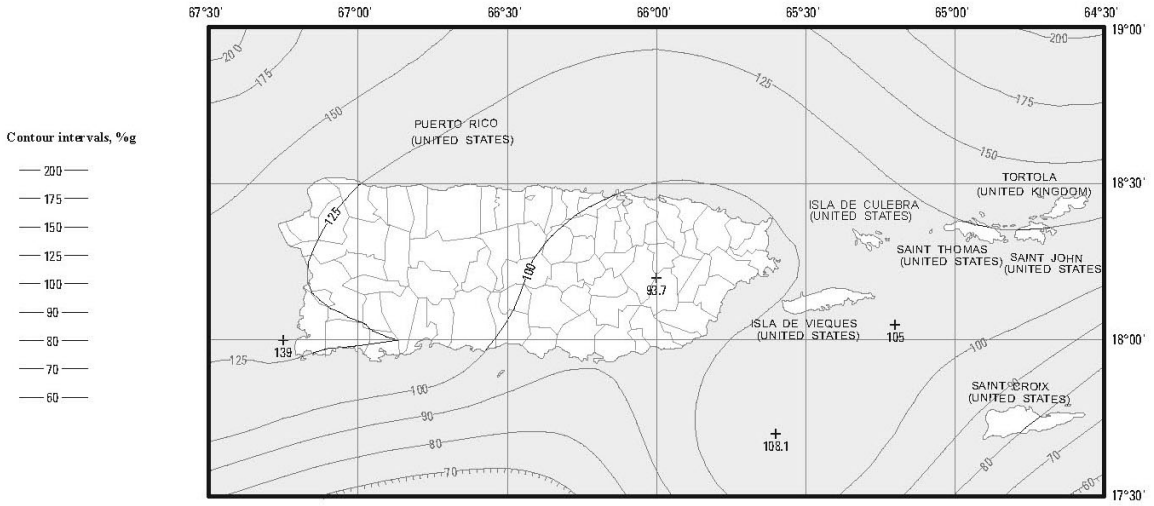
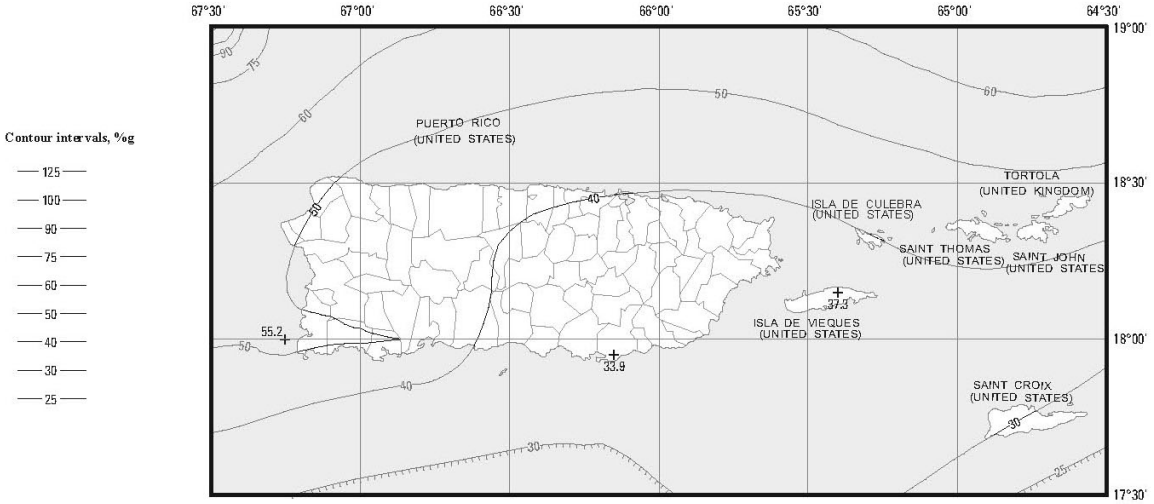


FIGURE 1613.3.1(5)
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR ALASKA OF 1.0-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B



0.2 Second Spectral Response Acceleration (5% of Critical Damping)



1.0 Second Spectral Response Acceleration (5% of Critical Damping)

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 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 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.seinstitute.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, D.C.

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.

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 Conterminous United States, Structural Engineers Association of California 2007 Convention Proceedings, pp. 163-175.

Mueller, 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

1613.3.3 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:

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

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

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, $S_{DS,}$ shall be determined from Equations 16-39 and 16-40, respectively:

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

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

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.

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.*

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.

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.

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 or are permitted to be idealized as rigid in accordance with Section 12.3.1 of ASCE 7 or, for diaphragms permitted to be idealized as flexible in accordance with Section 12.3.1 of ASCE 7, 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 including structural height limits, 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 Amendments to ASCE 7. The provisions of Section 1613.5 shall be permitted as an amendment to the relevant provisions of ASCE 7.

1613.5.1 Transfer of anchorage forces into diaphragm. Modify ASCE 7 Section 12.11.2.2.1 as follows:

12.11.2.2.1 Transfer of anchorage forces into diaphragm. Diaphragms shall be provided with continuous ties or struts between diaphragm chords to distribute these anchorage forces into the diaphragms. Diaphragm connections shall be positive, mechanical or welded. Added chords are permitted to be used to form subdiaphragms to transmit the anchorage forces to the main continuous cross-ties. The maximum length-to-width ratio of a wood, wood structural panel or untopped steel deck sheathed structural subdiaphragm that serves as part of the continuous tie system shall be 2.5 to 1. Connections and anchorages capable of resisting the prescribed forces shall be provided between the diaphragm and the attached components. Connections shall extend into the diaphragm a suffi-

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
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	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
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

cient distance to develop the force transferred into the diaphragm.

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

1613.6 Ballasted photovoltaic panel systems. Ballasted, roof-mounted photovoltaic panel systems need not be rigidly attached to the roof or supporting structure. Ballasted nonpenetrating systems shall be designed and installed only on roofs with slopes not more than one unit vertical in 12 units horizontal. Ballasted nonpenetrating systems shall be designed to resist sliding and uplift resulting from lateral and vertical forces as required by Section 1605, using a coefficient of friction determined by acceptable engineering principles. In structures assigned to Seismic Design Category C, D, E or F, ballasted nonpenetrating systems shall be designed to accommodate seismic displacement determined by nonlinear response-history analysis or shake-table testing, using input motions consistent with ASCE 7 lateral and vertical seismic forces for nonstructural 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 Section 4.10 of ACI 318. Where ACI 318 requires that nonprestressed 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 $^3/_8$-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 16.2.4 and 16.2.5 of ACI 318.

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.

$$T_T = w\,LS \le \alpha_T S \qquad \textbf{(Equation 16-41)}$$

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 16-41. 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.

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.

$$T_p = 200w \le \beta_T \qquad \textbf{(Equation 16-42)}$$

For SI: $T_p = 90.7w \le \beta_T$

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.

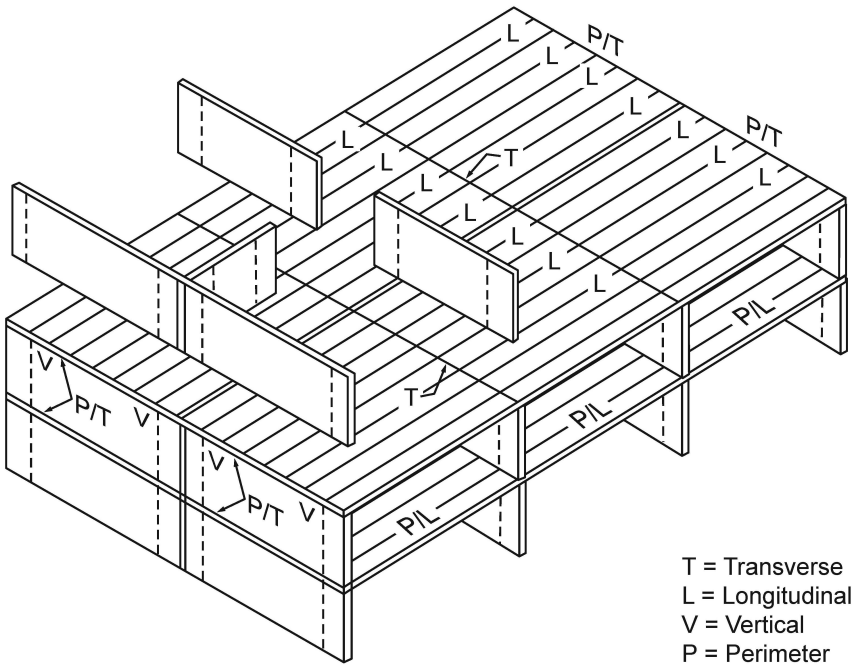


FIGURE 1615.4
LONGITUDINAL, PERIMETER, TRANSVERSE AND VERTICAL TIES

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 FOR COMMUNITY COLLEGES [DSA-SS/CC]

1616.1 Construction documents.

1616.1.1 *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 construction, 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-depth ratio for any roof or floor diaphragm consisting of steel and composite steel slab decking or concrete shall be based on test data and design calculations acceptable to the enforcement agency.*

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.*

1616.2.1.4 Analysis. *Structural analysis shall explicitly include consideration of stiffness of diaphragm in accordance with ASCE 7 Section 12.3.1. A diaphragm is rigid for the purpose of distribution of story shear and torsional moment where so indicated in Section 12.3.1 of ASCE 7.*

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 1511.*

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/m^2).*

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/m^3) 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/m^3) per total volume of the rack or cabinet, whichever is less.

Other media:

20 pounds per cubic foot (311 N/m^3) 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/m^2) 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 buildings in Risk Category I and II.*

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.*

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.*

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.*

1616.10 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 322 of the California Existing Buildings 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_{DS} Value in Determination of C_s and E_v. *The value of C_s and E_v are permitted to be calculated using a value of S_{DS} equal to 1.0, but not less than 70% of S_{DS} as defined in Section 11.4.4, provided that all of the following criteria are met:*

1. *The structure does not have irregularities, as defined in Section 12.3.2;*
2. *The structure does not exceed five stories above the base as defined in Section 11.2;*
3. *The structure has a fundamental period, T, that does not exceed 0.5 seconds, as determined using Section 12.8.2;*
4. *The structure meets the requirements necessary for the redundancy factor, ρ, to be permitted to be taken as 1.0, in accordance with Section 12.3.4.2;*
5. *The site soil properties are not classified as Site Class E or F, as defined in Section 11.4.2; and*
6. *The structure is classified as Risk Category I or II, as defined in Section 1.5.1.*

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 can be delivered to the foundation in a 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 seismic force-resisting 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 or has a center of mass located 4 feet (1.22 m) or more above the adjacent floor or roof level that directly supports the component 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/m^2).*

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 E580 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 C635, ASTM C636, and ASTM E580, Section 5 - Seismic Design Categories D, E and F as modified by this section.*

Exception to Section 13.5.8.1 shall not be used in accordance with ASTM E580 Section 5.5.

13.5.6.2.2 Modification to ASTM E580. *Modify ASTM E580 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. Lateral force diagonal bracing may be omitted in the short or transverse direction of exitways, not exceeding 8 feet wide, when perimeter support in accordance with ASTM E580 Sections 5.2.2 and 5.2.3 is provided and the perimeter wall laterally supporting the ceiling in the short or transverse direction is designed to carry the ceiling lateral forces. The connections between the ceiling grid, wall angle and the wall shall be designed to resist the ceiling lateral forces.*
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 $^1/_2$ 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 E580 Sections 5.2.2 and 5.2.3 are provided and perimeter walls are designed to carry the ceiling lateral forces. The connections between the ceiling grid, wall angle and the wall shall be designed to resist the ceiling lateral forces. Horizontal restraint point spacing shall be justified by analysis or test and shall not exceed a spacing of 12 feet by 12 feet. Bracing wires shall be secured with four tight twists in $1^1/_2$ inches, or an approved alternate connection.*
5. *Ceiling support and bracing wires shall be spaced a minimum of 6" from all pipes, ducts, conduits and equipment that are not braced for horizontal forces, unless approved otherwise by the building official.*

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 ft^2 (0.557 m^2) or less, or weigh 10 lb/ft (146 N/m) or less.*

1616.10.19 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.

1616.10.20 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.*

1616.10.21 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 in Table 1224.4.11.*
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.*

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.

1616.10.22 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.

1616.10.23 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.

1616.10.24 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 shall be explicitly accounted for in the analysis and in the testing of the isolator units.

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	BSC-CG	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																					
1607A.8.2							X														

The state agency does not adopt sections identified with 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 16*A*
STRUCTURAL DESIGN

SECTION 1601*A*
GENERAL

1601*A*.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 Registered Design Professional (RDP), are also subject to approval by the enforcement agency.*

SECTION 1602*A*
DEFINITIONS AND NOTATIONS

1602*A*.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.

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 Figure 1609.3(1), 1609.3(2), 1609.3(3) or ASCE 7.

W = Load due to wind pressure.

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

SECTION 1603*A*
CONSTRUCTION DOCUMENTS

1603*A*.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*A*.1.1 through *1603A.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*A*.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.*

1603*A*.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*A*.10 shall be indicated for each type of live load used in the design.

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

1603*A*.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/m^2), 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_s.
4. Thermal factor, C_t.
5. Drift surcharge load(s), P_d, where the sum of P_d and P_f exceeds 20 psf (0.96 kN/m^2).
6. Width of snow drift(s), w.

1603*A*.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*A*.3.1.
2. Risk category.
3. Wind exposure. Applicable wind direction if more than one wind exposure is utilized.
4. Applicable internal pressure coefficient.
5. Design wind pressures to be used for exterior component and cladding materials not specifically designed by the registered design professional responsible for the design of the structure, psf (kN/m^2).

1603*A*.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), *CS*.
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.*

1603*A*.1.6 Geotechnical information. The design load-bearing values of soils shall be shown on the construction documents.

1603*A*.1.7 Flood design data. For buildings located in whole or in part in flood hazard areas as established in Section 1612*A*.3, the documentation pertaining to design, if required in Section 1612*A*.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. Flood design class assigned according to ASCE 24.
2. In flood hazard areas other than coastal high hazard areas or coastal A zones, the elevation of the proposed lowest floor, including the basement.
3. In flood hazard areas other than coastal high hazard areas or coastal A zones, the elevation to which any nonresidential building will be dry floodproofed.
4. In coastal high hazard areas and coastal A zones, the proposed elevation of the bottom of the lowest horizontal structural member of the lowest floor, including the basement.

1603*A*.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*A*.1.8.1 Photovoltaic panel systems. The dead load of rooftop-mounted photovoltaic panel systems, including rack support systems, shall be indicated on the construction documents.

1603A.1.9 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 construction, 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 project 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 318, Part 10, Title 24, C.C.R.* ***[DSA-SS]*** *Sections 202 and 3402A* ***[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 design basis and 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 1604*A*
GENERAL DESIGN REQUIREMENTS

1604*A*.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*A*.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.

TABLE 1604*A*.3
DEFLECTION LIMITS[a, b, c, h, i]

CONSTRUCTION	*L* or L_r	*E*, *S* or *W*[f]	*D* + (*L* or L_r)[d, g]
Roof members:[e]			
Supporting plaster or stucco ceiling	*l*/360	*l*/360	*l*/240
Supporting nonplaster ceiling	*l*/240	*l*/240	*l*/180
Not supporting ceiling	*l*/180	*l*/180	*l*/120
Floor members	*l*/360	—	*l*/240
Exterior walls:			
With plaster or stucco finishes	—	*l*/360	—
With other brittle finishes	—	*l*/240	—
With flexible finishes	—	*l*/120	—
Veneered walls, anchored veneers and adhered veneers over 1 inch (25 mm) thick, including the mortar backing		*l/600*	—
Interior partitions:[b]			
With plaster or stucco finishes	*l*/360	—	—
With other brittle finishes	*l*/240	—	—
With flexible finishes	*l*/120	—	—
Farm buildings	—	—	*l*/180
Greenhouses	—	—	*l*/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 *l*/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed *l*/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed *l*/90. For roofs, this exception only applies when the metal sheets have no roof covering.

b. 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. The deflection limit for the *D*+*L* load combination only applies to the deflection due to the creep component of long-term dead load deflection plus the short-term live load deflection. For wood structural members that are dry at time of installation and used under dry conditions in accordance with the AWC NDS, the creep component of the long-term deflection shall be permitted to be estimated as the immediate dead load deflection resulting from 0.5*D*. For wood structural members at all other moisture conditions, the creep component of the long-term deflection is permitted to be estimated as the immediate dead load deflection resulting from *D*. The value of 0.5*D* shall not be used in combination with AWC NDS provisions for long-term loading.

e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to ensure adequate drainage shall be investigated for ponding. See Section 1611 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. Where members support glass in accordance with Section 2403 using the deflection limit therein, the wind load shall be no less than 0.6 times the "component and cladding" loads for the purpose of determining deflection.

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 *l*/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed *l*/175 for each glass lite or *l*/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 *l*/120.

i. For cantilever members, *l* shall be taken as twice the length of the cantilever.

1604*A*.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*A*.3.1 Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604*A*.3.2 through 1604*A*.3.5 or that permitted by Table 1604*A*.3.

1604*A*.3.2 Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

1604*A*.3.3 Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI S100, ASCE 8, SJI CJ, SJI JG, SJI K or SJI LH/DLH, as applicable.

1604*A*.3.4 Masonry. The deflection of masonry structural members shall not exceed that permitted by TMS 402/ACI 530/ASCE 5.

1604*A*.3.5 Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

1604*A*.3.6 Limits. The deflection limits of Section 1604*A*.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-depth ratio for any roof or floor diaphragm consisting of steel and composite steel slab decking shall not exceed those given in Table 1604A.4, unless test data and design calculations acceptable to the enforcement agency are submitted and approved for the use of other 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.*

1604*A*.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

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*	*1 1/2:1*
70-150	*200*	*2:1 or as required for deflection*	*3:1*	*Not to be used*	*2:1*
10-70	*400*	*2 1/2:1 or as required for deflection*	*4:1*	*As required for deflection*	*2 1/2:1*
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*	*3 1/2:1*

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:

$$F = \frac{\Delta_w x 10^6}{q_{ave} L}$$

   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.*

on the action of the system is considered and provided for in the design. *Structural analysis shall explicitly include consideration of stiffness of diaphragms in accordance with ASCE 7 Section 12.3.1.* Where required by ASCE 7, 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*A* for wind loads, Section 1610*A* for lateral soil loads and Section 1613*A* for earthquake loads.

1604A.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. Where a referenced standard specifies that the assignment of a risk category be in accordance with ASCE 7, Table 1.5-1, Table 1604.5 shall be used in lieu of ASCE 7, Table 1.5-1.

TABLE 1604*A*.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: • 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: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing Group E occupancies with an occupant load greater than 250. • Buildings and other structures containing educational occupancies for students above the 12th grade 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, wastewater 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: 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 *California Fire Code*; 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: • ***[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.* • 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 ***[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.* • 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: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *California Fire Code*; 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.

1604.5*A*.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*A*.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*A*.

1604*A*.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*A*, shall be load tested in accordance with Section 1710*A*.

1604*A*.8 Anchorage. Buildings and other structures, and portions thereof, shall be provided with anchorage in accordance with Sections 1604*A*.8.1 through 1604*A*.8.3, as applicable.

1604*A*.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*A*.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 1.4.5 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 1609*A* for wind design requirements and 1613*A* for earthquake design requirements.

1604*A*.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*A*.1, or the snow load specified in Section 1608*A*, in accordance with Section 1605*A*, acting on all portions of the deck.
2. The reactions resulting from the dead load and live load specified in Table 1607*A*.1, or the snow load specified in Section 1608*A*, in accordance with Section 1605*A*, acting on the cantilevered portion of the deck, and no live load or snow load on the remaining portion of the deck.

1604*A*.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*A*.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*A*
LOAD COMBINATIONS

1605*A*.1 General. Buildings and other structures and portions thereof shall be designed to resist:

1. The load combinations specified in Section 1605*A*.2, 1605*A*.3.1 or 1605*A*.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*A*-5 and 16*A*-7 in Section 1605*A*.2.

2. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16*A*-12, 16*A*-14 and 16*A*-16 in Section 1605*A*.3.1.
3. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16*A*-21 and 16*A*-22 in Section 1605*A*.3.2.

1605*A*.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*A*.2 or 1605*A*.3 shall be permitted. Where the load combinations specified in Section 1605*A*.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*A*.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.*

1605*A*.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:

$1.4(D + F)$ **(Equation 16*A*-1)**

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

$1.2(D + F) + 1.6(L_r \text{ or } S \text{ or } R) + 1.6H + (f_1 L \text{ or } 0.5W)$ **(Equation 16*A*-3)**

$1.2(D + F) + 1.0W + f_1 L + 1.6H + 0.5(L_r \text{ or } S \text{ or } R)$ **(Equation 16*A*-4)**

$1.2(D + F) + 1.0E + f_1 L + 1.6H + f_2 S$ **(Equation 16*A*-5)**

$0.9D + 1.0W + 1.6H$ **(Equation 16*A*-6)**

$0.9(D + F) + 1.0E + 1.6H$ **(Equation 16*A*-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*A*.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*A*.3 Load combinations using allowable stress design.

1605*A*.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:

$D + F$ **(Equation 16*A*-8)**

$D + H + F + L$ **(Equation 16*A*-9)**

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

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

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

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

$D + H + F + 0.75\,(0.7\,E) + 0.75\,L + 0.75\,S$ **(Equation 16*A*-14)**

$0.6D + 0.6W + H$ **(Equation 16*A*-15)**

$0.6(D + F) + 0.7E + H$ **(Equation 16*A*-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*A*-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*A*-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*A*.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*A*.3.1, except that increases shall be permitted in accordance with Chapter 23.

1605*A*.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*A*.3.2 Alternative basic load combinations. In lieu of the basic load combinations specified in Section 1605*A*.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 that have been increased or load combinations that 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.

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

$D + L + 0.6\,\omega W$ **(Equation 16*A*-18)**

$D + L + 0.6\,\omega W + S/2$ **(Equation 16*A*-19)**

$D + L + S + 0.6\,\omega W/2$ **(Equation 16*A*-20)**

$D + L + S + E/1.4$ **(Equation 16*A*-21)**

$0.9D + E/1.4$ **(Equation 16*A*-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 (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.

1605*A*.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*A*.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*A*
DEAD LOADS

1606*A*.1 General. Dead loads are those loads defined in Chapter 2 of this code. Dead loads shall be considered permanent loads.

1606*A*.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 1511.*

SECTION 1607*A*
LIVE LOADS

1607*A*.1 General. Live loads are those loads defined in *Chapter 2 of this code.*

1607*A*.2 Loads not specified. For occupancies or uses not designated in Table 1607*A*.1, the live load shall be determined in accordance with a method approved by the building official.

1607*A*.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*A*.1.

1607*A*.4 Concentrated live loads. Floors and other similar surfaces shall be designed to support the uniformly distributed live loads prescribed in Section 1607*A*.3 or the concentrated live loads, given in Table 1607*A*.1, whichever produces the greater load effects. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area of $2^1/_2$ feet by $2^1/_2$ feet (762 mm by 762 mm) and shall be located so as to produce the maximum load effects in the structural members.

1607*A*.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 is 80 psf (3.83 kN/m^2) or greater. The partition load shall be not less than a uniformly distributed live load of 15 psf (0.72 kN/m^2).

TABLE 1607*A*.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[o, 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 and control 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	100	—
On single-family dwellings only	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	80	1,000
Operating rooms, laboratories	60	1,000
Patient rooms	40	1,000
Mechanical and electrical equipment areas including open areas around equipment	*50*	
Storage		
Light	*125*	
Heavy	*250*	
Dining Area (not used for assembly)	*100*	*1,000*
Kitchen and serving areas	*50*	*1,000*
18. Hotels (see residential)	—	—
19. Libraries[n]		
Corridors above first floor	80	1,000
Reading rooms	60[m]	1,000
Stack rooms	150[b, m]	1,000
20. Manufacturing		
Heavy	250[m]	3,000
Light	125[m]	2,000
21. Marquees, except one- and two-family dwellings	75	—

(continued)

TABLE 1607*A*.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]	
Ice skating rink	250[m]	—
Reviewing stands, grandstands and bleachers[q]	100[c, m]	
Roller skating rink	100[m]	
Stadiums and arenas with fixed seats (fastened to floor)	60[c, m]	
25. Residential		
One- and two-family dwellings		
Uninhabitable attics without storage[i]	10	
Uninhabitable attics with storage[i, j, k]	20	
Habitable attics and sleeping areas[k]	30	
Canopies, including marquees	20	—
All other areas	40	
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, except one- and two-family dwellings	20	
Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	
Primary roof members exposed to a work floor		
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manufacturing, storage warehouses, and repair garages		2,000
All other primary roof members		300
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 1607*A*.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[r]	100[m]	—
36. Storage racks and wall-hung cabinets	*Total loads[n]*	

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kN/m^2, 1 pound = 0.004448 kN, 1 pound per cubic foot = 16 kg/m^3.

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 this Table 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 1/2 inches by 4 1/2 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 book stack 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 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 pounds per square foot.

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 1607.12.3.

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

Table Notes TABLE 1607*A*.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.*

1607*A*.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.

1607*A*.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*A*.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*A*.7.1.

1607*A*.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*A*.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/m^2). This live load shall not be reduced.

1607*A*.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 in accordance with Section 1607*A*.7.5.

1607*A*.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*A*.7.5 Posting. The maximum weight of vehicles allowed into or on a garage or other structure shall be posted by the owner or the owner's authorized agent in accordance with Section 106.1.

1607*A*.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 for the structural loading conditions set forth in this section.

1607*A*.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*A*.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*A*.8.1.1 Concentrated load. Handrails and guards shall be designed to resist a concentrated load of 200 pounds (0.89 kN) in accordance with Section 4.5.1 of ASCE 7.

1607*A*.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*A*.8.2 Grab bars, shower seats and dressing room bench seats. Grab bars, shower seats and dressing room bench seats 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.*

1607*A*.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*A*.9 Impact loads. The live loads specified in Sections 1607*A*.3 through 1607*A*.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*A*.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*A*.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*A*.9.3 Elements supporting hoists for façade access equipment. In addition to any other applicable live loads, structural elements that support hoists for façade access equipment shall be designed for a live load consisting of the larger of the rated load of the hoist times 2.5 and the stall load of the hoist.

1607*A*.9.4 Lifeline anchorages for façade access equipment. In addition to any other applicable live loads, life-

line anchorages and structural elements that support lifeline anchorages shall be designed for a live load of at least 3,100 pounds (13.8 kN) for each attached lifeline, in every direction that a fall arrest load may be applied.

1607*A*.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*A*.1 are permitted to be reduced in accordance with Section 1607*A*.10.1 or 1607*A*.10.2. Uniform live loads at roofs are permitted to be reduced in accordance with Section 1607*A*.12.2.

1607*A*.10.1 Basic uniform live load reduction. Subject to the limitations of Sections 1607*A*.10.1.1 through 1607*A*.10.1.3 and Table 1607*A*.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:

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right) \qquad \textbf{(Equation 16}\textit{A}\textbf{-23)}$$

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*A*.1).

K_{LL}= Live load element factor (see Table 1607*A*.10.1).

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

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

TABLE 1607*A*.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*A*.10.1.1 One-way slabs. The tributary area, A_T, for use in Equation 16*A*-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.

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 be not less than *L* as calculated in Section 1607*A*.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*A*.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*A*.10.1.

1607*A*.10.2 Alternative uniform live load reduction. As an alternative to Section 1607*A*.10.1 and subject to the limitations of Table 1607*A*.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*A*-24.
4. For one-way slabs, the area, *A*, for use in Equation 16*A*-24 shall not exceed the product of the slab span and a width normal to the span of 0.5 times the slab span.

   $R = 0.08(A - 150)$ **(Equation 16*A*-24)**

   For SI: $R = 0.861(A - 13.94)$

   Such reduction shall not exceed the smallest of:

   1. 40 percent for members supporting one floor.
   2. 60 percent for members supporting two or more floors.
   3. *R* as determined by the following equation:

   $R = 23.1(1 + D/L_o)$ **(Equation 16*A*-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*A*.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*A*.10.

1607*A*.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*A*.1. The live loads acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

1607*A*.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*A*.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*A*.12.2 for reductions in minimum roof live loads and Section 7.5 of ASCE 7 for partial snow loading.

1607*A*.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*A*.12.2.1.

1607*A*.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*A*, 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).

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

where: $12 \le L_r \le 20$

For SI: $L_r = L_o R_1 R_2$

where: $0.58 \le L_r \le 0.96$

L_o = Unreduced roof live load per square foot (m^2) of horizontal projection supported by the member (see Table 1607*A*.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:

$R_1 = 1$ for $A_t \le 200$ square feet (18.58 m^2) **(Equation 16A-27)**

$R_1 = 1.2 - 0.001A_t$ for 200 square feet $< A_t <$ 600 square feet **(Equation 16A-28)**

For SI: $1.2 - 0.011A_t$ for 18.58 square meters $< A_t <$ 55.74 square meters

$R_1 = 0.6$ for $A_t \ge 600$ square feet (55.74 m^2) **(Equation 16A-29)**

where:

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

$R_2 = 1$ for $F \le 4$ **(Equation 16A-30)**

$R_2 = 1.2 - 0.05F$ for $4 < F < 12$ **(Equation 16A-31)**

$R_2 = 0.6$ for $F \ge 12$ **(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.

1607*A*.12.3 Occupiable roofs. Areas of roofs that are occupiable, such as vegetative roofs, 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*A*.10.

1607*A*.12.3.1 Vegetative and landscaped roofs. The weight of all landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil as determined in accordance with ASTM E2397. The uniform design live load in unoccupied landscaped areas on roofs shall be 20 psf (0.958 kN/m^2). The uniform design live load for occupied landscaped areas on roofs shall be determined in accordance with Table 1607*A*.1.

1607*A*.12.4 Awnings and canopies. Awnings and canopies shall be designed for uniform live loads as required in Table 1607*A*.1 as well as for snow loads and wind loads as specified in Sections 1608*A* and 1609*A*.

1607*A*.12.5 Photovoltaic panel systems. Roof structures that provide support for photovoltaic panel systems shall be designed in accordance with Sections 1607*A*.12.5.1 through 1607*A*.12.5.4, as applicable.

1607*A*.12.5.1 Roof live load. Roof surfaces to be covered by solar photovoltaic panels or modules shall be designed for the roof live load, L_r, assuming that the photovoltaic panels or modules are not present. The roof photovoltaic live load in areas covered by solar photovoltaic panels or modules shall be in addition to the panel loading unless the area covered by each solar photovoltaic panel or module is inaccessible. Areas where the clear space between the panels and the rooftop is not more than 24 inches (610 mm) shall be considered inac-

cessible. Roof surfaces not covered by photovoltaic panels shall be designed for the roof live load.

1607*A*.12.5.2 Photovoltaic panels or modules. The structure of a roof that supports solar photovoltaic panels or modules shall be designed to accommodate the full solar photovoltaic panels or modules and ballast dead load, including concentrated loads from support frames in combination with the loads from Section 1607*A*.12.5.1 and other applicable loads. Where applicable, snow drift loads created by the photovoltaic panels or modules shall be included.

1607*A*.12.5.3 Photovoltaic panels or modules installed as an independent structure. Solar photovoltaic panels or modules that are independent structures and do not have accessible/occupied space underneath are not required to accommodate a roof photovoltaic live load, provided the area under the structure is restricted to keep the public away. All other loads and combinations in accordance with Section 1605*A* shall be accommodated.

Solar photovoltaic panels or modules that are designed to be the roof, span to structural supports and have accessible/occupied space underneath shall have the panels or modules and all supporting structures designed to support a roof photovoltaic live load, as defined in Section 1607*A*.12.5.1 in combination with other applicable loads. Solar photovoltaic panels or modules in this application are not permitted to be classified as "not accessible" in accordance with Section 1607*A*.12.5.1.

1607*A*.12.5.4 Ballasted photovoltaic panel systems. Roof structures that provide support for ballasted photovoltaic panel systems shall be designed, or analyzed, in accordance with Section 1604*A*.4; checked in accordance with Section 1604*A*.3.6 for deflections; and checked in accordance with Section 1611*A* for ponding.

1607A.12.6 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/m^2) of the total area encompassed by the framework.*

1607*A*.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*A*.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*A*.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-geared bridge, trolley and hoist. . . . . 0 percent

1607*A*.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*A*.13.4 Longitudinal force. The longitudinal force on crane runway beams, except for bridge cranes with hand-geared 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 and stiffness to resist the loads to which they are subjected but not less than a horizontal load of 5 psf (0.240 kN/m^2). *The 5 psf (0.24 kN/m^2) service 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/m^2) shall not exceed the limits in Table 1604A.3.*

1607*A*.14.1 Fabric partitions. Fabric partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength and stiffness to resist the following load conditions:

1. The horizontal distributed load need only be 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 mm^2)] of the fabric face at a height of 54 inches (1372 mm) above the floor.

SECTION 1608*A*
SNOW LOADS

1608*A*.1 General. Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but t he design roof load shall not be less than that determined by Section 1607*A*.

1608*A*.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*A*.2 for the contiguous United States. Site-specific case studies shall be made in areas designated "CS" in Figure 1608*A*.2. Ground snow loads for sites at elevations above the limits indicated in Figure 1608*A*.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).

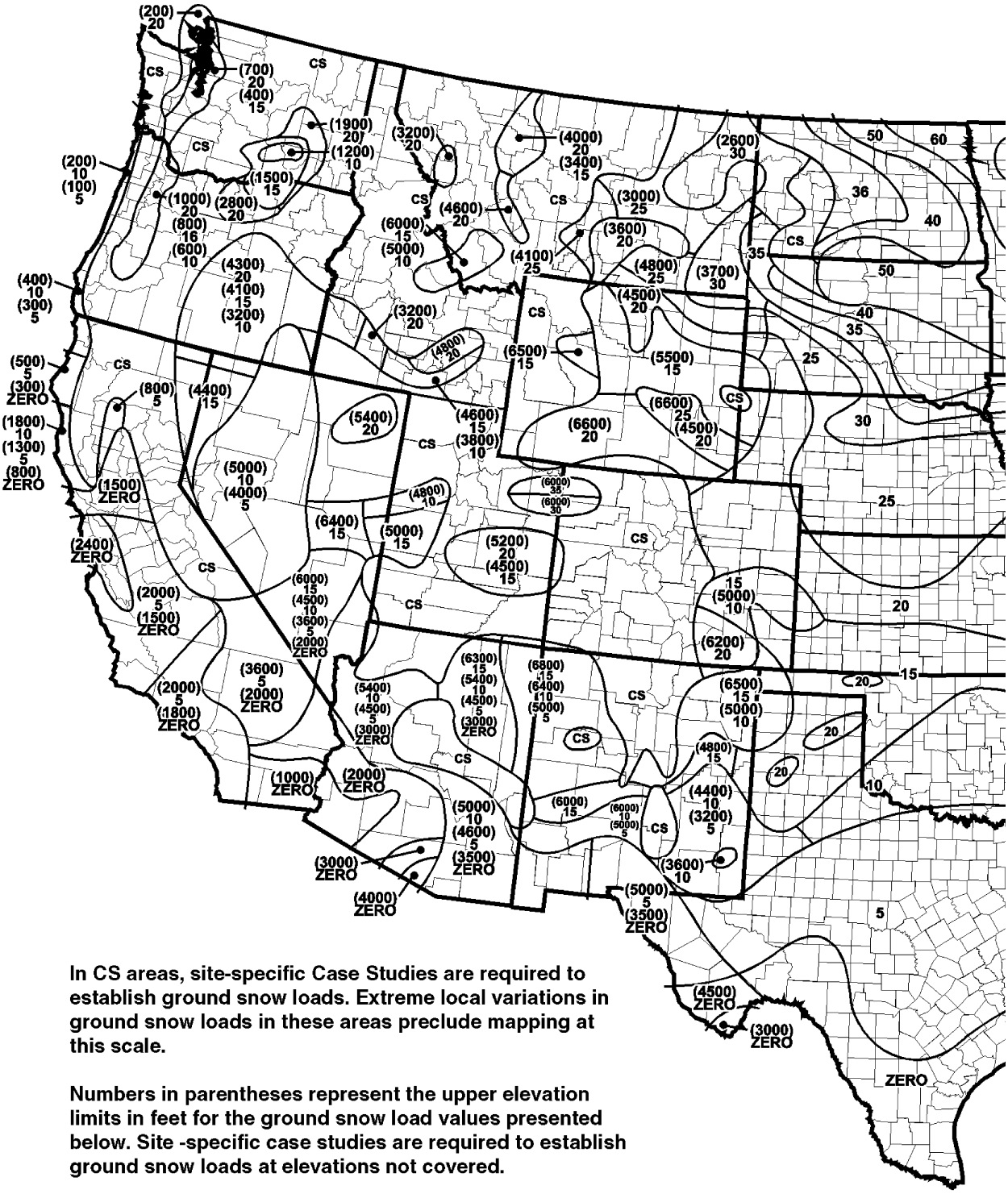


FIGURE 1608*A*.2
GROUND SNOW LOADS, p_g, FOR THE UNITED STATES (psf)

FIGURE 1608*A*.2–continued
GROUND SNOW LOADS, p_g, FOR THE UNITED STATES (psf)

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 1609*A* WIND LOADS

1609*A*.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*A*.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*A*.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*A* 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*A*.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*A*.1.1.1, residential structures using the provisions of AWC WFCM.
3. Subject to the limitations of Section 1609*A*.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 ASCE 49 and Sections 31.4 and 31.5 of ASCE 7.

The wind speeds in Figures 1609*A*.3(1), 1609*A*.3(2) and 1609*A*.3(3) are ultimate design wind speeds, V_{ult}, and shall be converted in accordance with Section 1609*A*.3.1 to nominal design wind speeds, V_{asd}, when the provisions of the standards referenced in Exceptions 4 and 5 are used.

1609*A*.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*A*.4. The provisions of ICC 600, AWC 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*A*.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 E1996 and ASTM E1886 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 E1996.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the small missile test of ASTM E1996.

Exceptions:

1. Wood structural panels with a minimum thickness of $^{7}/_{16}$ inch (11.1 mm) and maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in buildings with a mean roof height of 33 feet (10 058 mm) or less that are classified as a 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*A*.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*A*.3.1 does not exceed 140 mph (63 m/s).
2. Glazing in Risk Category I buildings, 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.

TABLE 1609*A*.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
$^1/_4$-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 $2^1/_2$ 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*A*.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.

1609*A*.1.2.2 Application of ASTM E1996. The text of Section 6.2.2 of ASTM E1996 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} ≤ 160 mph (63 m/s), or 140 mph (54 m/s) ≤ ultimate design wind speed, V_{ult} ≤ 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*A*.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: [DSA-SS] *This story drift limit need not be applied for single-story open buildings in Risk Category I and II.*

Exception: [OSHPD 1 & 4] *This story drift limit need not be applied for single-story open structures.*

1609*A*.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*A*.3 Ultimate design wind speed. The ultimate design wind speed, V_{ult}, in mph, for the determination of the wind loads shall be determined by Figures 1609*A*.3(1), 1609*A*.3(2) and 1609*A*.3(3). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609*A*.3(1). 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 1609*A*.3(2). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609*A*.3(3). 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.

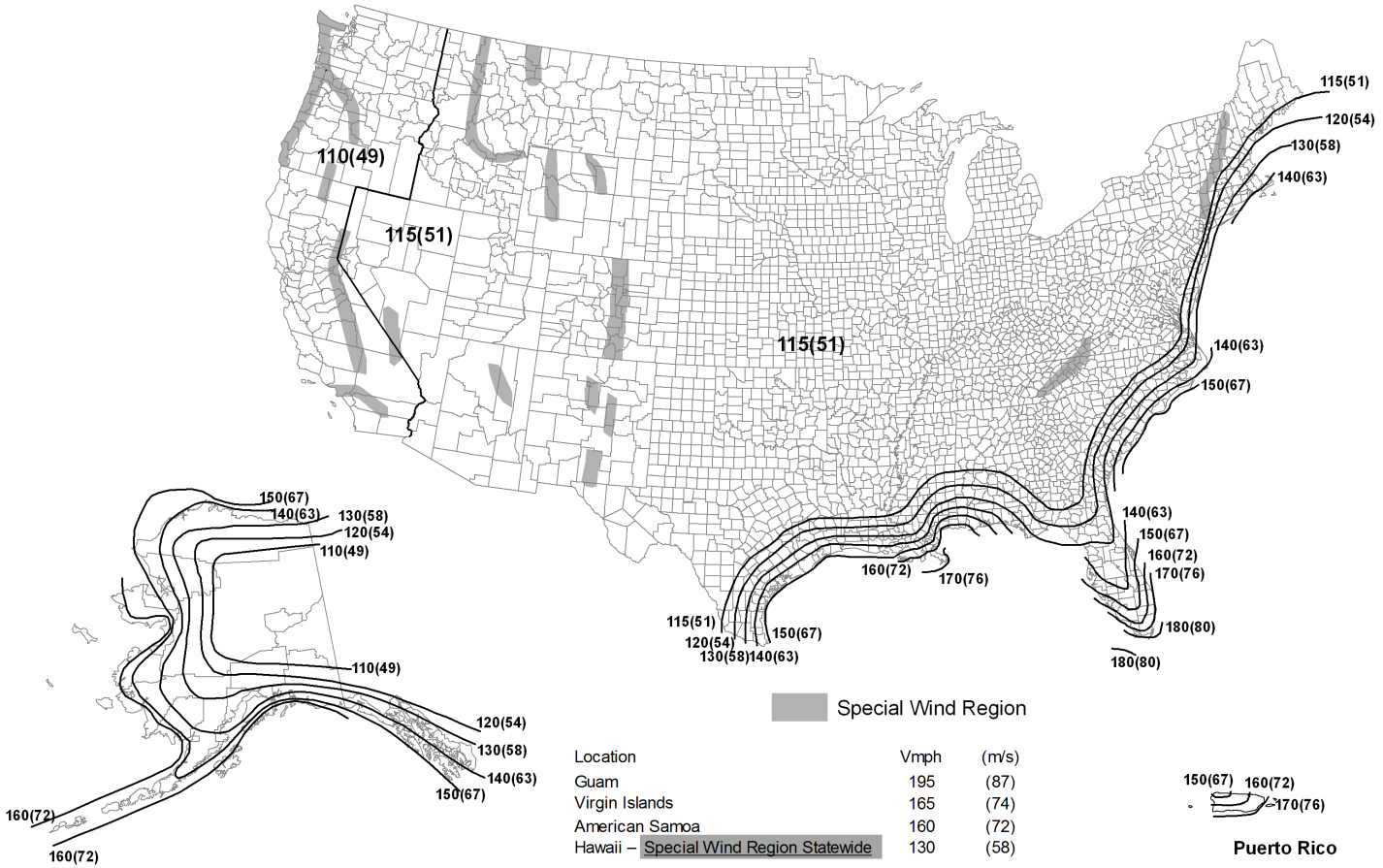
1609*A*.3.1 Wind speed conversion. When required, the ultimate design wind speeds of Figures 1609*A*.3(1), 1609*A*.3(2) and 1609*A*.3(3) shall be converted to nominal design wind speeds, V_{asd}, using Table 1609*A*.3.1 or Equation 16*A*-33.

$$V_{asd} = V_{ult}\sqrt{0.6} \qquad \textbf{(Equation 16A-33)}$$

where:

V_{asd} = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609*A*.1.1.

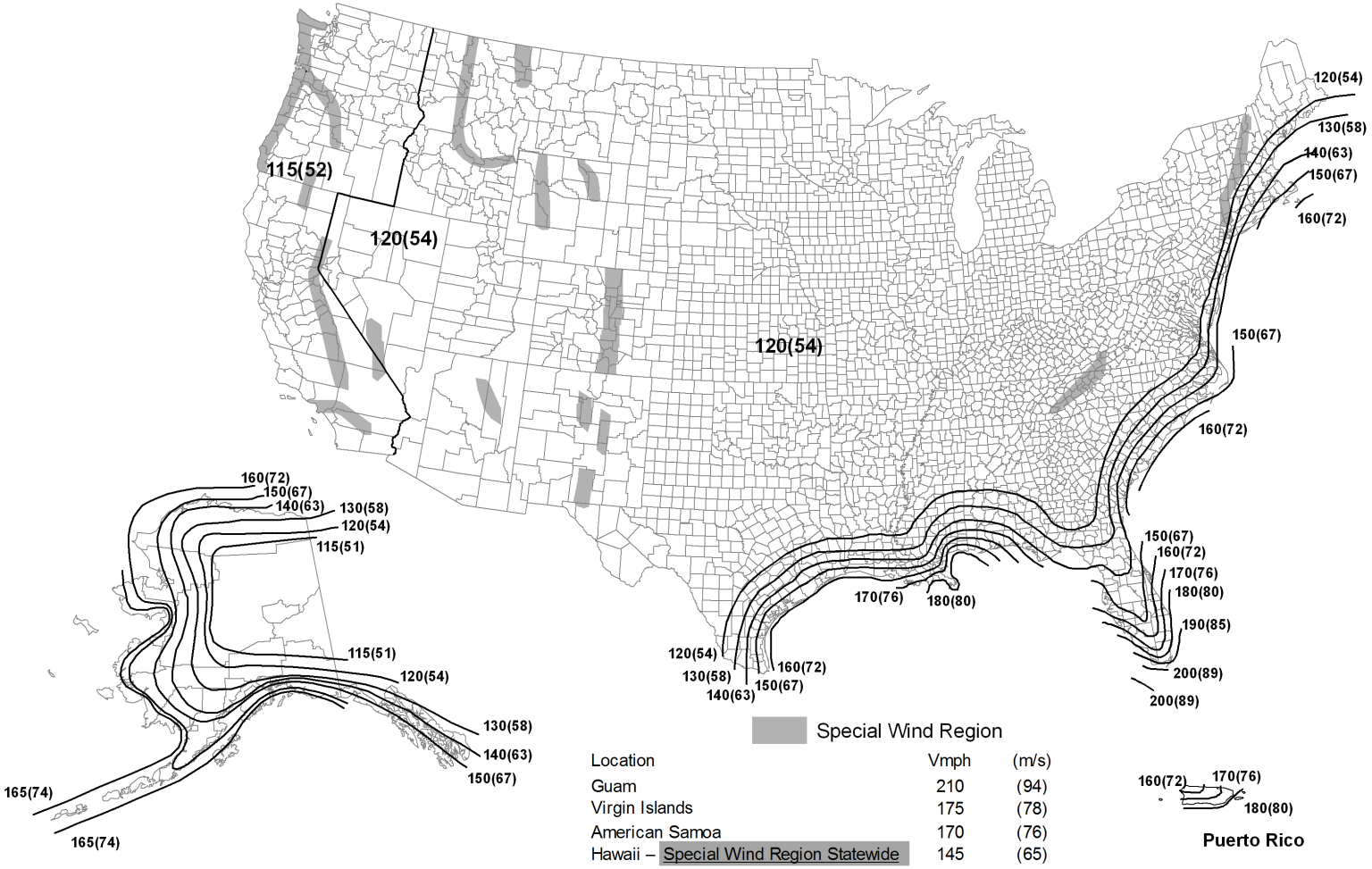
V_{ult} = ultimate design wind speeds determined from Figure 1609A, 1609B or 1609C.



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 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

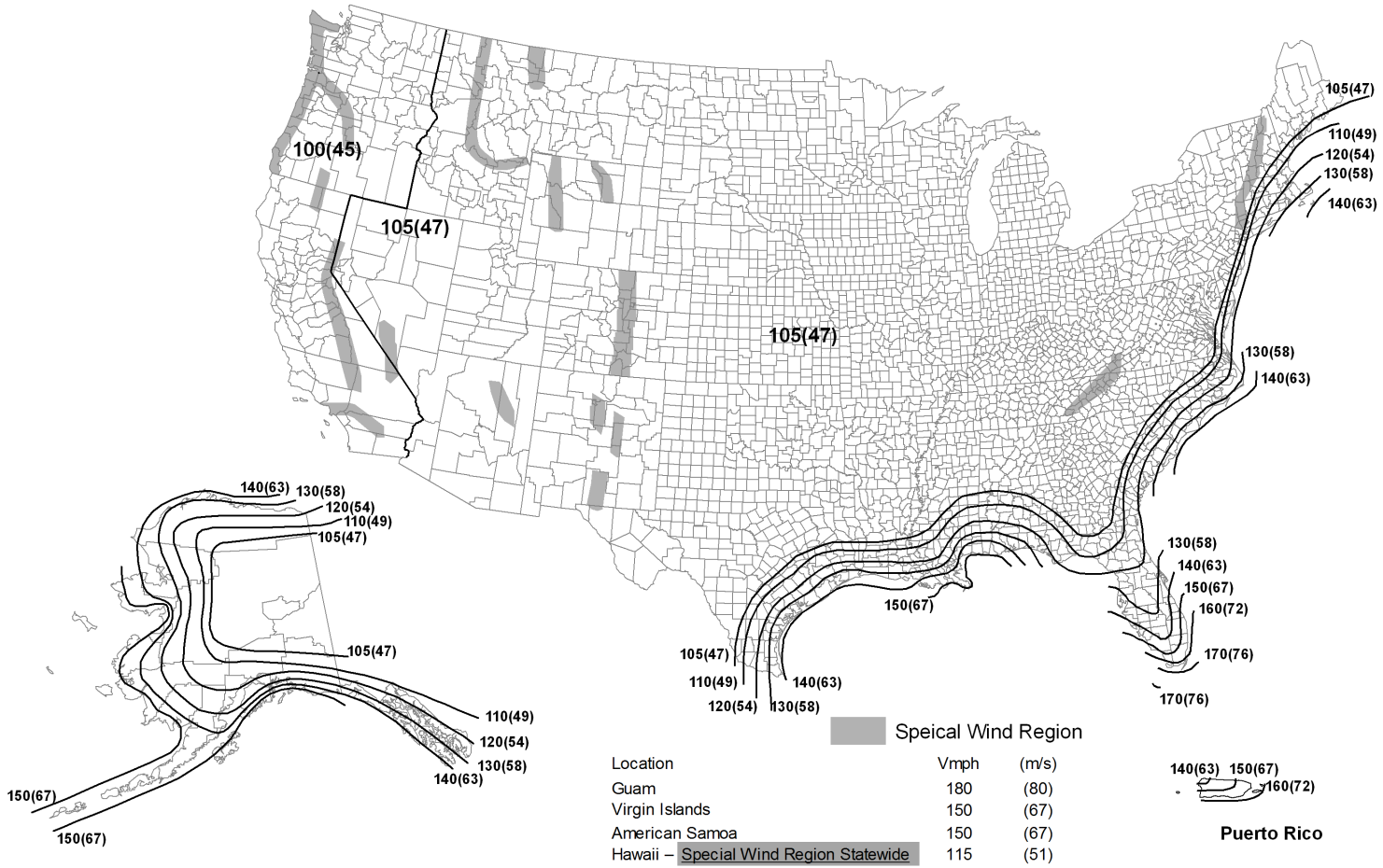
FIGURE 1609*A*.3(1)
ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES



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 1609*A*.3(2)
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 1609*A*.3(3)
ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES

TABLE 1609*A*.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*A*.1.1.

c. V_{ult} = ultimate design wind speeds determined from Figure 1609*A*.3(1), 1609*A*.3(2) or 1609*A*.3(3).

1609*A*.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*A*.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*A*.4.2 and 1609*A*.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1609*A*.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*A*.4.3 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1609*A*.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*A*.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 Exposure B or D does 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*A*.5 Roof systems. Roof systems shall be designed and constructed in accordance with Sections 1609*A*.5.1 through 1609*A*.5.3, as applicable.

1609*A*.5.1 Roof deck. The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609*A*.5.2 Roof coverings. Roof coverings shall comply with Section 1609*A*.5.1.

Exception: Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609*A*.5.1 are permitted to be designed in accordance with Section 1609*A*.5.3.

Asphalt shingles installed over a roof deck complying with Section 1609*A*.5.1 shall comply with the wind-resistance requirements of Section 1504.1.1.

1609*A*.5.3 Rigid tile. Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:

$$M_a = q_h C_L b L L_a [1.0 - GC_p] \qquad \textbf{(Equation 16A-34)}$$

For SI:

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

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 1504.2.1.

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, feet-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 that 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*A*.6 Alternate all-heights method. The alternate wind design provisions in this section are simplifications of the ASCE 7 Directional Procedure.

1609*A*.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, that 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*A*.6.1.1 Modifications. The following modifications shall be made to certain subsections in ASCE 7: in Section 1609*A*.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*A*.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*A*.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/m^2).

1609*A*.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*A*-35.

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

Design wind forces for the MWFRS shall be not 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 be not less than 16 psf (0.77 kN/m^2) acting in either direction normal to the surface.

1609*A*.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*A*-35.

1609*A*.6.4.1 Main wind force-resisting systems. The MWFRS shall be investigated for the torsional effects identified in ASCE 7 Figure 27.4-8.

TABLE 1609*A*.6.2
NET PRESSURE COEFFICIENTS, C_{net} [a, b]

STRUCTURE OR PART THEREOF	DESCRIPTION		C_{net} FACTOR			
			Enclosed		Partially enclosed	
	Walls:		+ Internal pressure	- Internal pressure	+ Internal pressure	- Internal pressure
	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
1. Main windforce-resisting frames and systems	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 1609*A*.6.2—continued
NET PRESSURE COEFFICIENTS, C_{net} [a, b]

STRUCTURE OR PART THEREOF	DESCRIPTION		C_{net} FACTOR	
2. Components and cladding not in areas of discontinuity—roofs and overhangs	**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
3. Components and cladding in areas of discontinuities—roofs and overhangs (continued)	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	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 < 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*A*.6.2—continued
NET PRESSURE COEFFICIENTS, C_{net} [a, b]

STRUCTURE OR PART THEREOF	DESCRIPTION		C_{net} FACTOR	
3. Components and cladding in areas of discontinuities—roofs and overhangs (continued)	**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
4. Components and cladding not in areas of discontinuity—walls and parapets (continued)	Wall Elements: $h \leq 60$ 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 1609*A*.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	-0.92	-1.23
		500 square feet or more	-0.75	-1.06
	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: $h \le 60$ 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
	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
	Negative		-2.45	-2.76

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 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*A*.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.

1609*A*.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*A*.6.2.
2. Where C_{net} has more than one value, the more severe wind load condition shall be used for design.

1609*A*.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*A*.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*A*.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*A*
SOIL LATERAL LOADS

1610*A*.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*A*. 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*A*.4.2 and 1805*A*.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*A*
RAIN LOADS

1611*A*.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*A*.1 or on other rainfall rates determined from approved local weather data.

$$R = 5.2(d_s + d_h) \qquad \textbf{(Equation 16A-36)}$$

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/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*A*.2 Ponding instability. Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Section 8.4 of ASCE 7.

TABLE 1610*A*.1
LATERAL SOIL LOAD

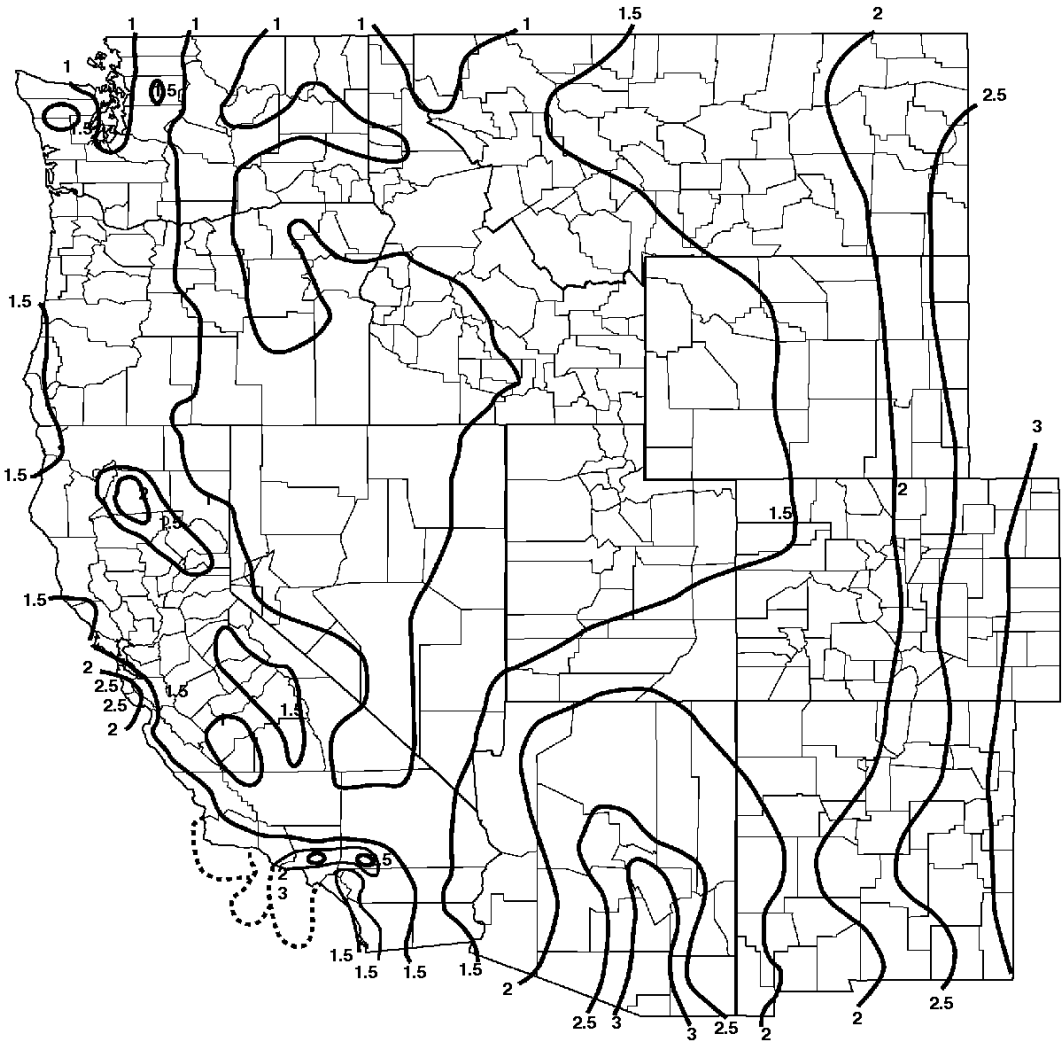
DESCRIPTION OF BACKFILL MATERIAL[c]	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD[a] (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly 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.

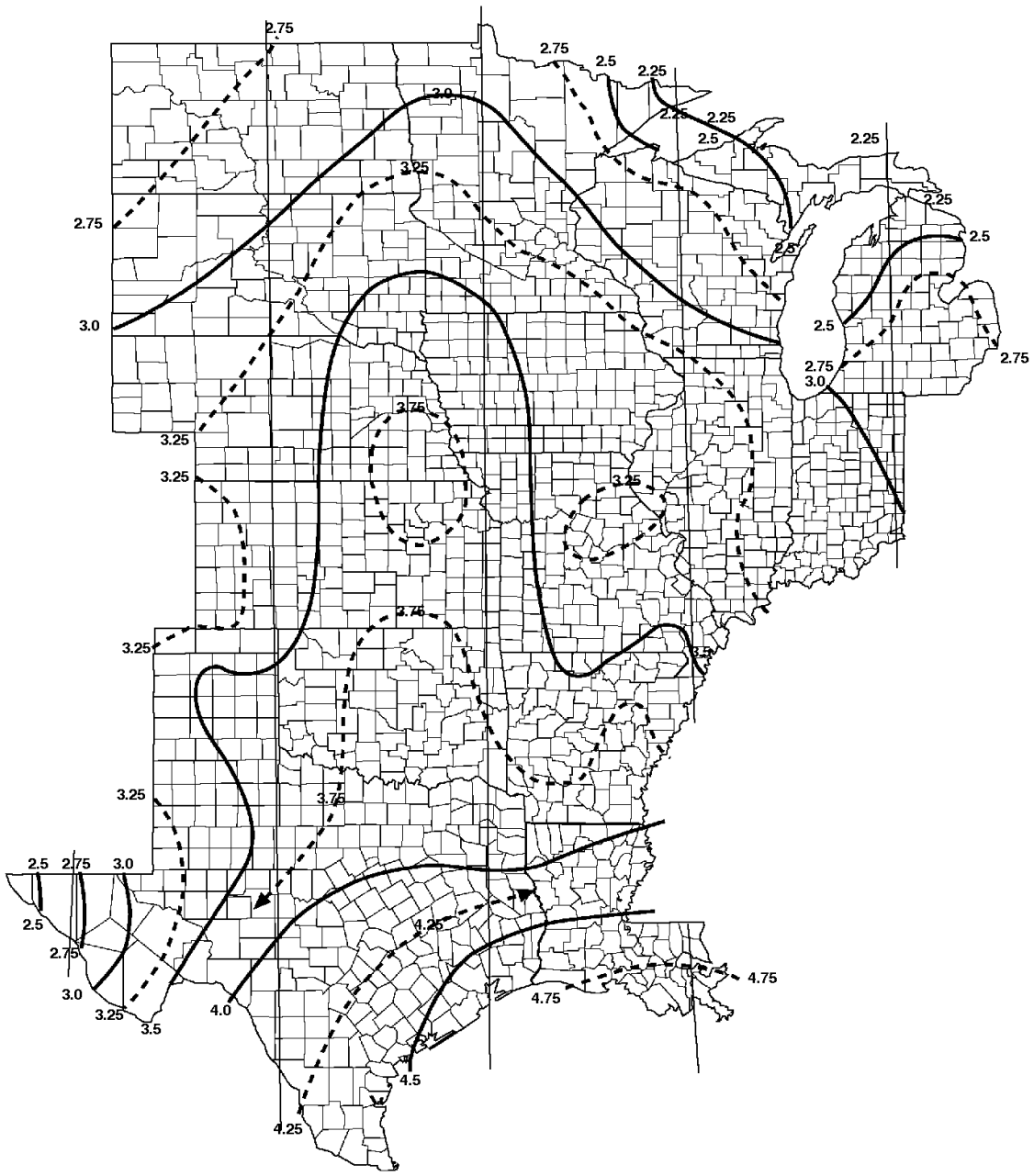
b. Unsuitable as backfill material.

c. The definition and classification of soil materials shall be in accordance with ASTM D2487.



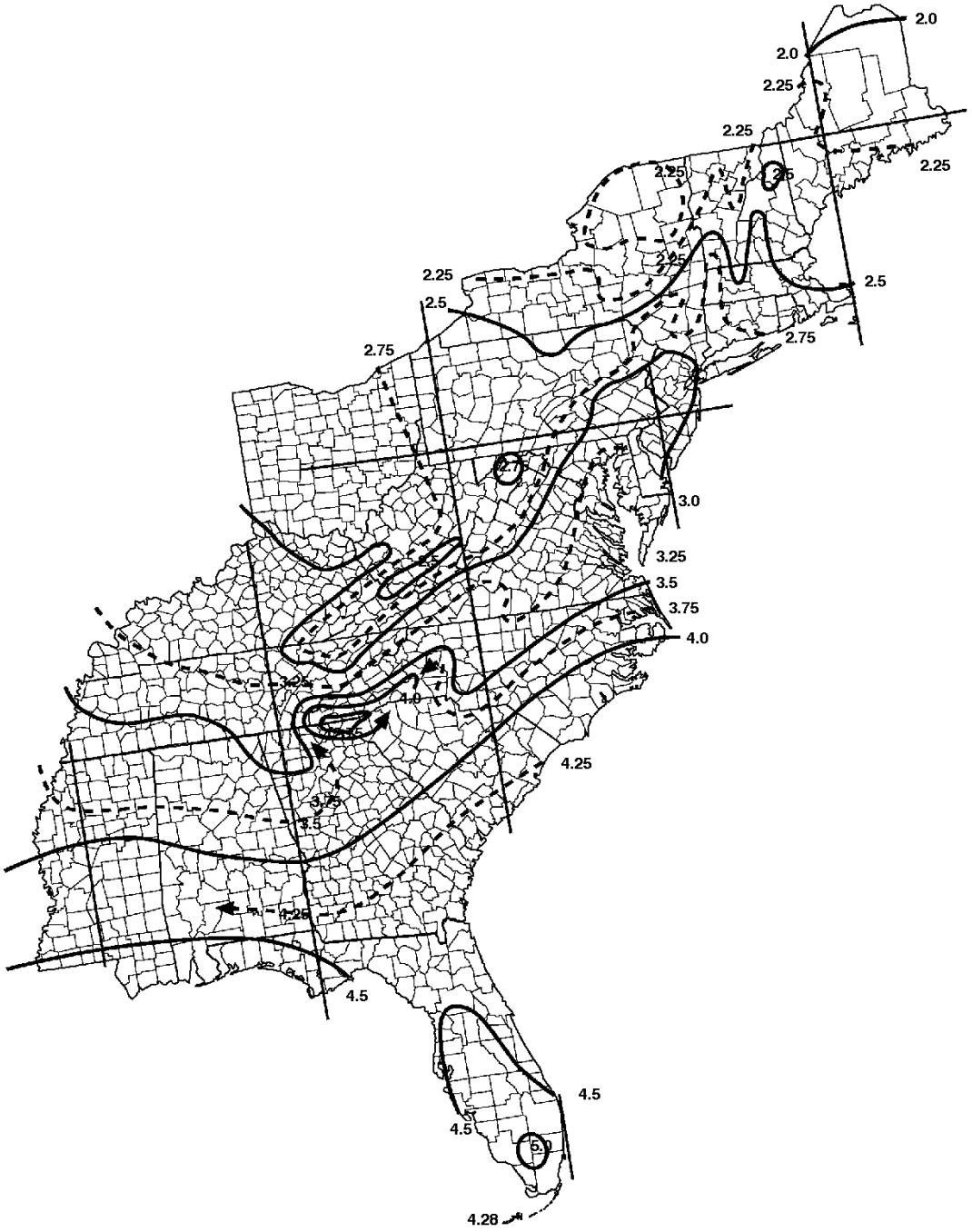
[P] FIGURE 1611*A*.1
100-YEAR, 1-HOUR RAINFALL (INCHES) WESTERN UNITED STATES

For SI: 1 inch = 25.4 mm.
Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611*A*.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) CENTRAL UNITED STATES

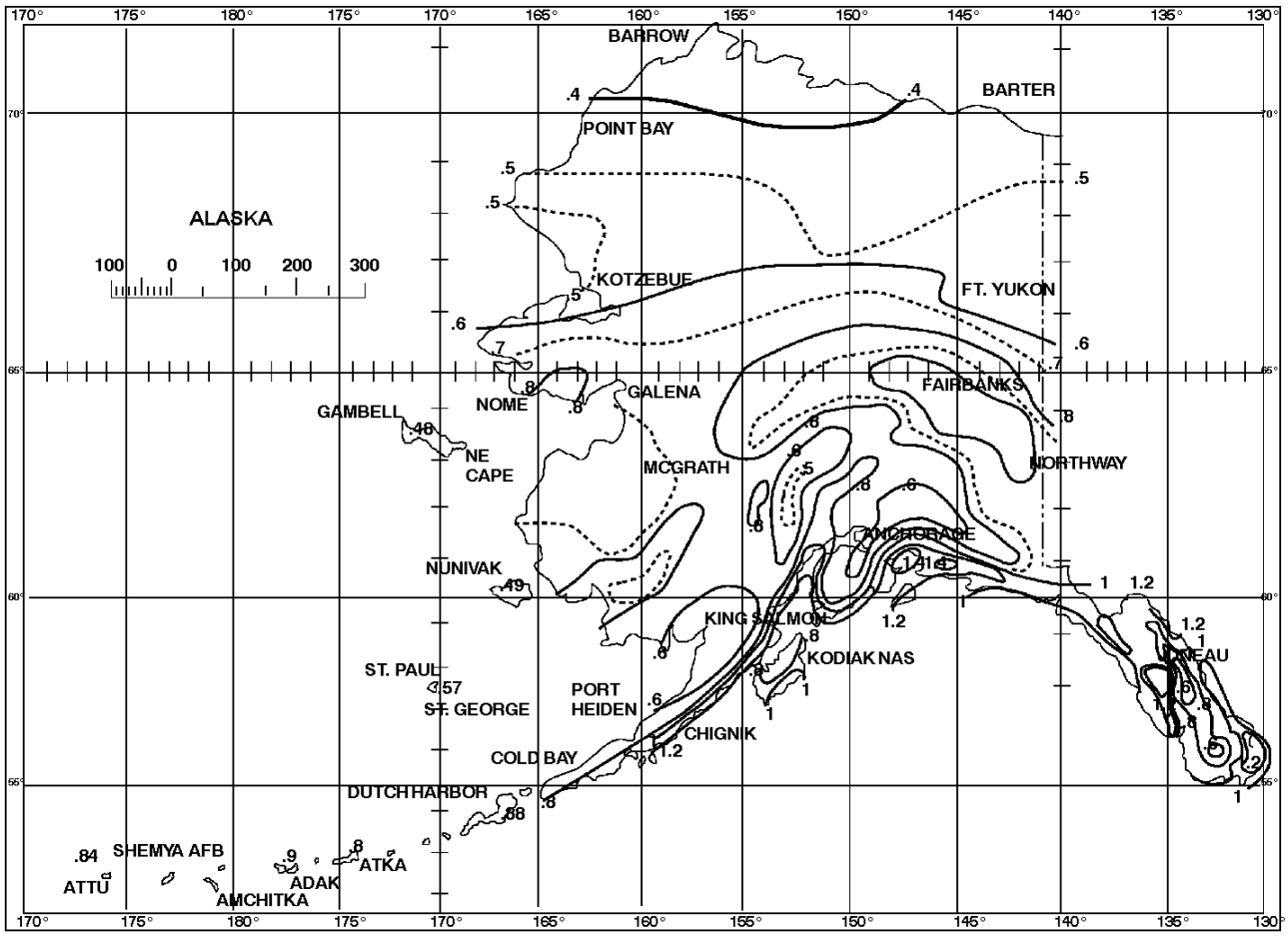
For SI: 1 inch = 25.4 mm.
Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.



[P] FIGURE 1611*A*.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES) EASTERN UNITED STATES

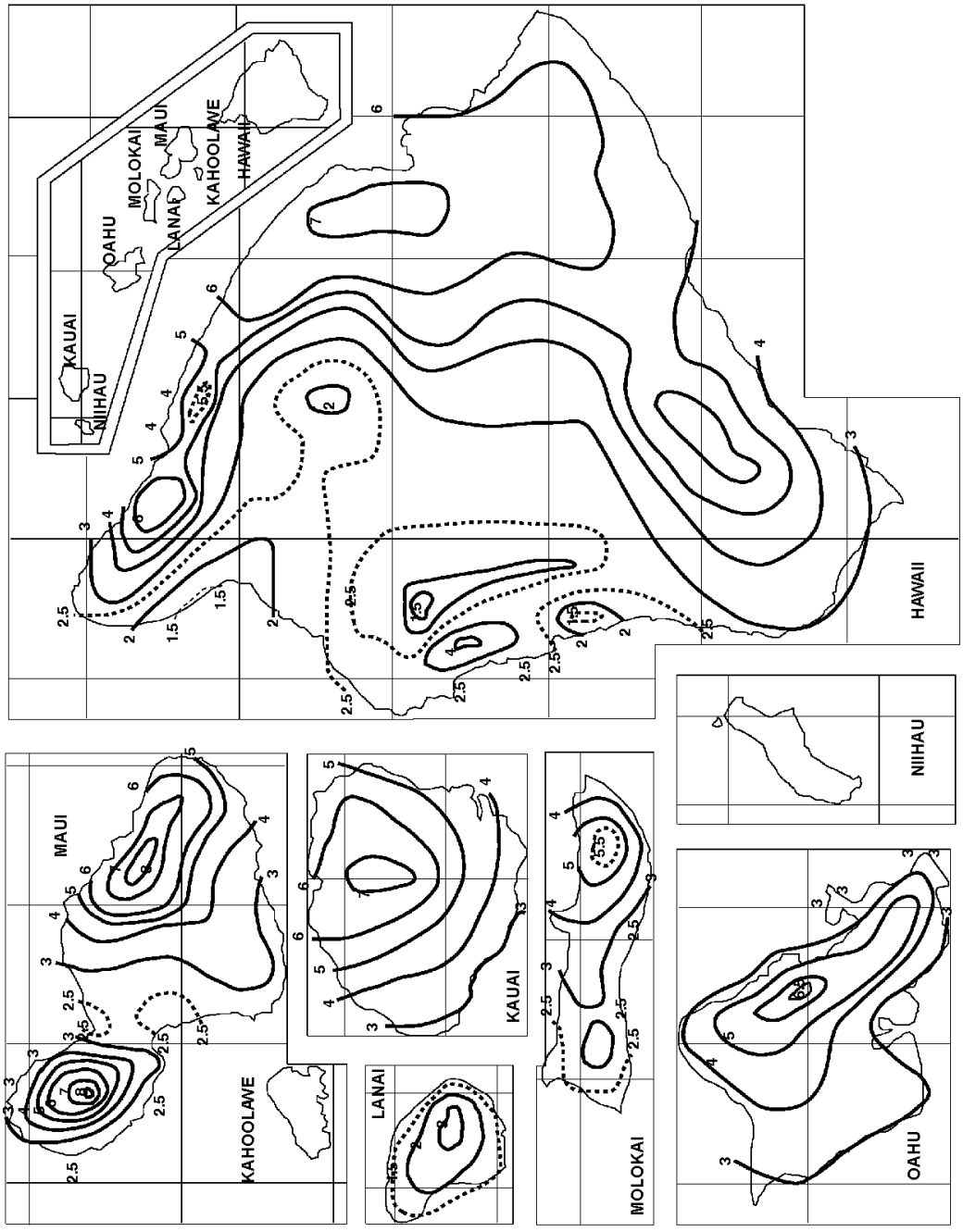
For SI: 1 inch = 25.4 mm.

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



[P] FIGURE 1611*A*.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*A*.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.

1611*A*.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*A*.1. Such roofs shall also be checked for ponding instability in accordance with Section 1611*A*.2.

SECTION 1612*A*
FLOOD LOADS

1612*A*.1 General. Within flood hazard areas as established in Section 1612*A*.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*A*.2 Definitions. The following words and terms are defined in Chapter 2.

BASE FLOOD.

BASE FLOOD ELEVATION.

BASEMENT.

COASTAL A ZONE.

COASTAL HIGH HAZARD AREA.

DESIGN FLOOD.

DESIGN FLOOD ELEVATION.

DRY FLOODPROOFING.

EXISTING CONSTRUCTION.

EXISTING STRUCTURE.

FLOOD or FLOODING.

FLOOD DAMAGE-RESISTANT MATERIALS.

FLOOD HAZARD AREA.

FLOOD INSURANCE RATE MAP (FIRM).

FLOOD INSURANCE STUDY.

FLOODWAY.

LOWEST FLOOR.

SPECIAL FLOOD HAZARD AREA.

START OF CONSTRUCTION.

SUBSTANTIAL DAMAGE.

SUBSTANTIAL IMPROVEMENT.

1612*A*.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.

1612*A*.3.1 Design flood elevations. Where design flood elevations are not included in the flood hazard areas established in Section 1612*A*.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*A*.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*A*.4 Design and construction. The design and construction of buildings and structures located in flood hazard areas, including coastal high hazard areas and coastal A zones, shall be in accordance with Chapter 5 of ASCE 7 and ASCE 24.

1612*A*.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 other than coastal high hazard areas or coastal A zones:
   1.1. The elevation of the lowest floor, including the basement, as required by the lowest floor elevation inspection in Section 110.3.3 and for the final inspection in Section 110.3.10.1.
   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 coastal high hazard areas and coastal A zones:

   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 and for the final inspection in Section 110.3.10.1.

   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/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 1613*A*
EARTHQUAKE LOADS

1613*A*.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 1613*A*.

> **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.

1613*A*.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 ASCE 7 Section 11.2 and* ***[OSHPD 1 & 4]*** *Section 3402A.1 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. *See ASCE 7.*

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.*

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.

1613*A*.3 Seismic ground motion values. Seismic ground motion values shall be determined in accordance with this section.

1613*A*.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(8).

1613*A*.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*A*.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*A*-37 and 16*A*-38, respectively:

$$S_{MS} = F_a S_s \qquad \textbf{(Equation 16}\textit{A}\textbf{-37)}$$

$$S_{M1} = F_v S_1 \qquad \textbf{(Equation 16}\textit{A}\textbf{-38)}$$

where:

F_a = Site coefficient defined in Table 1613*A*.3.3(1).

F_v = Site coefficient defined in Table 1613*A*.3.3(2).

S_S = The mapped spectral accelerations for short periods as determined in Section 1613*A*.3.1.

S_1 = The mapped spectral accelerations for a 1-second period as determined in Section 1613*A*.3.1.

1613*A*.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*A*-39 and 16*A*-40, respectively:

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

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

where:

S_{MS}= The maximum considered earthquake spectral response accelerations for short period as determined in Section 1613*A*.3.3.

S_{M1}= The maximum considered earthquake spectral response accelerations for 1-second period as determined in Section 1613*A*.3.3.

1613*A*.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*.

1613*A*.3.5.1 Alternative seismic design category determination. *Not permitted by DSA-SS and OSHPD.*

1613*A*.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.

1613*A*.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 1613*A*.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 1613*A*.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.

1613*A*.5 Amendments to ASCE 7. The provisions of Section 1613.5 shall be permitted as an amendment to the relevant provisions of ASCE 7.

1613*A*.5.1 Transfer of anchorage forces into diaphragm. Modify ASCE 7 Section 12.11.2.2.1 as follows:

12.11.2.2.1 Transfer of anchorage forces into diaphragm. Diaphragms shall be provided with continuous ties or struts between diaphragm chords to distribute these anchorage forces into the diaphragms. Diaphragm connections shall be positive, mechanical or welded. Added chords are permitted to be used to form subdiaphragms to transmit the anchorage forces to the main continuous cross-ties. The maximum length-to-width ratio of a wood, wood structural panel or untopped steel deck sheathed structural subdiaphragm that serves as part of the continuous tie system shall be 2.5 to 1. Connections and anchorages capable of resisting the prescribed forces shall be provided between the diaphragm and the attached components. Connections shall extend into the diaphragm a sufficient distance to develop the force transferred into the diaphragm.

1613A.6 Ballasted photovoltaic panel systems. Ballasted, roof-mounted photovoltaic panel systems need not be rigidly attached to the roof or supporting structure. Ballasted nonpenetrating systems shall be designed and installed only on roofs with slopes not more than one unit vertical in 12 units horizontal. Ballasted nonpenetrating systems shall be designed to resist sliding and uplift resulting from lateral and vertical forces as required by Section 1605, using a coefficient of friction determined by acceptable engineering principles. In structures assigned to Seismic Design Category D, E or F, ballasted nonpenetrating systems shall be designed to accommodate seismic displacement determined by nonlinear response-history analysis or shake-table testing, using input motions consistent with ASCE 7 lateral and vertical seismic forces for nonstructural components on roofs.

[OSHPD 1 & 4] Ballasted photovoltaic panel systems shall be considered as an alternative system.

SECTION 1614*A*
ATMOSPHERIC ICE LOADS

1614*A*.1 General. Ice-sensitive structures shall be designed for atmospheric ice loads in accordance with Chapter 10 of ASCE 7.

SECTION 1615*A*
STRUCTURAL INTEGRITY

1615*A*.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*A*.3. Bearing wall structures shall comply with the requirements of Section 1615*A*.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.*

1615*A*.3 Frame structures. Frame structures shall comply with the requirements of this section.

1615*A*.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 Section 4.10 of ACI 318. Where ACI 318 requires that nonprestressed 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*A*.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*A*.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*A*.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 $^3/_8$-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*A*.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*A*.4.

1615*A*.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 16.2.4 and 16.2.5 of ACI 318.

1615*A*.4.2 Other bearing wall structures. Ties in bearing wall structures other than those covered in Section 1615*A*.4.1 shall conform to this section.

1615*A*.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*A*-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.

$$T_T = w\,LS \le \alpha_T S \qquad \textbf{(Equation 16A-41)}$$

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.

1615*A*.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*A*-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.

1615*A*.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

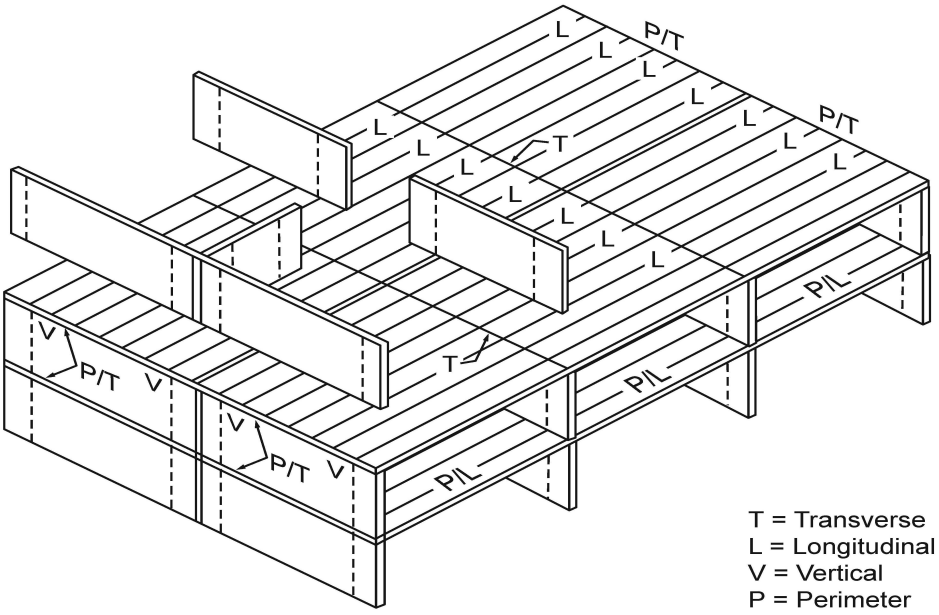


FIGURE 1615*A*.4
LONGITUDINAL, PERIMETER, TRANSVERSE AND VERTICAL TIES

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*A*-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.

$T_p = 200w \le \beta_T$ **(Equation 16*A*-42)**

For SI: $T_p = 90.7w \le \beta_T$

where:

w = As defined in Section 1614*A*.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*A*.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.1.40.*

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 or 18, the ground motion, 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]*** *Structural design criteria including wind tunnel design recommendations are required where design is based on ASCE 7 Chapter 31.*

[DSA-SS] *Peer review requirements in Section 322 of the California Existing Building Code shall apply to design reviews required by ASCE 7 Chapters 17 and 18.*

[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.*
12. *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_{DS} value in determination of C_s and E_v. *The value of C_s and E_v are permitted to be calculated using a value of S_{DS} equal to 1.0, but not less than 70% of S_{DS} as defined in Section 11.4.4, provided that all of the following criteria are met:*

1. The structure does not have irregularities, as defined in Section 12.3.2;

2. The structure does not exceed five stories above the base as defined in Section 11.2;

3. The structure has a fundamental period, T, that does not exceed 0.5 seconds, as determined using Section 12.8.2;

4. The structure meets the requirements necessary for the redundancy factor, ρ, to be permitted to be taken as 1.0, in accordance with Section 12.3.4.2;

5. The site soil properties are not classified as Site Class E or F, as defined in Section 11.4.2; and

6. The structure is classified as Risk Category I or II, as defined in Section 1.5.1.

7. ***[OSHPD 1 & 4]*** *The structure is a nonconforming building not supporting SPC-3 or higher buildings.*

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:*

$$\delta_M = C_d \delta_{max} \qquad \textbf{(Equation 12.12-1)}$$

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 can be delivered to the foundation in a 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 seismic force-resisting 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:*

All nonstructural 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)[1] FOR FREESTANDING SKILLED NURSING AND ACUTE PSYCHIATRIC BUILDINGS

DESCRIPTION	IMPORTANCE FACTOR (I_p)[1]
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, mechanical smoke removal 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 or has a center of mass located 4 feet (1.22 m) or more above the adjacent floor or roof level that directly support the component, 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.13.3 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 Prequalified post-installed anchors and specialty inserts in concrete and masonry.

Post-installed anchors and specialty inserts in concrete that are pre-qualified for seismic applications in accordance with ACI 355.2, ACI 355.4, ICC-ES AC193, ICC-ES AC232, ICC-ES AC308 or ICC-ES AC446 shall be permitted. Post-installed anchors in masonry 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 and shall not be used in building enclosures. Re-use of screw anchors or screw anchor holes shall not be permitted.

Exception: [DSA-SS] *Screw anchors are not prohibited for use in building enclosures.*

1616A.1.20 ASCE 7, Section 13.4.5 *Modify ASCE 7 Section 13.4.5 by adding Section 13.4.5.1 as follows:*

13.4.5.1 Power actuated fasteners. *Power actuated fasteners qualified in accordance with ICC-ES AC 70 shall be deemed to satisfy the requirements of Section 13.4.5.*

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 non-bearing non-shear wall partitions only. Power actuated fastener shall not be used to anchor seismic bracing, exterior cladding or curtain wall systems.

Exception: *Power actuated fasteners in steel to steel connections prequalified for seismic application by cyclic tests in accordance with ICC-ES AC 70 shall be permitted for seismic design.*

1616A.1.21 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/m^2).*

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 E580, 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 C635, ASTM C636, and ASTM E580, Section 5 - Seismic Design Categories D, E, and F as modified by Section 13.5.6.2.2.*

Exception to Section 13.5.8.1 shall not be used in accordance with ASTM E580 Section 5.5.

13.5.6.2.2 Modification to ASTM E580. *Modify ASTM E580 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. Lateral force diagonal bracing may be omitted in the short or transverse direction of exitways, not exceeding 8 feet wide, when perimeter support in accordance with ASTM E580 Sections 5.2.2 and 5.2.3 is provided and the perimeter wall laterally supporting the ceiling in the short or transverse direction is designed to carry the ceiling lateral forces. The connections between the ceiling grid, wall angle and the wall shall be designed to resist the ceiling lateral forces.*
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 $^1/_2$ 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 E580, Sections 5.2.2 and 5.2.3, are provided and perimeter walls are designed to carry the ceiling lateral forces. The connections between the ceiling grid, wall angle and the wall shall be designed to resist the ceiling lateral forces. Horizontal restraint point spacing shall be justified by analysis or test and shall not exceed a spacing of 12 feet by 12 feet. Bracing wires shall be secured with four tight twists in $1^1/_2$ inches, or an approved alternate connection.*
5. *Ceiling support and bracing wires shall be spaced a minimum of 6" from all pipes, ducts, conduits and equipment that are not braced for horizontal forces, unless approved otherwise by the building official.*

1616A.1.22 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.1.23 ASCE 7 Tables 13.5-1 and 13.6-1. *Modify ASCE 7, Tables 13.5-1 & 13.6-1 by the following:*

1. *For components with R_p greater than 1.5, overstrength factor (Ω_0) for design of anchorage to concrete and vibration isolators along with associated snubbers/connections shall be 2.0.*
2. *For Exterior Nonstructural Wall Elements and Connections, overstrength factor (Ω_0) shall be 1.0.*

1616A.1.24 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 $^3/_8$ 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.1.25 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 $^3/_8$ 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 ft^2 (0.557 m^2) or less, or weigh 10 lb/ft (146 N/m) or less.

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 $^3/_8$ 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 1/4	0.20
11	1 1/2	0.30
12	1 3/4	0.40
15	1 31/32	0.50
18 1/2	1 31/32	0.50
22 1/2	2	0.50
30	2 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_R).

1616A.1.35 ASCE 7, Section 17.2.4.7. *Modify ASCE 7, Section 17.2.4.7, by adding the following:*

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

1616A.1.36 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 not be used in Seismic Design Category E & F structures.*

1616A.1.37 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.1.38 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.1.39 Post-earthquake structural verification. [OSHPD 1 & 4] *Modify ASCE 7 by the following:*

> ***Scope:*** *For buildings with welded steel moment frames constructed under a permit issued prior to October 25, 1994 post-earthquake verification shall be in accordance with this section.*
>
> ***Verification:*** *After every seismic event that generates ground motions specified in the California Administrative Code, Chapter 6, Section 4.2.0.1 or the damage indicators specified in the California Administrative Code, Chapter 6, Section 4.2.0.2 at a welded steel moment frame building constructed under a permit issued prior to October 25, 1994, the owner shall retain a structural engineer to perform detailed joint evaluations required to meet the following requirements:*
>
> 1. *A detailed joint evaluation program shall be submitted to the enforcement agency for approval prepared in accordance with the requirements of the California Administrative Code, Chapter 6, Section 4.2.0.3.*
> 2. *Upon approval of the joint evaluation program required by Item 1 above for the joint inspections, a project to perform the joint inspections, detailed in the program, shall be submitted and a building permit shall be obtained by the owner no later than 6 months from the date of occurrence of the seismic event.*
>
>   ***Exception:*** *Where the ground motions at the building site are less than 0.4g, the permit shall be obtained no later than 12 months from the date of occurrence of the seismic event.*
>
> 3. *A detailed joint evaluation report shall be submitted to the enforcement agency no later than 6 months of obtaining the building permit. The report shall document the findings from the inspections of the joints and include conclusions on the adequacy of the structural system. Where unsafe conditions are discovered, the provisions of Section 116 shall apply.*
>
> *Where the detailed joint evaluation report is not submitted within the timeframes specified above, the building shall not be issued a building permit for any projects except for those for seismic compliance, maintenance and repair until the detailed joint evaluation work is complete.*

1616A.1.40 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 ft.) or 500 year flood elevation, whichever is higher, 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 – SPECIAL INSPECTIONS AND TESTS

(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	BSC-CG	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																					
Chapter / Section																					
1703.4											X										
1704.2				X	X						X										
1704.2.3	X																				
1705.5.3											X										
1705.13.3.1											X										
1707.1	X			X	X																

The state agency does not adopt sections identified with 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 17
SPECIAL INSPECTIONS AND TESTS

User note: Code change proposals to sections preceded by the designation [BF] will be considered by the IBC — Fire Safety Code Development Committee during the 2015 (Group A) Code Development Cycle. Sections preceded by the designation [F] will be considered by the International Fire Code Development Committee during the 2016 (Group B) Code Development Cycle. All other code change proposals will be considered by the IBC — Structural Code Development Committee during the Group B cycle. See explanation on page ix.

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.

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.

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 deter-

mine that the agency meets the applicable requirements specified in Sections 1703.1.1 through 1703.1.3.

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 to the building official and the registered design professional in responsible charge possible conflicts of intere0st 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 special 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 Record of approval. 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 available for public review at appropriate times.

1703.4 Performance. Specific information consisting of test reports conducted by an approved 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 product, material or assembly meets the applicable code requirements.

[OSHPD 2] Tests performed by an independent approved testing agency/laboratory having accreditation to the International Standards Organization (ISO) accreditation Standard 17025 or under the responsible charge of a competent approved independent Registered Design Professional shall be deemed to comply with requirements of this section. Test reports for structural tests shall be reviewed and accepted by an independent California licensed structural engineer.

1703.4.1 Research and investigation. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any product, 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 product, material or assembly subject to the requirements of this code. The costs, reports and investigations required under these provisions shall be paid by the owner or the owner's authorized agent.

1703.4.2 Research reports. Supporting data, where necessary to assist in the approval of products, materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

1703.5 Labeling. Products, materials or assemblies 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, material or assembly 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, material or assembly is representative of the product, material or assembly tested.

1703.5.3 Label information. The label shall contain the manufacturer's identification, model number, serial number or definitive information describing the performance characteristics of the product, material or assembly and the approved agency's identification.

1703.5.4 Method of labeling. Information required to be permanently identified on the product, material or assembly 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 owner or the owner's authorized agent 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 owner or the owner's authorized agent 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 special inspection records shall be filed with the building official.

SECTION 1704
SPECIAL INSPECTIONS AND TESTS, CONTRACTOR RESPONSIBILITY AND STRUCTURAL OBSERVATION

1704.1 General. Special inspections and tests, statements of special inspections, responsibilities of contractors, submittals to the building official and structural observations shall meet the applicable requirements of this section.

1704.2 Special inspections and tests. Where application is made to the building official for construction as specified in Sections 105 or 1.8.4, as applicable, the owner or the owner's authorized agent, other than the contractor, shall employ one or more approved agencies to provide special inspections and tests during construction on the types of work specified in Section 1705 and identify the approved agencies to the building official. These special inspections and tests are in addition

to the inspections by the building official that are identified in Section 110.

[OSHPD 2] An inspection agency having accreditation to the International Standards Organization (ISO) accreditation Standard 17020 shall be deemed to comply with the requirements for an approved inspection agency.

Exceptions:

1. Special inspections and tests 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 and tests 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 and tests 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. The contractor is permitted to employ the approved agencies where the contractor is also the owner.
5. ***[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. Prior to the start of the construction, the approved agencies shall provide written documentation to the building official demonstrating the competence and relevant experience or training of the special inspectors who will perform the special inspections and tests during construction. Experience or training shall be considered relevant where the documented experience or training is related in complexity to the same type of special inspection or testing 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 special inspectors 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 or testing is required shall remain accessible and exposed for special inspection or testing purposes until completion of the required special inspections or tests.

1704.2.3 Statement of special inspections. The applicant shall submit a statement of special inspections in accordance with Section 107.1 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. Approved agencies shall keep records of special inspections and tests. The approved agency shall submit reports of special inspections and tests to the building official and to the registered design professional in responsible charge. Reports shall indicate that work inspected or tested 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 tests, and correction of any discrepancies noted in the inspections or tests, shall be submitted at a point in time agreed upon prior to the start of work by the owner or the owner's authorized agent to the building official.

1704.2.5 Special inspection of fabricated items. Where fabrication of structural, load-bearing or lateral load-resisting members or assemblies is being conducted on the premises of a fabricator's shop, special inspections of the fabricated items shall be performed during fabrication.

Exceptions:

1. Special inspections during fabrication are not required where the fabricator maintains approved detailed fabrication and quality control procedures that provide a basis for control of the workmanship and the fabricator's ability to conform to approved construction documents and this code. Approval shall be based upon review of fabrication and quality control procedures and periodic inspection of fabrication practices by the building official.
2. Special inspections are not required where the fabricator is registered and approved in accordance with Section 1704.2.5.1.

1704.2.5.1 Fabricator approval. Special inspections during fabrication 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 agency. At completion of fabrication, the approved fabricator shall submit a certificate of compliance to the owner or the owner's authorized agent for submittal to the building official as specified in Section 1704.5 stating that the work was performed in accordance with the approved construction documents.

1704.3 Statement of special inspections. Where special inspections or tests are 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 inspections or tests 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 inspections or tests for seismic or wind resistance as specified in Sections 1705.11, 1705.12 and 1705.13.
5. For each type of special inspection, identification as to whether it will be continuous special inspection, periodic special inspection or performed in accordance with the notation used in the referenced standard where the inspections are defined.

1704.3.2 Seismic requirements in the statement of special inspections. Where Section 1705.12 or 1705.13 specifies special inspections or tests for seismic resistance, the statement of special inspections shall identify the designated seismic systems and seismic force-resisting systems that are subject to the special inspections or tests.

1704.3.3 Wind requirements in the statement of special inspections. Where Section 1705.11 specifies special inspection for wind resistance, the statement of special inspections shall identify the main windforce-resisting systems and wind-resisting components that are subject to special inspections.

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 force-resisting component listed in the statement of special inspections shall submit a written statement of responsibility to the building official and the owner or the owner's authorized agent 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 inspections.

1704.5 Submittals to the building official. In addition to the submittal of reports of special inspections and tests in accordance with Section 1704.2.4, reports and certificates shall be submitted by the owner or the owner's authorized agent to the building official for each of the following:

1. Certificates of compliance for the fabrication of structural, load-bearing or lateral load-resisting members or assemblies on the premises of a registered and approved fabricator in accordance with Section 1704.2.5.1.
2. Certificates of compliance for the seismic qualification of nonstructural components, supports and attachments in accordance with Section 1705.13.2.
3. Certificates of compliance for designated seismic systems in accordance with Section 1705.13.3.
4. Reports of preconstruction tests for shotcrete in accordance with Section 1908.5.
5. Certificates of compliance for open web steel joists and joist girders in accordance with Section 2207.5.
6. Reports of material properties verifying compliance with the requirements of AWS D1.4 for weldability as specified in Section 26.5.4 of ACI 318 for reinforcing bars in concrete complying with a standard other than ASTM A706 that are to be welded; and
7. Reports of mill tests in accordance with Section 20.2.2.5 of ACI 318 for reinforcing bars complying with ASTM A615 and used to resist earthquake-induced flexural or axial forces in the special moment frames, special structural walls or coupling beams connecting special structural walls of seismic force-resisting systems in structures assigned to Seismic Design Category B, C, D, E or F.

1704.6 Structural observations. Where required by the provisions of Section 1704.6.1 or 1704.6.2, the owner or the owner's authorized agent shall employ a registered design professional to perform structural observations. Structural observation does not include or waive the responsibility for the inspections in Section 110 or the special inspections in Section 1705 or other sections of this code.

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 that, to the best of the structural observer's knowledge, have not been resolved.

1704.6.1 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.
2. The height of the structure is greater than 75 feet (22 860 mm) above the base as defined in ASCE 7.

3. The structure is assigned to Seismic Design Category E, is classified as Risk Category I or II, 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.

1704.6.2 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.
2. The building height 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 SPECIAL INSPECTIONS AND TESTS

1705.1 General. Special inspections and tests of elements and nonstructural components of buildings and structures shall meet the applicable requirements of this section.

1705.1.1 Special cases. Special inspections and tests 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 and nondestructive testing of steel construction in buildings, structures, and portions thereof shall be in accordance with this section.

Exception: Special inspections 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.

1705.2.1 Structural steel. Special inspections and nondestructive testing of structural steel elements in buildings, structures and portions thereof shall be in accordance with the quality assurance inspection requirements of AISC 360.

Exception: Special inspection of railing systems composed of structural steel elements shall be limited to welding inspection of welds at the base of cantilevered rail posts.

1705.2.2 Cold-formed steel deck. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck shall be in accordance with the quality assurance inspection requirements of SDI QA/QC.

1705.2.3 Open-web steel joists and joist girders. Special inspections of open-web steel joists and joist girders in buildings, structures and portions thereof shall be in accordance with Table 1705.2.3.

1705.2.4 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 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 1705.2.3
REQUIRED SPECIAL INSPECTIONS OF OPEN-WEB STEEL JOISTS AND JOIST GIRDERS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD[a]
1. Installation of open-web steel joists and joist girders.			
a. End connections – welding or bolted.	—	X	SJI specifications listed in Section 2207.1.
b. Bridging – horizontal or diagonal.	—		
1. Standard bridging.	—	X	SJI specifications listed in Section 2207.1.
2. Bridging that differs from the SJI specifications listed in Section 2207.1.		X	

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705.12, Special inspections for seismic resistance.

1705.3 Concrete construction. Special inspections and tests of concrete construction shall be performed in accordance with this section and Table 1705.3.

Exception: Special inspections and tests 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.
   2.3. The structural design of the footing is based on a specified compressive strength, f'_c, not more than 2,500 pounds per square inch (psi) (17.2 MPa), regardless of the compressive strength specified in the approved construction documents or used in the footing construction.

TABLE 1705.3
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD[a]	IBC REFERENCE
1. Inspect reinforcement, including prestressing tendons, and verify placement.	—	X	ACI 318 Ch. 20, 25.2, 25.3, 26.5.1-26.5.3	1908.4
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars other than ASTM A706; b. Inspect single-pass fillet welds, maximum $^5/_{16}$″; and c. Inspect all other welds.	— X	X X 	AWS D1.4 ACI 318: 26.5.4	—
3. Inspect anchors cast in concrete.	—	X	ACI 318: 17.8.2	—
4. Inspect anchors post-installed in hardened concrete members.[b] a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. b. Mechanical anchors and adhesive anchors not defined in 4.a.	 X 	 X	 ACI 318: 17.8.2.4 ACI 318: 17.8.2	—
5. Verify use of required design mix.	—	X	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C172 ASTM C31 ACI 318: 26.4.5, 26.12	1908.10
7. Inspect concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 26.4.5	1908.6, 1908.7, 1908.8
8. Verify maintenance of specified curing temperature and techniques.	—	X	ACI 318: 26.4.7-26.4.9	1908.9
9. Inspect prestressed concrete for: a. Application of prestressing forces; and b. Grouting of bonded prestressing tendons.	 X X	 — —	 ACI 318: 26.9.2.1 ACI 318: 26.9.2.3	—
10. Inspect erection of precast concrete members.	—	X	ACI 318: Ch. 26.8	—
11. Verify 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: 26.10.2	—
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 26.10.1(b)	—

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705.12, 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 17.8.2 in ACI 318, 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.

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 Welding of reinforcing bars. Special inspections of welding and qualifications of special inspectors for reinforcing bars shall be in accordance with the requirements of AWS D1.4 for special inspection and of AWS D1.4 for special inspector qualification.

1705.3.2 Material tests. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapters 19 and 20 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapters 19 and 20 of ACI 318.

1705.4 Masonry construction. Special inspections and tests of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6.

Exception: Special inspections and tests shall not be required for:

1. Empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category I, II or III.
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. Special inspections and tests for empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category IV shall be performed in accordance with TMS 402/ACI 530/ASCE 5, Level B Quality Assurance.

1705.4.2 Vertical masonry foundation elements. Special inspections and tests of vertical masonry foundation elements shall be performed in accordance with Section 1705.4.

1705.5 Wood construction. Special inspections 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 construction documents. 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 construction documents.

1705.5.2 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.

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 an approved agency. The approved agency 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 construction documents. Each inspected truss shall be stamped by the approved agency with an identifying mark.*

TABLE 1705.6
REQUIRED SPECIAL INSPECTIONS AND TESTS OF SOILS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
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, inspect subgrade and verify that site has been prepared properly.	—	X

1705.6 Soils. Special inspections and tests of existing site soil conditions, fill placement and load-bearing requirements shall be performed in accordance with 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 verify 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 D1557.

1705.7 Driven deep foundations. Special inspections and tests shall be performed during installation of driven deep foundation elements as specified in Table 1705.7. The approved geotechnical report and the construction documents prepared by the registered design professionals shall be used to determine compliance.

1705.8 Cast-in-place deep foundations. Special inspections and tests shall be performed during installation of cast-in-place deep foundation elements as specified in 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. Continuous special inspections shall be performed 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 Fabricated items. Special inspections of fabricated items shall be performed in accordance with Section 1704.2.5.

1705.11 Special inspections for wind resistance. Special inspections for wind resistance specified in Sections 1705.11.1 through 1705.11.3, 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.

1705.11.1 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

TABLE 1705.7
REQUIRED SPECIAL INSPECTIONS AND TESTS OF DRIVEN DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
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. Inspect 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 special inspections in accordance with Section 1705.2.	—	—
6. For concrete elements and concrete-filled elements, perform tests and additional special 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 SPECIAL INSPECTIONS AND TESTS OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Inspect 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 tests and additional special inspections in accordance with Section 1705.3.	—	—

other fastening of elements of the main windforce-resisting system, including wood shear walls, wood diaphragms, drag struts, braces and hold-downs.

Exception: Special inspections are not required for wood shear walls, shear panels and diaphragms, including nailing, bolting, anchoring and other fastening to other elements of the main windforce-resisting system, where the fastener spacing of the sheathing is more than 4 inches (102 mm) on center.

1705.11.2 Cold-formed steel light-frame construction. Periodic special inspection is required for welding operations of elements of the main windforce-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of elements of the main windforce-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

Exception: Special inspections are not required for cold-formed steel light-frame shear walls and diaphragms, including screwing, bolting, anchoring and other fastening to components of the windforce resisting system, where either of the following applies:

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.).

1705.11.3 Wind-resisting components. Periodic special inspection is required for fastening of the following systems and components:

1. Roof covering, roof deck and roof framing connections.
2. Exterior wall covering and wall connections to roof and floor diaphragms and framing.

1705.12 Special inspections for seismic resistance. Special inspections for seismic resistance shall be required as specified in Sections 1705.12.1 through 1705.12.9, unless exempted by the exceptions of Section 1704.2.

Exception: The special inspections specified in Sections 1705.12.1 through 1705.12.9 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.

1705.12.1 Structural steel. Special inspections for seismic resistance shall be in accordance with Section 1705.12.1.1 or 1705.12.1.2, as applicable.

1705.12.1.1 Seismic force-resisting systems. Special inspections of structural steel in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B, C, D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341.

Exception: Special inspections are not required in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B or C that are not specifically detailed for seismic resistance, with a response modification coefficient, *R*, of 3 or less, excluding cantilever column systems.

1705.12.1.2 Structural steel elements. Special inspections of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B, C, D, E or F other than those covered in Section 1705.12.1.1, including struts, collectors, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341.

Exception: Special inspections of structural steel elements are not required in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B or C with a response modification coefficient, *R*, of 3 or less.

1705.12.2 Structural wood. For the seismic force-resisting systems of structures assigned to Seismic Design Category C, D, E or F:

1. Continuous special inspection shall be required during field gluing operations of elements of the seismic force-resisting system.
2. Periodic special inspection shall be required for nailing, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.

Exception: Special inspections are not required for wood shear walls, shear panels and diaphragms, including nailing, bolting, anchoring and other fastening to other elements of the seismic force-resisting system, where the fastener spacing of the sheathing is more than 4 inches (102 mm) on center.

1705.12.3 Cold-formed steel light-frame construction. For the seismic force-resisting systems of structures assigned to Seismic Design Category C, D, E or F, periodic special inspection shall be required:

1. For welding operations of elements of the seismic force-resisting system; and
2. For screw attachment, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

Exception: Special inspections are not required for cold-formed steel light-frame shear walls and diaphragms, including screw installation, bolting, anchoring and other fastening to components of the seismic force-resisting system, where either of the following applies:

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.

1705.12.4 Designated seismic systems. For structures assigned to Seismic Design Category C, D, E or F, the special inspector shall examine designated seismic systems requiring seismic qualification in accordance with Section 13.2.2 of ASCE 7 and verify that the label, anchorage and mounting conform to the certificate of compliance.

1705.12.5 Architectural components. Periodic special inspection is required for 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.

Exception: *P*eriodic special inspection is not required for the following:

1. 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. Exterior cladding and interior and exterior veneer weighing 5 psf (24.5 N/m^2) or less.
3. Interior nonbearing walls weighing 15 psf (73.5 N/m^2) or less.

1705.12.5.1 Access floors. Periodic special inspection is required for the anchorage of access floors in structures assigned to Seismic Design Category D, E or F.

1705.12.6 Plumbing, mechanical and electrical components. Periodic special inspection of plumbing, mechanical and electrical components shall be required for the following:

1. Anchorage of electrical equipment for emergency and standby power systems in structures assigned to Seismic Design Category C, D, E or F.
2. Anchorage of other electrical equipment in structures assigned to Seismic Design Category E or F.
3. 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. Installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to Seismic Design Category C, D, E or F.
5. Installation and anchorage of vibration isolation systems in structures assigned to Seismic Design Category C, D, E or F where the approved construction documents require a nominal clearance of $^1/_4$ inch (6.4 mm) or less between the equipment support frame and restraint.

1705.12.7 Storage racks. Periodic special inspection is required for the anchorage of storage racks that are 8 feet (2438 mm) or greater in height in structures assigned to Seismic Design Category D, E or F.

1705.12.8 Seismic isolation systems. Periodic special inspection shall be provided for seismic isolation systems in seismically isolated structures assigned to Seismic Design Category B, C, D, E or F during the fabrication and installation of isolator units and energy dissipation devices.

1705.12.9 Cold-formed steel special bolted moment frames. Periodic special inspection shall be provided for the installation of cold-formed steel special bolted moment frames in the seismic force-resisting systems of structures assigned to Seismic Design Category D, E or F.

1705.13 Testing for seismic resistance. Testing for seismic resistance shall be required as specified in Sections 1705.13.1 through 1705.13.4, unless exempted from special inspections by the exceptions of Section 1704.2.

1705.13.1 Structural steel. Nondestructive testing for seismic resistance shall be in accordance with Section 1705.13.1.1 or 1705.13.1.2, as applicable.

1705.13.1.1 Seismic force-resisting systems. Nondestructive testing of structural steel in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B, C, D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341.

Exception: Nondestructive testing is not required in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B or C that are not specifically detailed for seismic resistance, with a response modification coefficient, *R*, of 3 or less, excluding cantilever column systems.

1705.13.1.2 Structural steel elements. Nondestructive testing of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B, C, D, E or F other than those covered in Section 1705.13.1.1, including struts, collectors, chords and foundation elements, shall be

performed in accordance with the quality assurance requirements of AISC 341.

Exception: Nondestructive testing of structural steel elements is not required in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B or C with a response modification coefficient, *R*, of 3 or less.

1705.13.2 Nonstructural components. For structures assigned to Seismic Design Category B, C, D, E or F, where the requirements of Section 13.2.1 of ASCE 7 for nonstructural components, supports or attachments are met by seismic qualification as specified in Item 2 therein, the registered design professional shall specify on the approved construction documents the requirements for seismic qualification by analysis, testing or experience data. Certificates of compliance for the seismic qualification shall be submitted to the building official as specified in Section 1704.5.

1705.13.3 Designated seismic systems. For structures assigned to Seismic Design Category C, D, E or F and with designated seismic systems that are subject to the requirements of Section 13.2.2 of ASCE 7 for certification, the registered design professional shall specify on the approved construction documents the requirements to be met by analysis, testing or experience data as specified therein. Certificates of compliance documenting that the requirements are met shall be submitted to the building official as specified in Section 1704.5.

1705.13.3.1 Special seismic certification. *[OSHPD 2]*

1. *Special seismic certification shall be required for life-safety components, such as emergency and standby power systems, mechanical smoke removal systems, and fire sprinkler/fire protection systems.*
2. *Equipment and components supporting sub-acute bed(s) shall have special seismic certification in accordance with Section 1705A.*

Construction documents for OSHPD 2 buildings without sub-acute beds shall explicitly state that skilled nursing facility or intermediate care facility does not admit patients needing sustained electrical life-support equipment.

1705.13.4 Seismic isolation systems. Seismic isolation systems in seismically isolated structures assigned to Seismic Design Category B, C, D, E or F shall be tested in accordance with Section 17.8 of ASCE 7.

[BF] 1705.14 Sprayed fire-resistant materials. Special inspections and tests of sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be performed in accordance with Sections 1705.14.1 through 1705.14.6. 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 and tests shall be performed after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, where applicable.

[BF] 1705.14.1 Physical and visual tests. The special inspections and tests shall include the following 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.

[BF] 1705.14.2 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 by the special inspector before the application of the sprayed fire-resistant material.

[BF] 1705.14.3 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.

[BF] 1705.14.4 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 1705.14.4.1.

[BF] 1705.14.4.1 Minimum allowable thickness. For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus $^1/_4$ 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 E605. Samples of the sprayed fire-resistant materials shall be selected in accordance with Sections 1705.14.4.2 and 1705.14.4.3.

[BF] 1705.14.4.2 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 E605, 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.

[BF] 1705.14.4.3 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.

[BF] 1705.14.4.4 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.

[BF] 1705.14.4.5 Structural members. The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

[BF] 1705.14.4.6 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.

[BF] 1705.14.4.7 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.

[BF] 1705.14.4.8 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.

[BF] 1705.14.4.9 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.

[BF] 1705.14.5 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 E605. 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.

[BF] 1705.14.6 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 E736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1705.14.6.1 through 1705.14.6.3.

[BF] 1705.14.6.1 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.

[BF] 1705.14.6.2 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.

[BF] 1705.14.6.3 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.

[BF] 1705.15 Mastic and intumescent fire-resistant coatings. Special inspections and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWCI 12-B. Special inspections and tests shall be based on the fire-resistance design as designated in the approved construction documents.

1705.16 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.

1705.16.1 Water-resistive barrier coating. A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating when installed over a sheathing substrate.

[BF] 1705.17 Fire-resistant penetrations and joints. In high-rise buildings or in buildings assigned to Risk Category III or IV, 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, 714.4.2, 715.3 and 715.4 shall be in accordance with Section 1705.17.1 or 1705.17.2.

[BF] 1705.17.1 Penetration firestops. Inspections of penetration firestop systems that are tested and listed in accordance with Sections 714.3.1.2 and 714.4.2 shall be conducted by an approved agency in accordance with ASTM E2174.

[BF] 1705.17.2 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 agency in accordance with ASTM E2393.

[F] 1705.18 Testing for smoke control. Smoke control systems shall be tested by a special inspector.

[F] 1705.18.1 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] 1705.18.2 Qualifications. Approved agencies for smoke control testing 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 Sections 104.11 *or 1.8.7, as applicable*. The cost of all tests and other investigations required under the provisions of this code shall be borne by the owner or the owner's authorized agent.

[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.

SECTION 1708
IN-SITU LOAD TESTS

1708.1 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 1708.2. 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.

1708.2 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.

1708.3 In-situ load tests. In-situ load tests shall be conducted in accordance with Section 1708.3.1 or 1708.3.2 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.

1708.3.1 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 1708.3.2 shall apply.

1708.3.2 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 force-resisting system, at a minimum the test load shall be equal to the specified factored design loads. For materials such as wood that have strengths that are dependent on load duration, the test load shall be adjusted to account for the difference in load duration of the test compared to the expected duration of the design loads being considered. For statically loaded components, the test load shall be left in place for a period of 24 hours. For components that carry dynamic loads (e.g., machine supports or fall arrest anchors), the load shall be left in place for a period consistent with the component's actual function. 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 1709
PRECONSTRUCTION LOAD TESTS

1709.1 General. 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 1709. 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.

1709.2 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 1709.3 shall apply.

1709.3 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 1709.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

1709.3.1 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 1709.3.2 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 1709.3.2, 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 1709.3.2.
2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.

1709.3.2 Deflection. The deflection of structural members under the design load shall not exceed the limitations in Section 1604.3.

1709.4 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.

1709.5 Exterior window and door assemblies. The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1709.5.1 or 1709.5.2. For the purposes of this section, the required design pressure shall be determined using the allowable stress design load combinations of Section 1605.3.

Exception: Structural wind load design pressures for window units smaller than the size tested in accordance with Section 1709.5.1 or 1709.5.2 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.

1709.5.1 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 1709.5.2. 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.

1709.5.2 Exterior windows and door assemblies not provided for in Section 1709.5.1. Exterior window and door assemblies shall be tested in accordance with ASTM E330. Structural performance of garage doors and rolling doors shall be determined in accordance with either ASTM E330 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.

1709.6 Skylights and sloped glazing. Skylights and sloped glazing shall comply with the requirements of Chapter 24.

1709.7 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.

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CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 17*A* – SPECIAL INSPECTIONS AND TESTS

(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	BSC-CG	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																					

The state agency does not adopt sections identified with 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 17*A*
SPECIAL INSPECTIONS AND TESTS

SECTION 1701*A*
GENERAL

1701*A*.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, and 22A, the provisions in Chapters 16, 19, 21 and 22, respectively, shall apply instead.*

1701*A*.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 Special inspections and tests. [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 approved agencies to provide special inspections and tests 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 Section 1704A.

1701A.4 Special inspections and tests. [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 approved agencies to provide special inspections and tests as required by the enforcement agency during construction on the types of work listed under Chapters 17A, 18A, 19A, 20, 21A, 22A, 23, and 25 and the California Existing Building Code and noted in the special test, inspection and observation plan required by Section 4-335 of the California Administrative Code.*

SECTION 1702*A* DEFINITIONS

1702*A*.1 Definitions. 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.*

APPROVED AGENCY.

APPROVED FABRICATOR.

CERTIFICATE OF COMPLIANCE.

DESIGNATED SEISMIC SYSTEM.

FABRICATED ITEM.

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."*

Quality Assurance *(QA). Special inspections and testing provided by an approved agency employed by the Owner. Project specific testing required by approved construction documents shall be performed by the approved agency responsible for Quality Assurance (QA), unless approved otherwise by the building official.*

Quality Control *(QC). Inspections and materials/functionality testing provided by the fabricator, erector, manufacturer or other responsible contractor as applicable.*

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 1703*A* APPROVALS

1703*A*.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 specified in Sections 1703*A*.1.1 through 1703*A*.1.3.

1703*A*.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 to the building official and the registered design professional in responsible charge possible conflicts of interest so that objectivity can be confirmed.

1703*A*.1.2 Equipment. An approved agency shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.

1703*A*.1.3 Personnel. An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and special inspections.

1703*A*.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*A*.3 Record of approval. 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 available for public review at appropriate times.

1703*A*.4 Performance. Specific information consisting of test reports conducted by an approved 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 product, material or assembly meets the applicable code requirements.

[OSHPD 1 & 4] Tests performed by an independent approved testing agency/laboratory having accreditation to the International Standards Organization (ISO) accreditation Standard 17025 or under the responsible charge of a competent approved independent Registered Design Professional shall be deemed to comply with requirements of this section. Test reports for structural tests shall be reviewed and accepted by an independent California licensed structural engineer.

1703*A*.4.1 Research and investigation. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any product, 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 product, material or assembly subject to the requirements of this code. The costs, reports and investigations required under these provisions shall be paid by the owner or the owner's authorized agent.

1703*A*.4.2 Research reports. Supporting data, where necessary to assist in the approval of products, materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

1703*A*.5 Labeling. Products, materials or assemblies required to be labeled shall be labeled in accordance with the procedures set forth in Sections 1703*A*.5.1 through 1703*A*.5.4.

1703*A*.5.1 Testing. An approved agency shall test a representative sample of the product, material or assembly 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*A*.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, material or assembly is representative of the product, material or assembly tested.

1703*A*.5.3 Label information. The label shall contain the manufacturer's identification, model number, serial number or definitive information describing the performance characteristics of the product, material or assembly and the approved agency's identification.

1703*A*.5.4 Method of labeling. Information required to be permanently identified on the product, material or assembly 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*A*.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 owner or the owner's authorized agent 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*A*.6.1 Follow-up inspection. The owner or the owner's authorized agent shall provide for special inspections of fabricated items in accordance with Section 1704*A*.2.5.

1703*A*.6.2 Test and inspection records. Copies of necessary test and special inspection records shall be filed with the building official.

SECTION 1704*A*
SPECIAL INSPECTIONS AND TESTS, CONTRACTOR RESPONSIBILITY AND STRUCTURAL OBSERVATION

1704*A*.1 General. Special inspections and tests, statements of special inspections, responsibilities of contractors, submittals to the building official and structural observations shall meet the applicable requirements of this section.

1704*A*.2 Special inspections and tests. Where application is made to the building official for construction as specified in Section 105, the owner shall employ one or more approved agencies to provide special inspections and tests during construction on the types of work specified in Section 1705*A* and identify the approved agencies to the building official. These special inspections and tests are in addition to the inspections by the building official that are identified in Section 110.

[OSHPD 1 & 4] An inspection agency having accreditation to the International Standards Organization (ISO) accreditation Standard 17020 shall be deemed to comply with the requirements for an approved inspection agency.

The inspectors shall act under the direction of the architect or structural engineer or both, and be responsible to the Owner. Where the California Administrative Code (CAC) Section 7-115 (a) 2 permits construction documents to be prepared under the responsible charge of a mechanical, electrical or civil engineer, inspectors shall be permitted to work under the direction of engineer in appropriate branch as permitted therein.

Exceptions:

1. Special inspections and tests are not required for construction of a minor nature or as warranted by conditions in the jurisdiction as approved by the building official.
2. *[DSA-SS, DSA-SS/CC] Reference to Section 105 and Section 110 shall be to the California Administrative Code instead.*

1704*A*.2.1 Special inspector qualifications. Prior to the start of the construction, the approved agencies shall provide written documentation to the building official demonstrating the competence and relevant experience or training of the special inspectors who will perform the special inspections and tests during construction. Experience or training shall be considered relevant where the documented experience or training is related in complexity to the same type of special inspection or testing 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 special inspectors for the work designed by them, provided they qualify as special inspectors.

1704*A*.2.2 Access for special inspection. The construction or work for which special inspection or testing is required shall remain accessible and exposed for special inspection or testing purposes until completion of the required special inspections or tests.

1704*A*.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 1704*A*.3.

[DSA-SS, DSA-SS/CC] Reference to Section 107.1 shall be to the California Administrative Code instead.

1704*A*.2.4 Report requirement. *The inspector(s) of record and* approved agencies shall keep records of inspections. The *inspector of record and* approved agency 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 tests, and correction of any discrepancies noted in the inspections or tests, shall be submitted at a point in time agreed upon prior to the start of work by the owner or the owner's authorized agent to the building official.

1704*A*.2.5 Special inspection of fabricated items. Where fabrication of structural, load-bearing or lateral load-resisting members or assemblies is being conducted on the premises of a fabricator's shop, special inspections of the fabricated items shall be performed during fabrication.

> **Exception:** ***[OSHPD 1 & 4]*** Special inspections during fabrication are not required where the fabricator maintains approved detailed fabrication and quality control procedures that provide a basis for control of the workmanship and the fabricator's ability to conform to approved construction documents and this code. Approval shall be based upon review of fabrication and quality control procedures and periodic inspection of fabrication practices by the *special inspector and/or* building official, *as determined by the building official.*

1704*A*.3 Statement of special inspections. Where special inspections or tests are required by Section 1705*A*, the registered design professional in responsible charge shall prepare a statement of special inspections in accordance with Section 1704*A*.3.1 for submittal by the applicant in accordance with Section 1704*A*.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*A*.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 inspections or tests 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 inspections or tests for seismic or wind resistance as specified in Sections 1705*A*.11, 1705*A*.12 and 1705*A*.13.
5. For each type of special inspection, identification as to whether it will be continuous special inspection, periodic special inspection or performed in accordance with the notation used in the referenced standard where the inspections are defined.

1704*A*.3.2 Seismic requirements in the statement of special inspections. Where Section 1705*A*.12 or 1705*A*.13 specifies special inspections or tests 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 the special inspections or tests.

1704*A*.3.3 Wind requirements in the statement of special inspections. Where Section 1705*A*.11 specifies special inspection for wind resistance, the statement of special inspections shall identify the main windforce-resisting systems and wind-resisting components that are subject to special inspections.

1704*A*.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 force-resisting component listed in the statement of special inspections shall submit a written statement of responsibility to the building official and the owner or the owner's authorized agent 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 inspections.

1704*A*.5 Submittals to the building official. In addition to the submittal of reports of special inspections and tests in accordance with Section 1704*A*.2.4, reports and certificates shall be submitted by the owner or the owner's authorized agent to the building official for each of the following:

1. ***[OSHPD 1 & 4]*** Certificates of compliance for the fabrication of structural, load-bearing or lateral load-resisting members or assemblies on the premises of *an* approved fabricator in accordance with Section *1704A.2.5*.
2. Certificates of compliance for the *manufacturer's certification* of nonstructural components, supports and attachments in accordance with Section 1705*A*.13.2.

3. Certificates of compliance for *equipment/components requiring special seismic certification* in accordance with Section 1705*A*.13.3.
4. Reports of preconstruction tests for shotcrete in accordance with Section 1908.5.
5. Certificates of compliance for open web steel joists and joist girders in accordance with Section 2207.5.
6. Reports of material properties verifying compliance with the requirements of AWS D1.4 for weldability as specified in Section 26.5.4 of ACI 318 for reinforcing bars in concrete complying with a standard other than ASTM A706 that are to be welded; and
7. Reports of mill tests in accordance with Section 20.2.2.5 of ACI 318 for reinforcing bars complying with ASTM A615 and used to resist earthquake-induced flexural or axial forces in the special moment frames, special structural walls or coupling beams connecting special structural walls of seismic force-resisting systems in structures assigned to Seismic Design Category B, C, D, E or F.

1704*A*.6 Structural observations. The owner shall employ a registered design professional to perform structural observations. Structural observation does not include or waive the responsibility for the inspections in Section 110 or the special inspections in Section 1705*A* or other sections of this code.

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 that, to the best of the structural observer's knowledge, have not been resolved.

[DSA-SS, DSA-SS/CC] Reference to Section 110 shall be to the California Administrative Code instead.

SECTION 1705*A*
REQUIRED SPECIAL INSPECTIONS AND TESTS

1705*A*.1 General. Special inspections and tests of elements and nonstructural components of buildings and structures shall meet the applicable requirements of this section.

1705*A*.1.1 Special cases. Special inspections and tests 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*A*.2 Steel construction. The special inspections and nondestructive testing of steel construction in buildings, structures, and portions thereof shall be in accordance with this section.

Exception: Special inspections 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.

1705*A*.2.1 Structural steel. Special inspections and nondestructive testing of structural steel elements in buildings, structures and portions thereof shall be in accordance with the quality assurance requirements *of this section, Chapter 22A and quality control requirements of AISC 360, AISC 341 and AISC 358.*

Exception: Special inspection of railing systems composed of structural steel elements shall be limited to welding inspection of welds at the base of cantilevered rail posts.

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:

1. *N4., Item 2. (Quality Assurance Inspector Qualifications)*
2. *N5., Item 2. (Quality Assurance)*
3. ***[DSA-SS, DSA-SS/CC]*** *N5., Item 3. (Coordinated Inspection)*
4. ***[DSA-SS, DSA-SS/CC]*** *N5., Item 4. (Inspection of Welding)*
5. ***[DSA-SS, DSA-SS/CC]*** *N7 (Approved Fabricators and Erectors)*
6. ***[DSA-SS, DSA-SS/CC]*** *N8 (Nonconforming Material and Workmanship)*

In addition to the quality assurance inspection requirements contained in AISC 360, Section N5 (Minimum Requirements for Inspection of Structural Steel Buildings), 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 require-

ments of Table 1705A.2.1 of the California Building Code shall apply.

In addition to the quality assurance requirements contained in AISC 341, Chapter J, Section J5 (Inspection Tasks), the requirements of Section 1704A.3 and Table 1705A.2.1 of the California Building Code shall apply.

1705*A*.2.2 Cold-formed steel deck. Special inspections for cold-formed steel floor and roof deck shall be in accordance with the quality assurance inspection requirements of SDI QA/QC.

Deck weld special inspection shall also satisfy requirements in Table 1705A.2.1 and Section 1705A.2.5.

1705*A*.2.3 Open-web steel joists and joist girders. Special inspections of open-web steel joists and joist girders in buildings, structures and portions thereof shall be in accordance with Table 1705*A*.2.3.

1705A.2.3.1 Steel joist and joist girder inspection. *Special inspection is required during the manufacture and welding of steel joists or joist girders. The approved agency 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 approved agency 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.*

1705*A*.2.4 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 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.2.4.1 Light-framed steel truss inspection. *The manufacture of cold-formed light framed steel trusses shall be continuously inspected by an approved agency. The approved agency shall verify conformance of materials and manufacture with approved plans and specifications. The approved agency 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.2.5 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.*

Exception: [OSHPD 1 & 4] *Inspection and nondestructive testing personnel meeting the requirements of AISC 341 Section J4 (in addition to AISC 360 Section N4) shall be permitted to perform quality control and quality assurance inspections at the premises of an approved fabricator's shop.*

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 approved agency shall furnish the architect, structural engineer, and the enforcement agency with a verified report that the welding has been done in conformance with AWS D1.1, D1.3, D1.8, and the approved construction documents.

1705*A*.3 Concrete construction. Special inspections and tests of concrete construction shall be performed in accordance with this section and Table 1705*A*.3.

Exception: Special inspections and tests shall not be required for concrete patios, driveways and sidewalks, on grade.

1705*A*.3.1 Welding of reinforcing bars. Special inspections of welding and qualifications of special inspectors for reinforcing bars shall be in accordance with the requirements of AWS D1.4 for special inspection and of AWS D1.4 for special inspector qualification.

1705*A*.3.2 Material tests. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapters 19 and 20 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapters 19 and 20 of ACI 318.

1705A.3.3 Batch plant inspection. *Except as provided under this section, the quality and quantity of materials used in transit-mixed concrete and in batched aggregates shall be continuously inspected by an approved agency at the location where materials are measured.*

1705A.3.3.1 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 C94, Sections 9 and 10, 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 construction (without basement or retaining wall higher than 6' in height*

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 AWS D1.8	1705A.2.1
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	AWS D1.3	—
b. Reinforcing steel:				
1. Verification of weldability of reinforcing steel other than ASTM A706.	—	X	AWS D1.4, ACI 318: Sections 26.6.4.1, 18.2.8, 25.5.7.4	—
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.2.1
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.12, Special inspections for seismic resistance.

TABLE 1705*A*.2.3
REQUIRED SPECIAL INSPECTIONS OF OPEN-WEB STEEL JOISTS AND JOIST GIRDERS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD[a]
1. Installation of open-web steel joists and joist girders.			
a. End connections – welding or bolted.	—	X	SJI specifications listed in Section 2207.1.
b. Bridging – horizontal or diagonal.	—		
1. Standard bridging.	—	X	SJI specifications listed in Section 2207.1.
2. Bridging that differs from the SJI specifications listed in Section 2207.1.		X	

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705*A*.12, Special inspections for seismic resistance.

measured from bottom of footing to top of wall) and isolated foundations supporting equipment only, where deep foundation elements are not used.

When continuous batch plant inspection is waived, the following requirements shall apply and shall be described in the construction documents:

1. *An approved agency shall check the first batch at the start of the day to verify materials and proportions conform to the approved mix design.*
2. *A licensed weighmaster shall positively identify quantity of materials and certify 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 the truck driver with load identified thereon. The load shall not be placed without a batch ticket identifying the mix. The inspector of record shall keep a daily record of placements, identifying each truck, its load, and time of receipt at the jobsite, and approximate location of deposit in the structure and shall maintain a copy of the daily record as required by the enforcement agency.*

1705A.3.3.2 Batch plant inspection not required. [DSA-SS, DSA-SS/CC] *Batch plant inspection is not required for any of the following conditions, provided they are identified on the approved construction documents and the licensed weighmaster and batch ticket requirements of Section 1705A.3.3.1 are implemented:*

1. *Site flatwork*
2. *Unenclosed site structures, including but not limited to lunch or car shelters, bleachers, solar structures, flag or light poles, or retaining walls.*
3. *Controlled low-strength material backfill.*
4. *Single-story relocatable buildings less than 2,160 square feet.*

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 approved agency 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 approved agency 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.*

TABLE 1705A.3
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD[a]	IBC REFERENCE
1. Inspect reinforcement, including prestressing tendons, and verify placement.	—	X	ACI 318 Ch. 20, 25.2, 25.3, 26.5.1-26.5.3	1908.4
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars other than ASTM A706; b. Inspect single-pass fillet welds, maximum $^5/_{16}$″; and c. Inspect all other welds.	— X	X X	AWS D1.4 ACI 318: 26.5.4	—
3. Inspect anchors cast in concrete.	—	X	ACI 318: 17.8.2	—
4. Inspect anchors post-installed in hardened concrete members.[b, c] a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. b. Mechanical anchors and adhesive anchors not defined in 4.a.	X	 X	 ACI 318: 17.8.2.4 ACI 318: 17.8.2	—
5. Verify use of required design mix.	—	X	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C172 ASTM C31 ACI 318: 26.4.5, 26.12	1908.10
7. Inspect concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 26.4.5	1908.6, 1908.7, 1908.8
8. Verify maintenance of specified curing temperature and techniques.	—	X	ACI 318: 26.4.7-26.4.9	1908.9
9. Inspect prestressed concrete for: a. Application of prestressing forces; and b. Grouting of bonded prestressing tendons.	 X X	 — —	 ACI 318: 26.9.2.1 ACI 318: 26.9.2.3	—
10. Inspect erection of precast concrete members.	—	X	ACI 318: Ch. 26.8	—
11. Verify 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: 26.10.2	—
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 26.10.1(b)	—

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705.12, 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 17.8.2 in ACI 318, 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, except where the factored design tension on the anchors is less than 100 lbs and those anchors are clearly noted on the approved construction documents or where the anchors are shear dowels across cold joints in slabs on grade where the slab is not part of the lateral force-resisting system.

1705*A*.4 Masonry construction. Special inspections and tests of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402/ACI 530/ASCE 5*, as set forth in Table 3.1.3 Level C requirements* and TMS 602/ACI 530.1/ASCE 6. *Special inspection and testing of post-installed anchors in masonry shall be required in accordance with requirements for concrete in Chapters 17A and 19A.*

1705*A*.4.1 Glass unit masonry and masonry veneer in Risk *Categories II, III or* IV. Special inspections and tests for glass unit masonry or masonry veneer designed in accordance with Section 2110*A* or Chapter 14, respectively, where they are part of a structure classified as *Risk Categories II, III or* IV shall be performed in accordance with TMS 402/ACI 530/ASCE 5, Level B Quality Assurance.

1705*A*.4.2 Vertical masonry foundation elements. Special inspections and tests of vertical masonry foundation elements shall be performed in accordance with Section 1705*A*.4.

1705*A*.5 Wood construction. Special inspections of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704*A*.2.5 *except as modified in this section.* Special inspections of site-built assemblies shall be in accordance with this section.

1705*A*.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*A*.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 construction documents. 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 construction documents.

1705*A*.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 construction documents, and applicable standards.*

The approved agency 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 an approved agency.*

The approved agency 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 approved agency with an identification mark.

Exception: *Special Inspection is not required for noncustom members of $5^{1}/_{8}$ inch maximum width and 18 inch maximum depth, and with a maximum clear span 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 an approved agency.*

The approved agency 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 approved agency.

1705A.5.6 Timber connectors. *The installation of all split ring and shear plate timber connectors, and timber rivets shall be continuously inspected by an approved agency. The approved agency shall furnish the architect, structural engineer and the enforcement agency with a report verifying that the materials, timber connectors and workmanship conform to the approved construction documents.*

1705*A*.6 Soils. Special inspections and tests of existing site soil conditions, fill placement and load-bearing requirements shall be performed in accordance with this section and Table 1705*A*.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 verify 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 D1557.

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 lim-

TABLE 1705*A*.6
REQUIRED SPECIAL INSPECTIONS AND TESTS OF SOILS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
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, inspect subgrade and verify that site has been prepared properly.	—	X

ited 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.

1705*A*.7 Driven deep foundations. Special inspections and tests shall be performed during installation of driven deep foundation elements as specified in Table 1705*A*.7. The approved geotechnical report and the construction 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.

1705*A*.8 Cast-in-place deep foundations. Special inspections and tests shall be performed during installation of cast-in-place deep foundation elements as specified in Table 1705*A*.8. The approved geotechnical report and the construction documents prepared by the registered design professionals shall be used to determine compliance.

1705*A*.9 Helical pile foundations. Continuous special inspections shall be performed 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.

TABLE 1705*A*.7
REQUIRED SPECIAL INSPECTIONS AND TESTS OF DRIVEN DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
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. Inspect 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 special inspections in accordance with Section 1705*A*.2.	—	—
6. For concrete elements and concrete-filled elements, perform tests and additional special inspections in accordance with Section 1705*A*.3.	—	—
7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

TABLE 1705*A*.8
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Inspect 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 tests and additional special inspections in accordance with Section 1705*A*.3.	—	—

1705*A*.10 Fabricated items. Special inspections of fabricated items shall be performed in accordance with Section 1704*A*.2.5.

1705*A*.11 Special inspections for wind resistance. Special inspections for wind resistance specified in Sections 1705*A*.11.1 through 1705*A*.11.3, unless exempted by the exceptions to Section 1704*A*.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.

1705*A*.11.1 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 elements of the main windforce-resisting system, including wood shear walls, wood diaphragms, drag struts, braces and hold-downs.

1705*A*.11.2 Cold-formed steel light-frame construction. Periodic special inspection is required for welding operations of elements of the main windforce-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of elements of the main windforce-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

1705*A*.11.3 Wind-resisting components. Periodic special inspection is required for fastening of the following systems and components:

1. Roof covering, roof deck and roof framing connections.
2. Exterior wall covering and wall connections to roof and floor diaphragms and framing.

1705*A*.12 Special inspections for seismic resistance. Special inspections for seismic resistance shall be required as specified in Sections 1705*A*.12.1 through 1705*A*.12.9, unless exempted by the exceptions of Section 1704*A*.2.

1705*A*.12.1 Structural steel. Special inspections for seismic resistance shall be in accordance with Section 1705*A*.12.1.1 or 1705*A*.12.1.2, as applicable.

1705*A*.12.1.1 Seismic force-resisting systems. Special inspections of structural steel in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341 *as modified by Section 1705A.2.1 of this code*.

1705*A*.12.1.2 Structural steel elements. Special inspections of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category D, E or F other than those covered in Section 1705*A*.12.1.1, including struts, collectors, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341 *as modified by Section 1705A.2.1 of this code*.

1705*A*.12.2 Structural wood. For the seismic force-resisting systems of structures assigned to Seismic Design Category D, E or F:

1. Continuous special inspection shall be required during field gluing operations of elements of the seismic force-resisting system.
2. Periodic special inspection shall be required for nailing, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.

1705*A*.12.3 Cold-formed steel light-frame construction. For the seismic force-resisting systems of structures assigned to Seismic Design Category D, E or F, periodic special inspection shall be required:

1. For welding operations of elements of the seismic force-resisting system; and
2. For screw attachment, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

1705*A*.12.4 *Special inspection for special seismic certification*. For structures assigned to Seismic Design Category D, E or F, the special inspector shall examine *equipment and components* requiring *special* seismic *certification* in accordance with *Section 1705A.13.3 or* ASCE 7 Section 13.2.2 and verify that the label, anchorage and mounting conform to the certificate of compliance.

1705*A*.12.5 Architectural components. Periodic special inspection is required for 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.

1705*A*.12.5.1 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*A*.12.6 Plumbing, mechanical and electrical components. Periodic special inspection of plumbing, mechanical and electrical components shall be required for the following:

1. Anchorage of electrical equipment for emergency and standby power systems in structures assigned to Seismic Design Category D, E or F.
2. Anchorage of other electrical equipment in structures assigned to Seismic Design Category E or F.
3. 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. Installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to Seismic Design Category D, E or F.

5. Installation and anchorage of vibration isolation systems in structures assigned to Seismic Design Category D, E or F where the approved construction documents require a nominal clearance of $^1/_4$ inch (6.4 mm) or less between the equipment support frame and restraint.

1705*A*.12.7 Storage racks. Periodic special inspection is required for the anchorage of storage racks that are 8 feet (2438 mm) or greater in height in structures assigned to Seismic Design Category D, E or F.

1705*A*.12.8 Seismic isolation *and damping systems.* Periodic special inspection shall be provided for seismic isolation *and damping* systems in structures assigned to Seismic Design Category D, E or F 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.*

1705*A*.13 Testing for seismic resistance. Testing for seismic resistance shall be required as specified in Sections 1705*A*.13.1 through 1705*A*.13.4, unless exempted from special inspections by the exception of Section 1704*A*.2.

1705*A*.13.1 Structural steel. Nondestructive testing for seismic resistance shall be in accordance with Section 1705*A*.13.1.1 or 1705*A*.13.1.2, as applicable.

1705*A*.13.1.1 Seismic force-resisting systems. Nondestructive testing of structural steel in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341.

1705*A*.13.1.2 Structural steel elements. Nondestructive testing of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category D, E or F other than those covered in Section 1705*A*.13.1.1, including struts, collectors, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341.

1705*A*.13.2 Nonstructural components. For structures assigned to Seismic Design Category D, E or F, where requirements of Section 13.2.1 of ASCE 7 for non-structural components, supports, or attachments are met by *manufacturer's certification* as specified in Item 2 therein, the registered design professional shall specify on the approved construction documents the requirements for seismic *certification* by analysis *or* testing. Certificates of compliance for the *manufacturer's certification* shall be submitted to the building official as specified in Section 1704*A*.5.

Seismic sway braces satisfying requirements of FM 1950 shall be deemed to satisfy the requirements of this section. Component tests shall be supplemented by assembly tests, when required by the building official.

1705*A*.13.3 *Special seismic certification.* For structures assigned to Seismic Design Category D, E or F, *equipment and components* that are subject to the requirements of Section 13.2.2 of ASCE 7 for *special seismic* certification, the registered design professional shall specify on the approved construction documents the requirements to be met by analysis *or* testing as specified therein. Certificates of compliance documenting that the requirements are met shall be submitted to the building official as specified in Section 1704*A*.5.

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 a small unit, 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.*

For a multi-component system, where active or energized components are certified by tests, connecting elements, attachments, and supports can be justified by supporting analysis.

1705A.13.3.1 [OSHPD 1 & 4] *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. *Fluoroscopy and x-ray equipment required for radiological/diagnostic imaging service (for service requirements see CBC Section 1224.18.1), and any fluoroscopy and/or radiographic system provided in support of diagnostic assessment of trauma injuries.*
8. *CT (Computerized Tomography) systems used for diagnostic assessment of trauma injuries.*

   Exception: *CT equipment used for treatment or in hybrid operating rooms, including those used for interventional CT, unless used for diagnostic assessment of trauma injuries.*
9. *Air conditioning units excluding Variable/Constant Air Volume (VAV/CAV) boxes up to 75 lbs.*
10. *Air handling units.*

11. *Chillers, including associated evaporators, and condensers.*
12. *Cooling towers.*
13. *Transformers.*
14. *Electrical substations.*
15. *UPS and batteries.*
16. *Panelboards as defined in the California Electrical Code (CEC) Article 100.*
17. *Industrial control panels as defined in the California Electrical Code (CEC) Article 100.*
18. *Power isolation and correction systems.*
19. *Motorized surgical lighting systems.*
20. *Motorized operating table systems.*
21. *Internal communication servers and routers.*
22. *Medical gas and vacuum systems.*
23. *Electrical busways as defined in UL 857.*
24. *Electrical control panels powered by the life safety branch in accordance with the California Electrical Code (CEC) Article 517.32 or the critical branch in accordance with the California Electrical Code (CEC) Article 517.33.*

Exceptions:

1. *Equipment and components weighing not more than 50 lbs. supported directly on structures or surface mounted on equipment or components that are not required to have special seismic certification by this section.*
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, pumps, and compressors up to 20 hp.*
6. *Electrical controllers, switches, transformers, circuit breakers, and fuses up to 10 lbs. or 10 amperes.*
7. *Components where importance factor, I_p, is permitted to be 1.0 by this code.*
8. *Emergency generators up to 25 kilowatts.*
9. *Equipment and components used for clinical trials only.*

1705A.13.4 **Seismic isolation *and damping* systems.** Seismic isolation *and damping* systems in structures assigned to Seismic Design Category D, E or F shall be tested in accordance with Section 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.

[BF] 1705*A*.14 Sprayed fire-resistant materials. Special inspections and tests of sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be performed in accordance with Sections 1705*A*.14.1 through 1705*A*.14.6. 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 and tests shall be performed after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, where applicable.

[BF] 1705*A*.14.1 Physical and visual tests. The special inspections and tests shall include the following 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.

[BF] 1705*A*.14.2 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 by the special inspector before the application of the sprayed fire-resistant material.

[BF] 1705*A*.14.3 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.

[BF] 1705*A*.14.4 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*A*.14.4.1.

[BF] 1705*A*.14.4.1 Minimum allowable thickness. For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the

design thickness minus $^1/_4$ 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 E605. Samples of the sprayed fire-resistant materials shall be selected in accordance with Sections 1705*A*.14.4.2 and 1705*A*.14.4.3.

[BF] 1705*A*.14.4.2 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 E605, 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.

[BF] 1705*A*.14.4.3 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.

[BF] 1705*A*.14.4.4 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.

[BF] 1705*A*.14.4.5 Structural members. The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

[BF] 1705*A*.14.4.6 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.

[BF] 1705*A*.14.4.7 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.

[BF] 1705*A*.14.4.8 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.

[BF] 1705*A*.14.4.9 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.

[BF] 1705*A*.14.5 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 E605. 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.

[BF] 1705*A*.14.6 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 E736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1705*A*.14.6.1 through 1705*A*.14.6.3.

[BF] 1705*A*.14.6.1 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.

[BF] 1705*A*.14.6.2 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.

[BF] 1705*A*.14.6.3 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.

[BF] 1705*A*.15 Mastic and intumescent fire-resistant coatings. Special inspections and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWCI 12-B. Special inspections and tests shall be based on the fire-resistance design as designated in the approved construction documents.

1705*A*.16 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*A*.16.1 Water-resistive barrier coating. A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating when installed over a sheathing substrate.

[BF] 1705*A*.17 Fire-resistant penetrations and joints. In high-rise buildings or in buildings assigned to Risk Category III or IV, 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, 714.4.2, 715.3 and 715.4 shall be in accordance with Section 1705*A*.17.1 or 1705*A*.17.2.

[BF] 1705*A*.17.1 Penetration firestops. Inspections of penetration firestop systems that are tested and listed in accordance with Sections 714.3.1.2 and 714.4.2 shall be conducted by an approved agency in accordance with ASTM E2174.

[BF] 1705*A*.17.2 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 agency in accordance with ASTM E2393.

[F] 1705*A*.18 Testing for smoke control. Smoke control systems shall be tested by a special inspector.

[F] 1705*A*.18.1 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*A*.18.2 Qualifications. Approved agencies for smoke control testing shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

1705A.19 Shotcrete. *All shotcrete work shall be continuously inspected during placing by an approved agency. The special shotcrete inspector shall check the materials, placing equipment, details of construction and construction procedure. The approved agency 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.19.1 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 1706*A*
DESIGN STRENGTHS OF MATERIALS

1706*A*.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*A*.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*A*.

SECTION 1707*A*
ALTERNATIVE TEST PROCEDURE

1707*A*.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 owner or the owner's authorized agent.

SECTION 1708*A*
IN-SITU LOAD TESTS

1708*A*.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 1708*A*.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.

1708*A*.2 Test standards. Structural components and assemblies shall be tested in accordance with the appropriate refer-

enced 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.

1708*A*.3 In-situ load tests. In-situ load tests shall be conducted in accordance with Section 1708*A*.3.1 or 1708*A*.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.

1708*A*.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 1708*A*.3.2 shall apply.

1708*A*.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 force-resisting system, at a minimum the test load shall be equal to the specified factored design loads. For materials such as wood that have strengths that are dependent on load duration, the test load shall be adjusted to account for the difference in load duration of the test compared to the expected duration of the design loads being considered. For statically loaded components, the test load shall be left in place for a period of 24 hours. For components that carry dynamic loads (e.g., machine supports or fall arrest anchors), the load shall be left in place for a period consistent with the component's actual function. 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 1709*A*
PRECONSTRUCTION LOAD TESTS

1709*A*.1 General. 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 1709*A*. 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.

1709*A*.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 1709*A*.3 shall apply.

1709*A*.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 1709*A*.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

1709*A*.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 1709*A*.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 1709*A*.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 1709*A*.3.2.
2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.

1709*A*.3.2 Deflection. The deflection of structural members under the design load shall not exceed the limitations in Section 1604.3.

1709*A*.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.

1709*A*.5 Exterior window and door assemblies. The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1709*A*.5.1 or 1709*A*.5.2. For the purposes of this section, the required design pressure shall be determined using the allowable stress design load combinations of Section 1605.3.

Exception: Structural wind load design pressures for window units smaller than the size tested in accordance with Section 1709*A*.5.1 or 1709*A*.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.

1709*A*.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 1709.5.2. 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.

1709*A*.5.2 Exterior windows and door assemblies not provided for in Section 1709*A*.5.1. Exterior window and door assemblies shall be tested in accordance with ASTM E330. Structural performance of garage doors and rolling doors shall be determined in accordance with either ASTM E330 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.

1709*A*.6 Skylights and sloped glazing. Skylights and sloped glazing shall comply with the requirements of Chapter 24.

1709*A*.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.

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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	BSC-CG	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										
Adopt only those sections that are listed below																					
Chapter / Section																					
1801.2				X																	
1803.1.1– 1803.1.1.5				X																	
1803.2											X										
1803.6											X										
1803.7											X										
1804.4.1				X																	
1805.4.1				X																	
1805.4.3				X	X																
1810.3.1.5.1											X										
1810.3.10.4.1											X										
1810.3.10.4	X																				

The state agency does not adopt sections identified with 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 18

SOILS AND FOUNDATIONS

User note: Code change proposals to this chapter will be considered by the IBC – Structural Code Development Committee during the 2016 (Group B) Code Development Cycle. See explanation on page ix.

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 D2487.

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 D4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75 μm), determined in accordance with ASTM D422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.
4. Expansion index greater than 20, determined in accordance with ASTM D4829.

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 in the structure of rock upon which foundations are to be constructed, a sufficient number of borings shall be drilled to sufficient depths to assess the competency of the rock and its load-bearing capacity.

1803.5.7 Excavation near foundations. Where excavation will reduce support from any foundation, a registered design professional shall prepare an assessment of the structure as determined from examination of the structure, the review of available design documents and, if necessary, excavation of test pits. The registered design professional shall determine the requirements for underpinning and protection and prepare site-specific plans, details and sequence of work for submission. Such support shall be provided by underpinning, sheeting and bracing, or by other means acceptable to the building official.

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 one of the following:
    2.1. A site-specific study in accordance with Section 21.5 of ASCE 7.
    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, the following:
    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.
    3.7. Flotation of buried structures.
4. Discussion of mitigation measures such as, but not limited to, the following:
    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.
    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 permit applicant 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 reduce lateral support from any foundation or adjacent foundation without first underpinning or protecting the foundation against detrimental lateral or vertical movement, or both.

1804.2 Underpinning. Where underpinning is chosen to provide the protection or support of adjacent structures, the underpinning system shall be designed and installed in accordance with provisions of this chapter and Chapter 33.

1804.2.1 Underpinning sequencing. Underpinning shall be installed in a sequential manner that protects the neighboring structure and the working construction site. The sequence of installation shall be identified in the approved construction documents.

1804.3 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.

1804.4 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.

1804.4.1 [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.*

1804.5 Grading and fill in flood hazard areas. In flood hazard areas established in Section 1612.3, grading, fill, or both, 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 coastal high hazard areas, 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.

1804.6 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 D1557. The compaction shall be verified by special inspection in accordance with Section 1705.6.

1804.7 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
DAMPPROOFING 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 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 Dampproofing. 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 AWC 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, $^1/_8$ inch (3.2 mm) coat of surface-bonding mortar complying with ASTM C887, any of the materials permitted 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 $^3/_8$ 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 Sec-

tion 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 ground-water 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

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.

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 $^1/_2$-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 AWC 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 2303.1.9.1.

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:

1. The thickness shall comply with the requirements of Table 1807.1.6.2.
2. The size and spacing of vertical reinforcement shown in Table 1807.1.6.2 are 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.
3. 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 the bar diameter, d_b, [$d = t - (1.25 + d_b / 2)$]. The reinforcement shall be placed within a tolerance of $\pm\ ^3/_8$ inch (9.5 mm) where d is less than or equal to 8 inches (203 mm) or $\pm\ ^1/_2$ 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 $^3/_4$

inch (19.1 mm). Concrete cover for reinforcement measured from the outside face of the wall shall not be less than $1^1/_2$ 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 1905.1.7.

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

TABLE 1807.1.6.2
CONCRETE FOUNDATION WALLS[b, c]

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[e] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)								
		Design lateral soil load[a] (psf per foot of depth)								
		30[d]			45[d]			60		
		Minimum wall thickness (inches)								
		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.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.2.

c. "PC" means plain concrete.

d. 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).

e. For height of unbalanced backfill, see Section 1807.1.2.

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.11, of the specified location.

4. Grout shall comply with Section 2103.3.
5. Concrete masonry units shall comply with ASTM C90.
6. Clay masonry units shall comply with ASTM C652 for hollow brick, except compliance with ASTM C62 or ASTM C216 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 2103.2.1.
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 2104.1. 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.

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 7.4.3 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 7.4.4 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 requirements of Section 7.4.5 of TMS 402/ACI 530/ASCE 5.

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[f]	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).

TABLE 1807.1.6.3(2)
8-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE d ≥ 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[e]	45[e]	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 ≥ 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[a] (psf per foot of depth)		
		30[e]	45[e]	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 ≥ 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[e]	45[e]	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[c]	#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[c]	#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[c]	#6 at 72	#7 at 72	#8 at 72
	10-0[c]	#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.

1807.2 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 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.

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 materi-

als 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.

$$d = 0.5A\{1 + [1 + (4.36h/A)]^{1/2}\} \quad \textbf{(Equation 18-1)}$$

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.

$$d = \sqrt{\frac{4.25Ph}{S_3 b}} \quad \textbf{(Equation 18-2)}$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3 b}} \quad \textbf{(Equation 18-3)}$$

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.

1808.3.2 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 the surcharge. Existing footings or foundations that will be affected by any excavation shall be underpinned or otherwise protected against settlement and shall be protected against detrimental lateral or vertical movement or both.

Exception: Minor grading for landscaping purposes shall be permitted where done with walk-behind equipment, where the grade is not increased more than 1 foot

(305 mm) from original design grade or where approved by the building official.

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.
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 DC 10.5*. 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 DC 10.5*. 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.

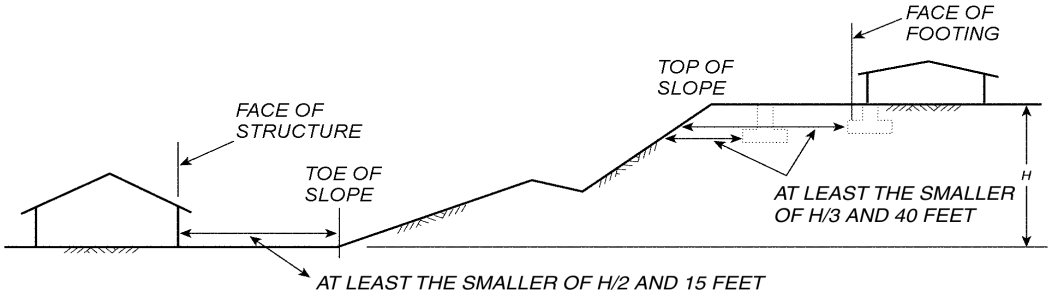
Exception: Where concrete footings supporting walls of light-frame construction are designed in accordance with Table 1809.7, a specific design in accordance with Chapter 19 is not required.

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 $1^1/_2$ 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 20.8.1.3.4 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.

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.



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 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.

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 Section 26.10 of ACI 318.

1808.8.6 Seismic requirements. See Section 1905 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 Section 18.13 of ACI 318 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 Section 18.13 of ACI 318.
2. Section 18.13.4.3(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.
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.
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.
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 Sections 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 2103.2.1 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 $1^1/_2$ 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 $3^5/_8$ 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.

     Exception: Unfilled hollow piers shall be permitted where the unsupported height of the pier is not more than four times its least dimension.
   - 3.3. 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.
4. 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.
5. 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 elements 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.

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_{DS}, 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 18.7.5.2, 18.7.5.3 and 18.7.5.4 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. Group effects shall be evaluated using a generally accepted method of analysis; the analysis for uplift of grouped elements with center-to-center spacing less than three times the least horizontal dimension of an element shall be evaluated in accordance with Section 1810.3.3.1.6.

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 $^{1}/_{16}$" 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 $^{3}/_{4}$ 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 (25.8.3.3). Where this chapter requires detailing of concrete deep foundation elements in accordance with Section 18.7.5.4 of ACI 318, compliance with Equation (25.8.3.3) of ACI 318 shall not be required.

1810.3.2.2 Prestressing steel. Prestressing steel shall conform to ASTM A416.

1810.3.2.3 Steel. Structural steel H-piles and structural steel sheet piling shall conform to the material requirements in ASTM A6. Steel pipe piles shall conform to the material requirements in ASTM A252. Fully welded steel piles shall be fabricated from plates that conform to the material requirements in ASTM A36, ASTM A283, ASTM A572, ASTM A588 or ASTM A690.

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 D25. 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 AWPA 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 cut-offs shall be treated in accordance with AWPA M4.

1810.3.2.5 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.

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. 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. 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 AWC 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 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 the following:

1. A geotechnical investigation in accordance with Section 1803.
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 D1143 or ASTM D4945. 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-percent 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 D3689. 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 D3689, 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 a generally accepted method of analysis. Where the deep foundation elements in the group are placed at a center-to-center spacing less than three 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 allowable working uplift 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:

$$P_a = 0.5\ P_u \qquad \textbf{(Equation 18-4)}$$

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 Structural steel H-piles. Sections of structural steel H-piles shall comply with the requirements for HP shapes in ASTM A6, or 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 $^3/_8$ inch (9.5 mm).

1810.3.5.3.2 Fully welded steel piles fabricated from plates. Sections of fully welded steel piles fabricated from plates 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 $^3/_8$ inch (9.5 mm).

1810.3.5.3.3 Structural steel sheet piling. Individual sections of structural steel sheet piling shall conform to the profile indicated by the manufacturer, and shall conform to the general requirements specified by ASTM A6.

1810.3.5.3.4 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 $^3/_{16}$ 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 $^3/_8$ 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 $^1/_{10}$ inch (2.5 mm).

1810.3.5.3.5 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.
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 $^1/_4$ inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).

1810.3.8.2 Precast nonprestressed piles. Precast nonprestressed 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 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 $^3/_8$ 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.

$$\rho_s = 0.12 f'_c / f_{yh} \qquad \textbf{(Equation 18-5)}$$

where:

f'_c = Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement ≤ 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:

$$\rho_s = 0.25(f'_c / f_{yh})(A_g / A_{ch} - 1.0)\,[0.5 + 1.4P/(f'_c A_g)] \quad \textbf{(Equation 18-6)}$$

but not less than

$$\rho_s = 0.12(f'_c / f_{yh})\,[0.5 + 1.4P/(f'_c A_g)] \geq 0.12 f'_c / f_{yh} \quad \textbf{(Equation 18-7)}$$

and need not exceed:

$$\rho_s = 0.021 \quad \textbf{(Equation 18-8)}$$

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 ≤ 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:

$$A_{sh} = 0.3s\,h_c\,(f'_c / f_{yh})(A_g / A_{ch} - 1.0)\,[0.5 + 1.4P/(f'_c A_g)] \quad \textbf{(Equation 18-9)}$$

but not less than:

$$A_{sh} = 0.12s\,h_c\,(f'_c / f_{yh})\,[0.5 + 1.4P/(f'_c A_g)] \quad \textbf{(Equation 18-10)}$$

where:

f_{yh} = yield strength of transverse reinforcement ≤ 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 tranverse 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:

$$\phi M_n = 3\sqrt{f'_c}\,S_m \quad \textbf{(Equation 18-11)}$$

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. 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.

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 $^{3}/_{8}$ 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 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 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 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.

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 A615 Grade 60 or 75 or ASTM A722 Grade 150.

The steel pipe or tube shall have a minimum wall thickness of $^{3}/_{16}$ 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 micropile 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*s* 104.11 *or 1.8.7, as applicable*. The alternative system design, supporting documentation and test data shall be submitted to the building official for review and approval.

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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 $^{3}/_{8}$ 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 preproduction 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 18.13.4.

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 $^{1}/_{16}$-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 18*A* – 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	BSC-CG	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																					

The state agency does not adopt sections identified with 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 18*A*
SOILS AND FOUNDATIONS

SECTION 1801*A*
GENERAL

1801*A*.1 Scope. The provisions of this chapter shall apply to building and foundation systems.

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, and 22A, the provisions in Chapters 16, 19, 21, and 22, respectively shall apply instead.*

1801*A*.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.

SECTION 1802*A*
DEFINITIONS

1802*A*.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*A*
GEOTECHNICAL INVESTIGATIONS

1803*A*.1 General. Geotechnical investigations shall be conducted in accordance with Section 1803*A*.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.*

1803*A*.2 Investigations required. Geotechnical investigations shall be conducted in accordance with Sections 1803*A*.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.*

1803*A*.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*A*.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 m^2) 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.

1803*A*.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*A*.5 Investigated conditions. Geotechnical investigations shall be conducted as indicated in Sections 1803*A*.5.1 through 1803*A*.5.12.

1803*A*.5.1 Classification. Soil materials shall be classified in accordance with ASTM D2487.

1803*A*.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*A*.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 D4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75 μm), determined in accordance with ASTM D422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.
4. Expansion index greater than 20, determined in accordance with ASTM D4829.

1803*A*.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.

1803*A*.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*A*.5.6 Rock strata. Where subsurface explorations at the project site indicate variations in the structure of rock upon which foundations are to be constructed, a sufficient number of borings shall be drilled to sufficient depths to assess the competency of the rock and its load-bearing capacity.

1803*A*.5.7 Excavation near foundations. Where excavation will reduce support from any foundation, a registered design professional shall prepare an assessment of the structure as determined from examination of the structure, the review of available design documents and, if necessary, excavation of test pits. The registered design professional shall determine the requirements for underpinning and protection and prepare site-specific plans, details and sequence of work for submission. Such support shall be provided by underpinning, sheeting and bracing, or by other means acceptable to the building official.

1803*A*.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*A*.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*A*.5.10 Alternate setback and clearance. Where setbacks or clearances other than those required in Section 1808*A*.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*A*.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*A*.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*A*.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*A*.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 one of the following:
    2.1. A site-specific study in accordance with Section 21.5 of ASCE 7.
    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, the following:
    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.

3.7. Flotation of buried structures.

4. Discussion of mitigation measures such as, but not limited to, the following:

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.

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 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 (NGA West 1) 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 1803*A*.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*A*.5.8.
10. Controlled low-strength material properties and testing in accordance with Section 1803*A*.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 322 of Part 10, Title 24, C.C.R., may be required by the enforcement agency. In Section 322 of Part 10, Title 24, C.C.R., where reference is made to structural or seismic-resisting system, it shall be replaced with geotechnical, foundation, or ground improvement, as appropriate.*

SECTION 1804*A*
EXCAVATION, GRADING AND FILL

1804*A*.1 Excavation near foundations. Excavation for any purpose shall not reduce lateral support from any foundation or adjacent foundation without first underpinning or protecting the foundation against detrimental lateral or vertical movement, or both.

1804*A*.2 Underpinning. Where underpinning is chosen to provide the protection or support of adjacent structures, the underpinning system shall be designed and installed in accordance with provisions of this chapter and Chapter 33.

1804*A*.2.1 Underpinning sequencing. Underpinning shall be installed in a sequential manner that protects the neighboring structure and the working construction site. The sequence of installation shall be identified in the approved construction documents.

1804*A*.3 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.

1804*A*.4 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*A*.5 Grading and fill in flood hazard areas. In flood hazard areas established in Section 1612*A*.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 coastal high hazard areas, 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*A*.6 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*A*.

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 D1557. The compaction shall be verified by special inspection in accordance with Section 1705.6.

1804*A*.7 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*A*.

SECTION 1805*A*
DAMPPROOFING AND WATERPROOFING

1805*A*.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*A*.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*A*.2 and a foundation drain shall be installed in accordance with Section 1805*A*.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*A*.5.4, 1805*A*.3 and 1805*A*.4.1 shall not apply in this case.

1805*A*.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*A*.5.4, 1805*A*.2, 1805*A*.3 and 1805*A*.4 shall not apply in this case.

1805*A*.1.2.1 Flood hazard areas. For buildings and structures in flood hazard areas as established in Section 1612*A*.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*A*.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*A*.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*A*.2 Dampproofing. Where hydrostatic pressure will not occur as determined by Section 1803*A*.5.4, floors and walls shall be dampproofed in accordance with this section. >

1805*A*.2.1 Floors. Dampproofing materials for floors shall be installed between the floor and the base course required by Section 1805*A*.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*A*.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, $^1/_8$ inch (3.2 mm) coat of surface-bonding mortar complying with ASTM C887, any of the materials permitted for waterproofing by Section 1805*A*.3.2 or other approved methods or materials.

1805*A*.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 $^3/_8$ 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*A*.3 Waterproofing. Where the ground-water investigation required by Section 1803*A*.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*A*.1.3, walls and floors shall be waterproofed in accordance with this section.

1805*A*.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*A*.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*A*.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*A*.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*A*.2.2.1.

1805*A*.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*A*.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*A*.1.3 shall be deemed adequate for lowering the groundwater table.

1805*A*.4.1 Floor base course. Floors of basements, except as provided for in Section 1805*A*.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.

1805*A*.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*A*.4.1, and shall be covered with not less than 6 inches (152 mm) of the same material.

1805*A*.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*A*
PRESUMPTIVE LOAD-BEARING VALUES OF SOILS

1806*A*.1 Load combinations. The presumptive load-bearing values provided in Table 1806*A*.2 shall be used with the allowable stress design load combinations specified in Section 1605*A*.3. The values of vertical foundation pressure and lateral bearing pressure given in Table 1806*A*.2 shall be permitted to be increased by one-third where used with the alternative basic load combinations of Section 1605*A*.3.2 that include wind or earthquake loads.

1806*A*.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*A*.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*A*.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.

TABLE 1806*A*.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*A*.3.2.

1806*A*.3 Lateral load resistance. Where the presumptive values of Table 1806*A*.2 are used to determine resistance to lateral loads, the calculations shall be in accordance with Sections 1806*A*.3.1 through 1806*A*.3.4.

1806*A*.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*A*.2.

1806*A*.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*A*.3.3 Increase for depth. The lateral bearing pressures specified in Table 1806*A*.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*A*.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 $^1/_2$ 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*A*
FOUNDATION WALLS, RETAINING WALLS AND EMBEDDED POSTS AND POLES

1807*A*.1 Foundation walls. Foundation walls shall be designed and constructed in accordance with Sections 1807*A*.1.1 through 1807*A*.1.6. Foundation walls shall be supported by foundations designed in accordance with Section 1808*A*.

1807*A*.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.*

1807*A*.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*A*.1.3 Rubble stone foundation walls. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.* >

1807*A*.1.4 Permanent wood foundation systems. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.* >

1807*A*.1.5 Concrete and masonry foundation walls. Concrete and masonry foundation walls shall be designed in accordance with Chapter 19*A* or 21*A*, as applicable. >

1807*A*.2 Retaining walls. Retaining walls shall be designed in accordance with Sections 1807*A*.2.1 through 1807*A*.2.3. *Freestanding cantilever walls shall be designed in accordance with Section 1807A.2.4.*

1807*A*.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*A*.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. For use with the load combinations, lateral soil loads due to gravity loads surcharge shall be considered gravity loads and seismic earth pressure increases due to earthquake shall be considered as seismic loads.* <

1807*A*.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*A* 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 freestanding 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.*

1807*A*.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*A*.3.1 through 1807*A*.3.3.

1807*A*.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*A*.3.2 Design criteria. The depth to resist lateral loads shall be determined using the design criteria established in Sections 1807*A*.3.2.1 through 1807*A*.3.2.3, or by other methods approved by the building official.

1807*A*.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.

$$d = 0.5A\{1 + [1 + (4.36h/A)]^{1/2}\} \qquad \textbf{(Equation 18}\textit{A}\textbf{-1)}$$

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 1806*A*.2 based on a depth of one-third the depth of embedment in pounds per square foot (psf) (kPa).

1807*A*.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.

$$d = \sqrt{\frac{4.25Ph}{S_3 b}} \qquad \textbf{(Equation 18}\textit{A}\textbf{-2)}$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3 b}} \qquad \textbf{(Equation 18}\textit{A}\textbf{-3)}$$

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*A*.2 based on a depth equal to the depth of embedment in pounds per square foot (kPa).

1807*A*.3.2.3 Vertical load. The resistance to vertical loads shall be determined using the vertical foundation pressure set forth in Table 1806*A*.2.

1807*A*.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*A*
FOUNDATIONS

1808*A*.1 General. Foundations shall be designed and constructed in accordance with Sections 1808*A*.2 through 1808*A*.9. Shallow foundations shall also satisfy the requirements of Section 1809*A*. Deep foundations shall also satisfy the requirements of Section 1810*A*.

1808*A*.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*A*.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.

1808*A*.3 Design loads. Foundations shall be designed for the most unfavorable effects due to the combinations of loads specified in Section 1605*A*.2 or 1605*A*.3. The dead load is permitted to include the weight of foundations and overlying fill. Reduced live loads, as specified in Sections 1607*A*.9 and 1607*A*.11, shall be permitted to be used in the design of foundations.

1808*A*.3.1 Seismic overturning. Where foundations are proportioned using the load combinations of Section 1605*A*.2 or 1605*A*.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.

1808.3.2 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 the surcharge. Existing footings or foundations that will be affected by any excavation shall be underpinned or otherwise protected against settlement and shall be protected against detrimental lateral or vertical movement or both.

Exception: Minor grading for landscaping purposes shall be permitted where done with walk-behind equipment, where the grade is not increased more than 1 foot (305 mm) from original design grade or where approved by the building official.

1808*A*.4 Vibratory loads. Where machinery operations or other vibrations are transmitted through the foundation, con-

sideration shall be given in the foundation design to prevent detrimental disturbances of the soil.

1808*A*.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*A*.6 Design for expansive soils. Foundations for buildings and structures founded on expansive soils shall be designed in accordance with Section 1808*A*.6.1 or 1808*A*.6.2.

Exception: Foundation design need not comply with Section 1808*A*.6.1 or 1808*A*.6.2 where one of the following conditions is satisfied:

1. The soil is removed in accordance with Section 1808*A*.6.3; or
2. The building official approves stabilization of the soil in accordance with Section 1808*A*.6.4.

1808*A*.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*A*.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 DC 10.5*. 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 DC 10.5*. 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.

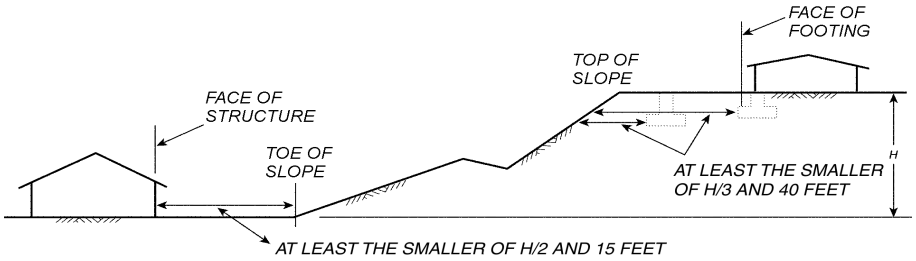
1808*A*.6.3 Removal of expansive soil. Where expansive soil is removed in lieu of designing foundations in accordance with Section 1808*A*.6.1 or 1808*A*.6.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive soils and shall comply with Section 1804*A*.5 or 1804*A*.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*A*.6.4 Stabilization. Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 1808*A*.6.1 or 1808*A*.6.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

1808*A*.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*A*.7.1 through 1808*A*.7.5.

1808*A*.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*A*.7.5 and Figure 1808*A*.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.



For SI: 1 foot = 304.8 mm.

FIGURE 1808*A*.7.1
FOUNDATION CLEARANCES FROM SLOPES

1808*A*.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*A*.7.5 and Figure 1808*A*.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*A*.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*A*.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*A*.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*A*.5.10.

1808*A*.8 Concrete foundations. The design, materials and construction of concrete foundations shall comply with Sections 1808*A*.8.1 through 1808*A*.8.6 and the provisions of Chapter 19*A*.

1808*A*.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*A*.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*A*.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*A*.8.2. Longitudinal bars spaced less than $1^1/_2$ 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.

1808*A*.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*A*.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*A*.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 Section 26.10 of ACI 318.

1808*A*.8.6 Seismic requirements. See Section 1905*A* 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 Section 18.13 of ACI 318 shall apply where not in conflict with the provisions of Sections 1808*A* through 1810*A*.

TABLE 1808*A*.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 1808*A*.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.

1808*A*.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*A*
SHALLOW FOUNDATIONS

1809*A*.1 General. Shallow foundations shall be designed and constructed in accordance with Sections 1809*A*.2 through 1809*A*.13.

1809*A*.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*A*.5. CLSM shall be placed in accordance with Section 1804*A*.6.

1809*A*.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.

1809*A*.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*A*.5 shall also be satisfied. The minimum width of footings shall be 12 inches (305 mm).

1809*A*.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.
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.
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.
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*A*.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*A*.7 Prescriptive footings for light-frame construction. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.* <

1809*A*.8 Plain concrete footings. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.*

1809*A*.9 Masonry-unit footings. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.* <

1809*A*.10 *Reserved.* <

1809*A*.11 Steel grillage footings. Grillage footings of structural steel elements 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.

1809*A*.12 Timber footings. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.*

1809*A*.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*A*.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_{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 1810*A*
DEEP FOUNDATIONS

1810*A*.1 General. Deep foundations shall be analyzed, designed, detailed and installed in accordance with Sections 1810*A*.1 through 1810*A*.4.

1810*A*.1.1 Geotechnical investigation. Deep foundations shall be designed and installed on the basis of a geotechnical investigation as set forth in Section 1803*A*.

1810*A*.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*A*.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*A*.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*A*.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*A*.2 Analysis. The analysis of deep foundations for design shall be in accordance with Sections 1810*A*.2.1 through 1810*A*.2.5.

1810*A*.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*A*.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 accor-

dance with Section 1810*A*.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*A*.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*A*.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*A*.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*A*.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 1810*A*.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*A*.3.9.4.2.2.

1810*A*.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. Group effects shall be evaluated using a generally accepted method of analysis; the analysis for uplift of grouped elements with center-to-center spacing less than three times the least horizontal dimension of an element shall be evaluated in accordance with Section 1810*A*.3.3.1.6.

1810*A*.3 Design and detailing. Deep foundations shall be designed and detailed in accordance with Sections 1810*A*.3.1 through 1810*A*.3.12.

1810*A*.3.1 Design conditions. Design of deep foundations shall include the design conditions specified in Sections 1810*A*.3.1.1 through 1810*A*.3.1.6, as applicable.

1810*A*.3.1.1 Design methods for concrete elements. Where concrete deep foundations are laterally supported in accordance with Section 1810*A*.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*A*.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*A*.2 and approved strength design methods.

1810*A*.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*A*.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*A*.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*A*.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 1616A.1.16.*

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 $^{1}/_{16}$-inch corrosion allowance.

Helical piles shall not be considered as carrying any horizontal loads.

1810*A*.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*A*.3.2.5. Horizontal joints in the casing shall be spliced in accordance with Section 1810*A*.3.6.

1810*A*.3.2 Materials. The materials used in deep foundation elements shall satisfy the requirements of Sections 1810*A*.3.2.1 through 1810*A*.3.2.8, as applicable.

1810*A*.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 $^3/_4$ inch (19.1 mm). Concrete to be compacted shall have a zero slump.

1810*A*.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*A*.3.2.2 Prestressing steel. Prestressing steel shall conform to ASTM A416.

1810*A*.3.2.3 Steel. Structural steel H-piles and structural steel sheet piling shall conform to the material requirements in ASTM A6. Steel pipe piles shall conform to the material requirements in ASTM A252. Fully welded steel piles shall be fabricated from plates that conform to the material requirements in ASTM A36, ASTM A283, ASTM A572, ASTM A588 or ASTM A690.

1810*A*.3.2.4 Timber. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.*

1810*A*.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.

1810*A*.3.2.6 Allowable stresses. The allowable stresses for materials used in deep foundation elements shall not exceed those specified in Table 1810*A*.3.2.6.

1810*A*.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*A*.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*A*.3.2.8 Justification of higher allowable stresses. Use of allowable stresses greater than those specified in Section 1810*A*.3.2.6 shall be permitted where supporting data justifying such higher stresses is filed with the building official. Such substantiating data shall include the following:

1. A geotechnical investigation in accordance with Section 1803*A*.
2. Load tests in accordance with Section 1810*A*.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*A*.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*A*.3.3.1 Allowable axial load. The allowable axial load on a deep foundation element shall be determined in accordance with Sections 1810*A*.3.3.1.1 through 1810*A*.3.3.1.9.

1810*A*.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*A*.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*A*.3.3.1.2 Load tests. Where design compressive loads are greater than those determined using the allowable stresses specified in Section 1810*A*.3.2.6, where the design load for any deep foundation element is in doubt, *where driven deep foundation elements are installed by means other than a pile hammer,* 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 D1143 *including Procedure G: Cyclic Loading Test* or ASTM D4945. 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*A*.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*A*.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*, or where the downward pressure and torque on such elements is greater than or equal to that applied to the test element that determined the ultimate axial load capacity at a comparable driving distance.*

TABLE 1810*A*.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*A*.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. 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*A*.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. Steel in tension	
Pipes, tubes or H-piles, where justified in accordance with Section 1810*A*.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 AWC 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 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*A*.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-percent Criterion.
3. Butler-Hoy Criterion.
4. Other methods approved by the building official.

1810*A*.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*A*.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*A* or a greater value is substantiated by a load test in accordance with Section 1810*A*.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*A*.

1810*A*.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 D3689. The maximum allowable uplift load shall not exceed the ultimate load capacity as determined in Section 1810*A*.3.3.1.2, using the results of load tests conducted in accordance with ASTM D3689, *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.

1810*A*.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 a generally accepted method of analysis. Where the deep foundation elements in the group are placed at a center-to-center spacing less than three 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 allowable working uplift 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*A*.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*A*.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*A*.3.3.1.9 Helical piles. The allowable axial design load, P_a, of helical piles shall be determined as follows:

$$P_a = 0.5\ P_u \qquad \textbf{(Equation 18A-4)}$$

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.

1810*A*.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 D3966, 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.

1810*A*.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*A*.3.5 Dimensions of deep foundation elements. The dimensions of deep foundation elements shall be in accordance with Sections 1810*A*.3.5.1 through 1810*A*.3.5.3, as applicable.

1810*A*.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*A*.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*A*.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*A*.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*A*.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*A*.3.5 shall not apply to micropiles.

1810*A*.3.5.3 Steel. Steel deep foundation elements shall satisfy the requirements of this section.

1810*A*.3.5.3.1 Structural steel H-piles. Sections of structural steel H-piles shall comply with the requirements for HP shapes in ASTM A6, or 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 $^3/_8$ inch (9.5 mm).

1810*A*.3.5.3.2 Fully welded steel piles fabricated from plates. Sections of fully welded steel piles fabricated from plates 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 $^3/_8$ inch (9.5 mm).

1810*A*.3.5.3.3 Structural steel sheet piling. Individual sections of structural steel sheet piling shall conform to the profile indicated by the manufacturer, and shall conform to the general requirements specified by ASTM A6.

Installation of sheet piling shall satisfy inspection, monitoring, and observation requirements in Sections 1812A.6 and 1812A.7.

1810*A*.3.5.3.4 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 $^3/_{16}$ 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 $^3/_8$ 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 $^1/_{10}$ inch (2.5 mm).

1810*A*.3.5.3.5 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*A*.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*A*.2.2 to other deep foundation elements that do not have splices in the upper 10 feet (3048 mm) of embedment.

1810*A*.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.
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*A*.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*A*.3.8 Precast concrete piles. Precast concrete piles shall be designed and detailed in accordance with Sections 1810*A*.3.8.1 through 1810*A*.3.8.3.

1810*A*.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 $^1/_4$ inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).

1810*A*.3.8.2 Precast nonprestressed piles. Precast nonprestressed concrete piles shall comply with the requirements of Sections 1810*A*.3.8.2.1 through 1810*A*.3.8.2.3.

1810*A*.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*A*.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 $^3/_8$ 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*A*.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*A*.3.9.4.2.

1810*A*.3.8.3 Precast prestressed piles. Precast prestressed concrete piles shall comply with the requirements of Sections 1810*A*.3.8.3.1 through 1810*A*.3.8.3.3.

1810*A*.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*A*.3.8.3.2 Seismic reinforcement in Seismic Design Category C. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.* <

1810*A*.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:

$$\rho_s = 0.25(f'_c / f_{yh})(A_g / A_{ch} - 1.0)\,[0.5 + 1.4P/(f'_c A_g)] \quad \textbf{(Equation 18}\textit{A}\textbf{-6)}$$

but not less than

$$\rho_s = 0.12(f'_c / f_{yh})\,[0.5 + 1.4P/(f'_c A_g)] \geq 0.12 f'_c / f_{yh} \quad \textbf{(Equation 18}\textit{A}\textbf{-7)}$$

and need not exceed:

$$\rho_s = 0.021 \quad \textbf{(Equation 18}\textit{A}\textbf{-8)}$$

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 ≤ 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).

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:

$$A_{sh} = 0.3s\,h_c\,(f'_c / f_{yh})(A_g / A_{ch} - 1.0)\,[0.5 + 1.4P/(f'_c A_g)] \quad \textbf{(Equation 18}\textit{A}\textbf{-9)}$$

but not less than:

$$A_{sh} = 0.12s\,h_c\,(f'_c / f_{yh})\,[0.5 + 1.4P/(f'_c A_g)] \quad \textbf{(Equation 18}\textit{A}\textbf{-10)}$$

where:

f_{yh} = yield strength of transverse reinforcement ≤ 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 tranverse 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*A*.3.9 Cast-in-place deep foundations. Cast-in-place deep foundation elements shall be designed and detailed in accordance with Sections 1810*A*.3.9.1 through 1810*A*.3.9.6.

1810*A*.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:

$$\phi M_n = 3\sqrt{f'_c}\,S_m \quad \textbf{(Equation 18}\textit{A}\textbf{-11)}$$

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*A*.3.9.2 Required reinforcement. Where subject to uplift or where the required moment strength determined using the load combinations of Section 1605*A*.2 exceeds the design cracking moment determined in accordance with Section 1810*A*.3.9.1, cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.

1810*A*.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.

1810*A*.3.9.4 Seismic reinforcement. Where a structure is assigned to Seismic Design Category C, reinforcement shall be provided in accordance with Section 1810*A*.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*A*.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*A*.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*A*.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*A*.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*A*.2.1.
4. Closed ties or spirals where required by Section 1810*A*.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*A*.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*A*.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605*A*.2.

Transverse reinforcement shall consist of closed ties or spirals with a minimum $^{3}/_{8}$ 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*A*.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 1810*A*.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605*A*.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*A*.3.9.4.2.1 or 1810*A*.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 18.7.5.2, 18.7.5.3 and 18.7.5.4 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 18.7.5.4 of ACI 318 shall be permitted *for concrete deep foundation elements.* <

1810*A*.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 18.7.5.2, 18.7.5.3 and 18.7.5.4 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. < < <

1810*A*.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.

1810*A*.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*A*.3.10 Micropiles. Micropiles shall be designed and detailed in accordance with Sections 1810*A*.3.10.1 through 1810*A*.3.10.4.

1810*A*.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*A*.3.10.2 Materials. Reinforcement shall consist of deformed reinforcing bars in accordance with ASTM A615 Grade 60 or 75 or ASTM A722 Grade 150.

The steel pipe or tube shall have a minimum wall thickness of $^{3}/_{16}$ inch (4.8 mm). Splices shall comply with Section 1810*A*.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*A*.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.

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 $^{3}/_{8}$ 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 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 1616A.1.16.*

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 18.13.4.

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 $^{1}/_{16}$-inch corrosion allowance.

Micropiles shall not be considered as carrying any horizontal loads.

1810*A*.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*A*.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*A*.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 includ-

ing overstrength factor in accordance with Section 12.4.3 or 12.14.3.2 of ASCE 7.

1810*A*.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*A*.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*A*.4 Installation. Deep foundations shall be installed in accordance with Section 1810*A*.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*A*.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*A*.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*A*.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*A*.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*A*.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*A*.4.1.5 Defective timber piles. *Not permitted by DSA-SS, DSA-SS/CC or OSHPD.* <

1810*A*.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*A*.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*A*.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*A*.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*A*.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*A*.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*A*.3.3.1.2.

1810*A*.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 suc-

cessful 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*A*.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*A*.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*A*.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*A*.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*A*.4.12 Special inspection. Special inspections in accordance with Sections 1705*A*.7 and 1705*A*.8 shall be provided for driven and cast-in-place deep foundation elements, respectively. Special inspections in accordance with Section 1705*A*.9 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 comply 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 A722.*
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 1616A.1.16 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.*

SECTION 1812A
EARTH RETAINING SHORING

1812A.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 facilities are affected. Shoring used as construction means and methods only, which does not affect existing or new facilities, are not regulated by this section 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 1812A.2 through 1812A.8.

1812A.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 2303.1.9.1.

1812A.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.*

1812A.4 Design and testing: *Except for the modifications as set forth in Sections 1812A.4.1 through 1812A.4.3 below, all Prestressed Rock and Soil Tie-back Anchors shall comply with PTI Recommendations for Prestressed Rock and Soil Anchors (PTI-2004).*

1812A.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.*

***1812A.4.2 Structural requirements**:*

1. *Tendons shall be thread-bar anchors conforming to ASTM A722.*
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 1812A.8.*
5. *Design of shoring system shall account for both short and long-term deformation.*

***1812A.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 followings 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.*

***1812A.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.*

1812A.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 calender 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 minumum, shall be as follows:*
    a. *Intitial 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 intial date of monitoring and reading, current monitoring date and reading and difference between the two readings.*
9. *If the total cummulative horizontal or vertical movement (from start of construction) of the existing buildings reaches $^1/_2$ 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 cummulative horizontal or vertical movement (from start of construction) of the existing buildings reaches $^3/_4$ inch or soldier piles reaches $1^1/_2$ 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.*

1812A.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.*

1812A.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 1813A
VIBRO STONE COLUMNS
FOR GROUND IMPROVEMENT

1813A.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 1813A.2 through 1813A.5.*

1813A.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 Friction Cone and Piezocone Penetration Testing in accordance with ASTM D5778 complemented by the standard penetration test (SPT) in accordance with ASTM D1586, 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.*

1813A.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 subgrade reaction, long term settlement, and post-earthquake settlement can be considered uniform throughout.*

1813A.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 $^{3}/_{8}$ inch after compaction.*

1813A.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.*

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	BSC-CG	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**		**X**										
Adopt only those sections that are listed below																					
Chapter / Section																					
1901.1.1									X												
1901.1.2									X												
1901.1.3									X												
1901.1.4									X												
1901.3.1											X										
1901.3.2											X										
1901.3.3											X										
1901.3.4											X										
1905.1.2	X																				
1905.1.3	X																				
1905.1.9	X																				
1907.1.1				X																	
1909									X												

The state agency does not adopt sections identified with 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 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 1909 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 Anchoring to concrete. Anchoring to concrete shall be in accordance with ACI 318 as amended in Section 1905, and applies to cast-in (headed bolts, headed studs and hooked J- or L-bolts), post-installed expansion (torque-controlled and displacement-controlled), undercut and adhesive anchors.

1901.3.1 Power actuated fasteners. [OSHPD 2] *Power actuated fasteners qualified in accordance with ICC-ES AC 70 shall be deemed to satisfy the requirements of ASCE 7 Section 13.4.5.*

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 non-bearing non-shear wall partitions only. Power actuated fastener shall not be used to anchor seismic bracing, exterior cladding or curtain wall systems.

> ***Exception:*** *Power actuated fasteners in steel to steel connections prequalified for seismic application by cyclic tests in accordance with ICC-ES AC 70 shall be permitted for seismic design.*

1901.3.2 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 232 or AC 446 shall be deemed to satisfy the requirements of this section.

1901.3.3 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.*

1901.3.4 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.*

1901.3.4.1 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.

1901.3.4.2 Testing procedure. *The test procedure shall be as permitted by an approved evaluation report using criteria adopted in this code. All post-installed anchors shall be tension tested.*

> ***Exception:*** *Torque controlled post installed anchors shall be permitted to be tested using torque based on an approved test report using criteria adopted in this code.*

Alternatively, manufacturer's recommendation for testing may be approved by the enforcement agency based on an approved test report using criteria adopted in this code.

1901.3.4.3 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 components, 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.*

1901.3.4.4 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 ($1^1/_4$) times the maximum design strength of anchors as provided in approved evaluation report using criteria adopted in this code or determined in accordance with Chapter 17 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 evaluation report using criteria adopted in this code.*

1901.3.4.5 Test acceptance criteria. *Acceptance criteria for post-installed anchors shall be based on approved evaluation 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:*

   Torque-controlled post-installed anchors tested with a calibrated torque wrench shall attain the specified torque within $^1/_2$ turn of the nut; or one-quarter ($^1/_4$) turn of the nut for a $^3/_8$-inch sleeve anchor only.

1901.4 Composite structural steel and concrete structures. Systems of structural steel acting compositely with reinforced concrete shall be designed in accordance with Section 2206 of this code.

1901.5 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.

1901.6 Special inspections and tests. Special inspections and tests 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.

Exception: *The following standards as referenced in Chapter 35 shall be permitted to be used.*

1. *ASTM C150*
2. *ASTM C595*
3. *ASTM C1157*

1903.2 Special inspections. *Where required, special inspections and tests shall be in accordance with Chapter 17.*

1903.3 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.*

1903.4 Flat wall insulating concrete form (ICF) systems. *Insulating concrete form material used for forming flat concrete walls shall conform to ASTM E2634.*

SECTION 1904
DURABILITY REQUIREMENTS

1904.1 Structural concrete. Structural concrete shall conform to the durability requirements of ACI 318.

Exception: *For Group R-2 and R-3 occupancies not more than three stories above grade plane, the specified compressive strength, f'_c, for concrete in basement walls, foundation walls, exterior walls and other vertical surfaces exposed to the weather shall be not less than 3,000 psi (20.7 MPa).*

1904.2 Nonstructural concrete. *The registered design professional shall assign nonstructural concrete a freeze-thaw exposure class, as defined in ACI 318, based on the anticipated exposure of nonstructural concrete. Nonstructural concrete shall have a minimum specified compressive strength, f'_c, of 2,500 psi (17.2 MPa) for Class F0; 3,000 psi (20.7 MPa) for Class F1; and 3,500 psi (24.1 MPa) for Classes F2 and F3. Nonstructural concrete shall be air entrained in accordance with 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 1905.1.8.

1905.1.1 ACI 318, Section 2.3. Modify existing definitions and add the following definitions to ACI 318, Section 2.3.

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 14, including 14.6.2.

ORDINARY PRECAST STRUCTURAL WALL. A precast wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26.

ORDINARY REINFORCED CONCRETE STRUCTURAL WALL. A *cast-in-place* wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26.

ORDINARY STRUCTURAL PLAIN CONCRETE WALL. A wall complying with the requirements of Chapter 14, *excluding 14.6.2*.

SPECIAL STRUCTURAL WALL. A cast-in-place or precast wall complying with the requirements of 18.2.4 through 18.2.8, 18.10 and 18.11, 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."*

1905.1.2 ACI 318, Section 18.2.1. Modify ACI 318 Sections 18.2.1.2 and 18.2.1.6 to read as follows:

18.2.1.2 – Structures assigned to Seismic Design Category A shall satisfy requirements of Chapters 1 through 17 and 19 through 26*; Chapter 18 does not apply*. Structures assigned to *Seismic Design Category* B, C, D, E or F also shall satisfy 18.2.1.3 through 18.2.1.7, as applicable. *Except for structural elements of plain concrete complying with Section 1905.1.7 of the California Building Code, structural elements of plain concrete are prohibited in structures assigned to Seismic Design Category C, D, E or F.*

18.2.1.6 – 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 18 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 18.3.

(b) Ordinary reinforced concrete structural walls and ordinary precast structural walls need not satisfy any provisions in Chapter 18.

(c) Intermediate moment frames shall satisfy 18.4.

(d) Intermediate precast structural walls shall satisfy 18.5.

(e) Special moment frames shall satisfy 18.6 through 18.9.

(f) Special structural walls shall satisfy 18.10.

(g) Special structural walls constructed using precast concrete shall satisfy 18.11.

All special moment frames and special structural walls shall also satisfy 18.2.4 through 18.2.8.

1905.1.3 ACI 318, Section 18.5. Modify ACI 318, Section 18.5, by adding new Section 18.5.2.2 and renumbering existing Sections 18.5.2.2 and 18.5.2.3 to become 18.5.2.3 and 18.5.2.4, respectively.

18.5.2.2 – 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.

18.5.2.3 – Elements of the connection that are not designed to yield shall develop at least 1.5 S_y.

18.5.2.4 – In structures assigned to SDC D, E or F, wall piers shall be designed in accordance with 18.10.8 or 18.14 in ACI 318.

1905.1.4 ACI 318, Section 18.11. Modify ACI 318, Section 18.11.2.1, to read as follows:

18.11.2.1 – Special structural walls constructed using precast concrete shall satisfy all the requirements of 18.10 *for cast-in-place special structural walls* in addition to 18.5.2.

1905.1.5 ACI 318, Section 18.13.1.1. Modify ACI 318, Section 18.13.1.1, to read as follows:

18.13.1.1 – Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of 18.13 and other applicable provisions of ACI 318 *unless modified by Chapter 18 of the California Building Code.*

1905.1.6 ACI 318, Section 14.6. Modify ACI 318, Section 14.6, by adding new Section 14.6.2 to read as follows:

14.6.2 – Detailed plain concrete structural walls.

14.6.2.1 – Detailed plain concrete structural walls are walls conforming to the requirements of ordinary structural plain concrete walls and 14.6.2.2.

14.6.2.2 – 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 14.6.1.

(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 doweled 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.

1905.1.7 ACI 318, Section 14.1.4. Delete ACI 318, Section 14.1.4, and replace with the following:

14.1.4 – Plain concrete in structures assigned to Seismic Design Category C, D, E or F.

14.1.4.1 – 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 as defined in ASCE 7 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 be not less than 7^1/$_2$ 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 14.6.1.

(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.*

1905.1.8 ACI 318, Section 17.2.3. Modify ACI 318 Sections 17.2.3.4.2, 17.2.3.4.3(d) and 17.2.3.5.2 to read as follows:

17.2.3.4.2 – 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 17.2.3.4.3. The anchor design tensile strength shall be determined in accordance with 17.2.3.4.4.

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 17.2.3.4.3(d).*

17.2.3.4.3(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 17.2.3.4.4*.

17.2.3.5.2 – 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 17.2.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.5.

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 shear strength in accordance with 17.5.2 and 17.5.3 need not be computed and 17.2.3.5.3 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 AWC 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 $1^3/_4$ 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 (51 mm) or 3-inch (76 mm) 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 light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.5.2 and 17.5.3 need not be computed and 17.2.3.5.3 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 $1^3/_4$ 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 (0.84 mm to 1.73 mm) 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 nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching sill plate or track to foundation or foundation stem wall need not satisfy 17.2.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with 17.5.2.1(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 $3^1/_2$ 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 that 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
SHOTCRETE

1908.1 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.

1908.2 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.

1908.3 Aggregate. Coarse aggregate, if used, shall not exceed $^3/_4$ inch (19.1 mm).

1908.4 Reinforcement. Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1908.4.1 through 1908.4.4.

1908.4.1 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.

1908.4.2 Clearance. When No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of $2^1/_2$ 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.

1908.4.3 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.

1908.4.4 Spirally tied columns. Shotcrete shall not be applied to spirally tied columns.

1908.5 Preconstruction tests. Where preconstruction tests are required by Section 1908.4, 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. Reports of preconstruction tests shall be submitted to the building official as specified in Section 1704.5.

1908.6 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.

1908.7 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.

1908.8 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.

1908.9 Curing. During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.

1908.9.1 Initial curing. Shotcrete shall be kept continuously moist for 24 hours after shotcreting is complete or shall be sealed with an approved curing compound.

1908.9.2 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.

1908.9.3 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.

1908.10 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 $^3/_8$ 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 $^3/_8$ 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.

1908.10.1 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.

1908.10.2 Panel criteria. When the maximum-size aggregate is larger than $^3/_8$ 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 $^3/_8$ 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.

1908.10.3 Acceptance criteria. The average compressive strength of three cores from the in-place work or a single test panel shall equal or exceed $0.85f'_c$ with no single core less than $0.75f'_c$. 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 $0.88f'_c$. To check accuracy, locations represented by erratic core or cube strengths shall be retested.

SECTION 1909
ADDITIONAL REQUIREMENTS FOR COMMUNITY COLLEGES [DSA-SS/CC]

1909.1 General.

1909.1.1 Construction documents. *Openings larger than 12 inches (305 mm) in any dimension shall be detailed on the structural drawings.*

1909.2 Tests and materials. *Where required, special inspections and tests shall be in accordance with Chapter 17A and this section.*

1909.2.1 Aggregates *- Modify ACI 318 Section 26.4.1.2.1(a).(1) as follows:*

(1) ***Normal weight aggregate:*** *Aggregate shall be nonreactive as determined by one of the methods in ASTM C33 Appendix XI Methods for Evaluating Potential for Deleterious Expansion Due to Alkali Reactivity of an Aggregate. Aggregates deemed to be deleterious or potentially deleterious may be used with the addition of a material that has been shown to prevent harmful expansion in accordance with Appendix XI of ASTM C33, when approved by the building official.*

1909.2.2 Steel fiber reinforcement *- Not permitted.*

1909.2.3 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 C150 for portland cement and ASTM C595 or ASTM C1157 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 C618 or ASTM C989, 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.*

1909.2.4 Tests of reinforcing bars. *Samples shall be taken from bundles as delivered from the mill, with the bundles identified as to heat number and the accompanying mill certificate. One tensile test and one bend test shall be made from a sample 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 or non-building structures provided they are identified in the construction documents and certified mill test reports are provided to the inspector of record for each shipment of such reinforcement.

***1909.2.5 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).

   Anchorages 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.*

***1909.2.6 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.

***1909.2.7 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.*

***1909.2.7.1 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.

***1909.2.7.2 Testing procedure.** The test procedure shall be as permitted by an approved evaluation report using criteria adopted in this code. All post-installed anchors shall be tension tested.*

***Exception:** Torque-controlled post-installed anchors and screw type anchors shall be permitted to be tested using torque based on an approved test report using criteria adopted in this code.*

Alternatively, the manufacturer's recommendation for testing may be approved by the enforcement agency based on approved test report using criteria adopted in this code.

***1909.2.7.3 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 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.*

1909.2.7.4 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 ($1^1/_4$) 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 Chapter 17 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 an approved test report using criteria adopted in this code.*

1909.2.7.5 Test acceptance criteria. *Acceptance criteria for post-installed anchors shall be based on an approved test report using criteria adopted in this code. Field tests shall satisfy the following minimum requirements.*

1. *Hydraulic ram method:*

   Anchors tested with a hydraulic jack or spring loaded apparatus 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 apparatus support shall not be located within 1.5 times the anchor's embedment depth to avoid restricting the concrete shear cone type failure mechanism from occurring.
2. *Torque wrench method:*

   Torque-controlled post-installed anchors tested with a calibrated torque wrench shall attain the specified torque within $^1/_2$ turn of the nut; or one-quarter ($^1/_4$) turn of the nut for a $^3/_8$-inch sleeve anchor only.

   Screw-type anchors tested with a calibrated torque wrench shall attain the specified torque within one-quarter ($^1/_4$) turn of the screw after initial seating of the screw head.

1909.3 Modifications to ACI 318

1909.3.1 ACI 318, Section 11.9. *Modify ACI 318 by adding Section 14.9 as follows:*

11.9 - ***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 11.6 and 11.7.

1909.3.2 ACI 318, Section 12.7.3. *Add Section 12.7.3.4 to ACI 318 as follows:*

12.7.3.4 *– At least two No. 5 bars in diaphragms having two layers of reinforcement in both directions and one No. 5 bar in diaphragms having a single layer of reinforcement in both directions shall be provided around openings larger than 12 inches in any dimension in addition to the minimum reinforcement required by Section 12.6.*

1909.3.3 ACI 318, Chapter 14. *Plain concrete is not permitted.*

1909.3.4 ACI 318, Section 18.10.6.5. *Modify ACI 318, Section 18.10.6.5 by adding the following:*

Where boundary members are not required by ACI 318 Section 18.10.6.2 or 18.10.6.3, 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 18.10.6.4 (a), (b) and (c).

1909.3.5 ACI 318, Section 18.12.6. *Add Section 18.12.6.2 to ACI 318 as follows:*

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.

1909.3.6 ACI 318, Table 21.2.2. *Replace Table 21.2.2 as follows:*

TABLE 21.2.2
STRENGTH REDUCTION FACTOR ϕ FOR MOMENT, AXIAL FORCE, OR COMBINED MOMENT AND AXIAL FORCE

NET TENSILE STRAIN ε_t	CLASSIFICATION	ϕ			
		Type of transverse reinforcement			
		Spirals conforming to 25.7.3		Other	
$\varepsilon_t \le \varepsilon_{ty}$	Compression-controlled	0.75	(a)	0.65	(b)
$\varepsilon_{ty} < \varepsilon_t < 0.005$	Transition[1, 2]	$0.75 + 0.15\frac{\varepsilon_t - \varepsilon_{ty}}{\varepsilon_t^* - \varepsilon_{ty}}$	(c)	$0.65 + 0.25\frac{\varepsilon_t - \varepsilon_{ty}}{\varepsilon_t^* - \varepsilon_{ty}}$	(d)
$\varepsilon_t \ge 0.005$	Tension-controlled[3]	0.9	(e)	0.9	(f)

1. For sections classified as transition, it shall be permitted to use ϕ corresponding to compression-controlled sections.
2. *ε_t^* is the greater of net tensile strain calculated for $P_n = 0.1A_g f'_c$ and 0.005.*
3. *For sections with factored axial compression force $P_u \ge 0.1A_g f'_c$, ϕ shall be calculated using equation (c) or (d) for sections classified as transition, as applicable.*

1909.3.7 ACI 318, Section 26.12.2.1(a). *Replace ACI 318 Section 26.12.2.1(a) by the following:*

26.12.2.1(a) - 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.

1909.4 Shotcrete.

1909.4.1 Preconstruction tests. *A test panel prepared in accordance with Section 1908.5 is required. Approval from the enforcement agency must be obtained prior to performing test panels.*

1909.4.2 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.*

1909.4.3 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.*

1909.4.4 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.

1909.4.5 Placing. *Shotcrete shall be placed in accordance with ACI 506.*

1909.5 Existing concrete structures. *The structural use of existing concrete with a core strength less than 1,500 psi (10.3MPa) 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 $^3/_4$ inch (19 mm).

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 19*A* – 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	BSC-CG	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																					

The state agency does not adopt sections identified with 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 19*A*
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 1901*A*
GENERAL

1901*A*.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.*

1901*A*.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*A* of this code. Except for the provisions of Sections 1904*A* and 1907*A*, 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*A*.3 Anchoring to concrete. Anchoring to concrete shall be in accordance with ACI 318 as amended in Section 1905*A*, and applies to cast-in (headed bolts, headed studs and hooked J- or L-bolts), post-installed expansion (torque-controlled and displacement-controlled), undercut and adhesive anchors.

1901*A*.4 Composite structural steel and concrete structures. Systems of structural steel acting compositely with reinforced concrete shall be designed in accordance with Section 2206*A* of this code.

1901*A*.5 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.*

1901*A*.6 Special inspection. Special inspections and tests of concrete elements of buildings and structures and concreting operations shall be as required by Chapter *17A and Section 1910A.*

SECTION 1902*A*
DEFINITIONS

1902*A*.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*A*.1.

SECTION 1903*A*
SPECIFICATIONS FOR TESTS AND MATERIALS

1903*A*.1 General. Materials used to produce concrete, concrete itself and testing thereof shall comply with the applicable standards listed in ACI 318.

Exception: *The following standards as referenced in Chapter 35 shall be permitted to be used.*

1. *ASTM C150*
2. *ASTM C595*
3. *ASTM C1157*

1903*A*.2 Special inspections. *Where required, special inspections and tests shall be in accordance with Chapter 17A and Section 1910A.*

1903*A*.3 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*A*.4 Flat wall insulating concrete form (ICF) systems. *Insulating concrete form material used for forming flat concrete walls shall conform to ASTM E2634.* ***[OSHPD 1 & 4]*** *Not Permitted by OSHPD.*

1903A.5 Aggregates *– Modify ACI 318 Section 26.4.1.2.1(a).(1) as follows:*

(1) ***Normal weight aggregate:*** *Aggregate shall be nonreactive as determined by one of the methods in ASTM C33 Appendix XI: Methods for Evaluating Potential for Deleterious Expansion Due to Alkali Reactivity of an Aggregate. Aggregates deemed to be deleterious or potentially deleterious may be used with the addition of a material that has been shown to prevent harmful expansion in accordance with Appendix XI of ASTM C33, when approved by the building official.*

1903A.6 [OSHPD 1 & 4] Limits on cementitious materials. *Modify ACI 318 Section 26.4.2.2(b) and Table 26.4.2.2(b) as follows:*

The maximum percentage of pozzolans, including fly ash and silica fume, and slag cement in concrete assigned to all exposure categories shall be in accordance with Table 26.4.2.2(b) and Section 26.4.2.2(b) Items (1) and (2).

Where pozzolans are used as cementitous materials, duration for minimum specified compressive strength of concrete (f'_c) that exceeds 28 days shall be considered an alternative system.

1903A.7 Steel fiber reinforcement *– Not permitted*

1903A.8 Welding of reinforcing bars *– Modify ACI 318 Section 26.6.4.1(b) by adding the following:*

Shop fusion welded stirrup/tie cage (or spiral assemblies) consisting of low-alloy steel reinforcing stirrups/ties conforming to ASTM A706 and longitudinal holding wires, conforming to ASTM A1064 shall be permitted. The fusion welds shall be made by machines using electric resistance welds. Tack welding of primary reinforcing bars together or to stirrups/ties is not permitted. Fusion welding of holding wires is not permitted on any portion of a reinforcing bar that is or will be bent in accordance with ACI 318 Section 25.3.

SECTION 1904*A*
DURABILITY REQUIREMENTS

1904*A*.1 Structural concrete. Structural concrete shall conform to the durability requirements of ACI 318.

1904*A*.2 Nonstructural concrete. *The registered design professional shall assign nonstructural concrete a freeze-thaw exposure class, as defined in ACI 318, based on the anticipated exposure of nonstructural concrete. Nonstructural con-*

crete shall have a minimum specified compressive strength, f'_c, of 2,500 psi (17.2 MPa) for Class F0; 3,000 psi (20.7 MPa) for Class F1; and 3,500 psi (24.1 MPa) for Classes F2 and F3. Nonstructural concrete shall be air entrained in accordance with ACI 318.

SECTION 1905*A*
MODIFICATIONS TO ACI 318

1905*A*.1 General. The text of ACI 318 shall be modified as indicated in Sections 1905*A.1.1* through *1905A.1.16*.

1905A.1.1 ACI 318 Section 4.12.2.2. *Modify ACI 318, Section 4.12.2.2 by adding the following:*

Where prestressed concrete elements are restrained from movement, an analysis of the stresses in the prestressed elements and loads in the adjoining structural system induced by the above-described effects shall be made in accordance with PCI Design Handbook.

1905A.1.2 ACI 318, Section 4.12.2.3. *Modify ACI 318 Section 4.12.2.3 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.

1905A.1.3 ACI 318, Section 9.6.1.3. *Modify ACI 318, Section 9.6.1.3 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.1.4 ACI 318, Section 11.2.4.1. *Replace ACI 318, Section 11.2.4.1 as follows:*

11.2.4.1 – 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.1.5 ACI 318 Section 11.7. *Add Section 11.7.6 to ACI 318.1 as follows:*

*11.7.6 – **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. Where wall panels do not connect to columns or other wall panels to develop at least 75 percent of the horizontal wall steel as noted below, vertical perimeter bars shall be retained by hooked wall bars*

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 paragraph 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 continuous. A continuous tie equivalent to two No. 5 bars minimum 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 connected to columns or to each other in such a manner as to develop at least 75 percent of the horizontal wall steel. No more than half of this continuous horizontal reinforcing shall 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 requirements of ACI 318, Section 25.5.2, for Class A shall be used. The reinforcing bars or welded tie details shall not be spaced over eight times the wall thickness vertically 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.

Exception: *Nonbearing, nonshear panels such as nonstructural architectural cladding panels or column covers are not required to meet the provisions of this section.*

1905A.1.6 ACI 318, Section 11.9. *Modify ACI 318 by adding Section 11.9 as follows:*

*11.9 – **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 11.6 and 11.7.

1905A.1.7 ACI 318, Section 12.7.3. *Add Section 12.7.3.4 to ACI 318 as follows:*

12.7.3.4 – At least two No. 5 bars in diaphragms having two layers of reinforcement in both directions and one No. 5 bar in diaphragms having a single layer of reinforcement in both directions shall be provided around openings larger than 12 inches in any dimension in addition to the minimum reinforcement required by Section 12.6.

1905A.1.8 ACI 318, Section 17.2.3. *Modify ACI 318, Sections 17.2.3.4.2, 17.2.3.4.3(d) and 17.2.3.5.2, to read as follows:*

17.2.3.4.2 – 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 17.2.3.4.3. The anchor design tensile strength shall be determined in accordance with Section 17.2.3.4.4.

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 17.2.3.4.3(d).*

17.2.3.4.3(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* 17.2.3.4.4.

17.2.3.5.2 – 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 17.2.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.5.

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 17.5.2 and 17.5.3 need not be computed and 17.2.3.5.3 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 AWC 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 $1^3/_4$ 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 17.5.2 and 17.5.3 need not be computed and 17.2.3.5.3 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 $1^3/_4$ 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 nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch (16 mm) in diameter of sill plate or track to foundation or foundation stem wall need not satisfy 17.2.3.5.3 (a) through (c) when the design strength of the anchors is determined in accordance with 17.5.2.1(c).*

1905A.1.9 ACI 318, Table 19.2.1.1. *Modify ACI 318, Table 19.2.1.1 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 normal weight 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.1.10 ACI 318, Section 18.5. [DSA-SS] Modify ACI 318, Section 18.5, by *replacing Section 18.5.2.1, adding new Section 18.5.2.2 and renumbering existing Sections 18.5.2.2 and 18.5.2.3 to become 18.5.2.3 and 18.5.2.4, respectively:*

18.5.2.1 – 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.

1905A.1.11 ACI 318, Section 18.10.6.5. *Modify ACI 318, Section 18.10.6.5 by adding the following:*

(c) Where boundary members are not required by ACI 318 Section 18.10.6.2 or 18.10.6.3 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 reinforce-

ment required per lineal foot of wall. Horizontal extent of boundary element shall be in accordance with ACI 318 Section 18.10.6.4 (a), (b) and (c).

1905A.1.12 ACI 318, Section 18.12.6. *Add Section 18.12.6.2 to ACI 318 as follows:*

18.12.6.2 – 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.1.13 **ACI 318, Section 18.13.1.1.** Modify ACI 318, Section 18.13.1.1, to read as follows:

18.13.1.1 – Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of 18.13 and other applicable provisions of ACI 318 *unless modified by Chapter 18A of the California Building Code.*

1905A.1.14 ACI 318, Table 21.2.2. *Replace Table 21.2.2 as follows:*

TABLE 21.2.2
STRENGTH REDUCTION FACTOR ϕ FOR MOMENT, AXIAL FORCE, OR COMBINED MOMENT AND AXIAL FORCE

NET TENSILE STRAIN ε_t	CLASSIFICATION	ϕ			
		Type of transverse reinforcement			
		Spirals conforming to 25.7.3		Other	
$\varepsilon_t \le \varepsilon_{ty}$	Compression-controlled	0.75	(a)	0.65	(b)
$\varepsilon_{ty} < \varepsilon_t < 0.005$	Transition[1, 2]	$0.75 + 0.15\frac{\varepsilon_t - \varepsilon_{ty}}{\varepsilon_t^* - \varepsilon_{ty}}$	(c)	$0.65 + 0.25\frac{\varepsilon_t - \varepsilon_{ty}}{\varepsilon_t^* - \varepsilon_{ty}}$	(d)
$\varepsilon_t \ge 0.005$	Tension-controlled[3]	0.9	(e)	0.9	(f)

1. For sections classified as transition, it shall be permitted to use ϕ corresponding to compression-controlled sections.
2. *ε_t^* is the greater of net tensile strain calculated for $P_n = 0.1A_g f'_c$ and 0.005.*
3. *For sections with factored axial compression force $P_u \ge 0.1A_g f'_c$, ϕ shall be calculated using equation (c) or (d) for sections classified as transition, as applicable.*

1905A.1.15 ACI 318, Section 24.2.1. *Add Section 24.2.1.1 to ACI 318 as follows:*

24.2.1.1 – Span to depth ratio. Prestressed Beam and Slab Span to depth ratios for continuous prestressed concrete members shall not exceed the following, except when calculations of deflections and vibration effects prove that greater values may be used without adverse effects:

Beams 30

One-way slabs 40

Two-way floor slabs 40

Two-way roof slabs 44

These ratios should be decreased for special conditions such as heavy loads and simple spans.

Maximum deflection criteria shall be in accordance with ACI 318 Section 24.2.2.

1905A.1.16 ACI 318, Section 26.12.2.1(a). *Replace ACI 318 Section 26.12.2.1(a) by the following:*

26.12.2.1(a) 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 (345 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.

SECTION 1906*A*
STRUCTURAL PLAIN CONCRETE

Not permitted by OSHPD and DSA-SS

SECTION 1907*A*
MINIMUM SLAB PROVISIONS

1907*A*.1 General. The thickness of concrete floor slabs supported directly on the ground shall not be less than $3^1/_2$ 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 that will not be enclosed at a later date.
5. Where approved based on local site conditions.

SECTION 1908*A*
SHOTCRETE

1908*A*.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.

1908*A*.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.

1908*A*.3 Aggregate. Coarse aggregate, if used, shall not exceed $^3/_4$ inch (19.1 mm).

For shear walls, when total rebar in any direction is more than 0.31 in^2/ft. or rebar size is larger than # 5, shotcrete shall conform to course aggregate grading No. 2 per Table 1.1 of ACI 506.

1908*A*.4 Reinforcement. Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1908*A*.4.1 through 1908*A*.4.4.

1908*A*.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.

1908*A*.4.2 Clearance. When No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of $2^1/_2$ 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.

1908*A*.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*A*.4.4 Spirally tied columns. Shotcrete shall not be applied to spirally tied columns.

1908*A*.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. Reports of preconstruction tests shall be submitted to the building official as specified in Section 1704*A*.5.

1908*A*.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.

1908*A*.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.

1908*A*.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.

1908*A*.9 Curing. During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.

1908*A*.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.

1908*A*.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.

1908*A*.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.

1908*A*.10 Strength tests. Strength tests for shotcrete shall be made *in accordance with ASTM C1604* 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 $^3/_8$ 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 $^3/_8$ 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.

1908A.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.

1908A.10.2 Panel criteria. When the maximum-size aggregate is larger than $^3/_8$ 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 $^3/_8$ 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.*

1908A.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.

➡ * ***1908A.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.

1908A.12 Placing. *Shotcrete shall be placed in accordance with ACI 506.*

SECTION 1909A
RESERVED

SECTION 1910A
CONCRETE, REINFORCEMENT AND ANCHOR TESTING

1910A.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 C150 for portland cement and ASTM C595 or ASTM C1157 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 C618 or ASTM C989, 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.*

1910A.2 Tests of reinforcing bars. *Samples shall be taken from bundles as delivered from the mill, with the bundles identified as to heat number and the accompanying mill certificate. One tensile test and one bend test shall be made from a sample 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 or non-building structures provided they are identified in the construction documents and certified mill test reports are provided to the inspector of record for each shipment of such reinforcement.

1910A.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).

   Anchorages 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 fur-*

nished 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.*

1910A.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.

1910A.5 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.*

1910A.5.1 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.

1910A.5.2 Testing procedure. *The test procedure shall be as permitted by an approved evaluation report using criteria adopted in this code. All post-installed anchors shall be tension tested.*

Exception: [OSHPD 1 & 4] *Torque-controlled post-installed anchors shall be permitted to be tested using torque based on an approved test report using criteria adopted in this code.*

Exception [DSA-SS]: *Torque-controlled post-installed anchors and screw type anchors shall be permitted to be tested using torque based on an approved test report using criteria adopted in this code.*

Alternatively, manufacturer's recommendation for testing may be approved by the enforcement agency, based on an approved test report using criteria adopted in this code.

1910A.5.3 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 components, 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.*

1910A.5.4 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 ($1^1/_4$) times the maximum design strength of anchors as provided in an approved evaluation report using criteria adopted in this code or determined in accordance with Chapter 17 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 an approved evaluation report using criteria adopted in this code.*

1910A.5.5 Test acceptance criteria. *Acceptance criteria for post-installed anchors shall be based on an approved evaluation report using criteria adopted in this code. Field tests shall satisfy the following minimum requirements.*

1. *Hydraulic ram method:*

   Anchors tested with a hydraulic jack or spring loaded apparatus 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 apparatus support shall not be located within 1.5 times the anchor's embedment depth to avoid restricting the concrete shear cone type failure mechanism from occurring.

2. *Torque wrench method:*

   Torque-controlled post-installed anchors tested with a calibrated torque wrench shall attain the specified torque within $^1/_2$ turn of the nut; or one-quarter ($^1/_4$) turn of the nut for a $^3/_8$ inch sleeve anchor only.

   [DSA-SS] *Screw-type anchors tested with a calibrated torque wrench shall attain the specified torque within one-quarter ($^1/_4$) turn of the screw after initial seating of the screw head.*

SECTION 1911A
EXISTING CONCRETE STRUCTURES

1911A.1 Existing concrete structures.

The structural use of existing concrete with a core strength less than 1,500 psi (10.3MPa) 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 $^3/_4$ inch (19 mm).

1911A.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.*

1911A.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.*

Design capacities, reliability, serviceability of FRP materials shall be permitted to be established in accordance with ICC-ES AC 125. Minimum inspection requirements of FRP composite systems shall be in accordance with ICC-ES AC 178.

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	BSC-CG	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																					
2003								X	X	X			X								

The state agency does not adopt sections identified with 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 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	BSC-CG	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												
Adopt only those sections that are listed below			X																		
Chapter / Section																					
2101.1.1									X												
2101.1.2									X												
2101.1.3									X												
2101.1.4									X												
2109.1.1																					
2113.9.2			X																		
2114									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 TMS 402/ACI 530/ASCE 5 or TMS 403 as well as applicable requirements of this chapter.

2101.2.1 Masonry veneer. Masonry veneer shall comply with the provisions of Chapter 14.

2101.3 Special inspection. The special inspection of masonry shall be as defined in Chapter 17, or an itemized testing and inspection program shall be provided that meets or exceeds the requirements of Chapter 17.

SECTION 2102
DEFINITIONS AND NOTATIONS

2102.1 General. The following terms are defined in Chapter 2:

AAC MASONRY.

ADOBE CONSTRUCTION.

Adobe, stabilized.
Adobe, unstabilized.

AREA.

Gross cross-sectional.
Net cross-sectional.

AUTOCLAVED AERATED CONCRETE (AAC).

BED JOINT.

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.

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.

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.

STONE MASONRY.

Ashlar stone masonry.
Rubble stone masonry.

STRENGTH.

Design strength.
Nominal strength.
Required strength.

TIE, WALL.

TILE, STRUCTURAL CLAY.

WALL.

Cavity wall.
Composite wall.
Dry-stacked, surface-bonded wall.
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 C1386, 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 Masonry units. Concrete masonry units, clay or shale masonry units, stone masonry units, glass unit masonry and AAC masonry units shall comply with Article 2.3 of TMS 602/ACI 503.1/ASCE 6. Architectural cast stone shall conform to ASTM C1364.

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 E119 or UL 263 and shall comply with the requirements of Table 602.

2103.1.1 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.

2103.2 Mortar. Mortar for masonry construction shall comply with Section 2103.2.1, 2103.2.2, 2103.2.3 or 2103.2.4.

2103.2.1 Masonry mortar. Mortar for use in masonry construction shall conform to Articles 2.1 and 2.6 A of TMS 602/ACI 530.1/ASCE 6.

2103.2.2 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C887. Surface bonding of concrete masonry units shall comply with ASTM C946.

2103.2.3 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 2103.2.3.

2103.2.3.1 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.

TABLE 2103.2.3
CERAMIC TILE MORTAR COMPOSITIONS

LOCATION	MORTAR	COMPOSITION
Walls	Scratchcoat	1 cement; $^1/_5$ hydrated lime; 4 dry or 5 damp sand
	Setting bed and leveling coat	1 cement; $^1/_2$ hydrated lime; 5 damp sand to 1 cement 1 hydrated lime, 7 damp sand
Floors	Setting bed	1 cement; $^1/_{10}$ hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand
Ceilings	Scratchcoat and sand bed	1 cement; $^1/_2$ hydrated lime; $2^1/_2$ dry sand or 3 damp sand

2103.2.3.2 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.

2103.2.3.3 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.

2103.2.3.4 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.

2103.2.3.5 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.

2103.2.3.6 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 be not 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.

2103.2.3.7 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.

2103.2.4 Mortar for adhered masonry veneer. Mortar for use with adhered masonry veneer shall conform to ASTM C270 for Type N or S, or shall comply with ANSI A118.4 for latex-modified Portland cement mortar.

2103.3 Grout. Grout shall comply with Article 2.2 of TMS 602/ACI 530.1/ASCE 6.

2103.4 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 and 2104.1.2 and with TMS 602/ACI 530.1/ASCE 6.

2104.1.1 Support on wood. Masonry shall not be supported on wood girders or other forms of wood construction except as permitted in Section 2304.12.

2104.1.2 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.

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 approved construction documents.

The quality assurance program shall comply with the inspection and testing requirements of Chapter 17 and TMS 602/ACI 530.1/ASCE 6.

SECTION 2106
SEISMIC DESIGN

2106.1 Seismic design requirements for masonry. Masonry structures and components shall comply with the requirements in Chapter 7 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 through 8 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 8.1.6.7.1.1, lap splices. As an alternative to Section 8.1.6.7.1.1, 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

$l_d = 0.002 d_b f_s$ **(Equation 21-1)**

For SI: $l_d = 0.29 d_b f_s$

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 8.1.6.7, splices of reinforcement. Modify Section 8.1.6.7 as follows:

8.1.6.7 – 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 A706 steel reinforcement. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section 8.1.6.7.3.

2107.4 TMS 402/ACI 530/ASCE 5, Section 8.3.6, maximum bar size. Add the following to Chapter 8:

8.3.6 – 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 through 7 and Chapter 9 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 through 7 and Chapter 11 of TMS 402/ACI 530/ASCE 5.

2108.2 TMS 402/ACI 530/ASCE 5, Section 9.3.3.3, development. Modify the second paragraph of Section 9.3.3.3 as follows:

The required development length of reinforcement shall be determined by Equation (9-16), 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 9.3.3.4, splices. Modify items (c) and (d) of Section 9.3.3.4 as follows:

9.3.3.4 (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 A706 steel reinforcement. Welded splices shall not be permitted in plastic hinge zones of intermediate or special reinforced walls.

9.3.3.4 (d) – Mechanical splices shall be classified as Type 1 or 2 in accordance with Section 18.2.7.1 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. 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 Appendix A 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 A.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 A.1.2 of TMS 402/ACI 530/ASCE 5, masonry shall be designed in accordance with the engineered design provisions of Section 2101.2 or the foundation wall provisions of Section 1807.1.5.

Section A.1.2.2 of TMS 402/ACI 530/ASCE 5 shall be modified as follows:

A.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_{asd} as determined in accordance with Sec-

tion 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 Appendix A 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 C946.

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, Appendix A 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 C67. 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:

$$f_r = 3\,PL_s\,/2\,S_w\,(S_t^2) \qquad \textbf{(Equation 21-2)}$$

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 $^1/_8$ 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 $2^1/_2$ 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)
$^1/_2$	—	—
$^5/_8$	12	200
$^3/_4$	15	300
$^7/_8$	18	400
1	21	500
$1^1/_8$	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 this chapter 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 $^3/_4$ inch (19.1 mm) and conforming to ASTM C926. Lathing shall comply with ASTM C1063. Fasteners shall be spaced at 16 inches (406 mm) on center maximum. Exposed wood surfaces shall be treated with an approved wood preservative or other protective coating prior to lath application.

SECTION 2110
GLASS UNIT MASONRY

2110.1 General. Glass unit masonry construction shall comply with Chapter 13 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 $^3/_4$ 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 and ramps or exit passageways.
2. Glass-block assemblies as permitted in Section 404.6, Exception 2.

SECTION 2111
MASONRY FIREPLACES

2111.1 General. The construction of masonry fireplaces, consisting of concrete or masonry, shall be in accordance with this section.

2111.2 Fireplace drawings. The construction documents shall describe in sufficient detail the location, size and construction of masonry fireplaces. The thickness and character- **

istics of materials and the clearances from walls, partitions and ceilings shall be indicated.

2111.3 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.

2111.3.1 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.

2111.4 Seismic reinforcement. In structures assigned to Seismic Design Category A or B, seismic reinforcement is not required. In structures assigned to Seismic Design Category C or D, masonry fireplaces shall be reinforced and anchored in accordance with Sections 2111.4.1, 2111.4.2 and 2111.5. In structures assigned to Seismic Design Category E or F, masonry fireplaces shall be reinforced in accordance with the requirements of Sections 2101 through 2108.

2111.4.1 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 2103.3. 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.

2111.4.2 Horizontal reinforcing. Vertical reinforcement shall be placed enclosed within $^{1}/_{4}$-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.

2111.5 Seismic anchorage. Masonry fireplaces and foundations shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade with two $^{3}/_{16}$-inch by 1-inch (4.8 mm by 25 mm) straps 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 $^{1}/_{2}$-inch (12.7 mm) bolts.

Exception: Seismic anchorage is not required for the following:

1. In structures assigned to Seismic Design Category A or B.
2. Where the masonry fireplace is constructed completely within the exterior walls.

2111.6 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 be not greater than $^{1}/_{4}$ 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 C27 or ASTM C1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C199.

2111.6.1 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 $^{1}/_{4}$ 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.

2111.7 Firebox dimensions. The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall be not 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 be not less than the cross-sectional area of the flue.

Exception: Rumford fireplaces shall be permitted provided that the depth of the fireplace is not less than 12 inches (305 mm) and at least one-third of the width of the fireplace opening, and the throat is not less than 12 inches (305 mm) above the lintel, and at least $^{1}/_{20}$ the cross-sectional area of the fireplace opening.

2111.8 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 not less than 8 inches (203 mm) above the top of the fireplace opening.

2111.8.1 Damper. Masonry fireplaces shall be equipped with a ferrous metal damper located not less than 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.

2111.9 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 C199. When a lining of firebrick not less than 2 inches (51 mm) thick, or a lining of vitrified clay not less than $^5/_8$ 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 C1261 and shall be laid with refractory mortar conforming to ASTM C199. Vitrified clay linings shall conform to ASTM C315.

2111.9.1 Smoke chamber dimensions. The inside height of the smoke chamber from the fireplace throat to the beginning of the flue shall be not 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.

2111.10 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.

2111.10.1 Hearth thickness. The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

2111.10.2 Hearth extension thickness. The minimum thickness of hearth extensions shall be 2 inches (51 mm).

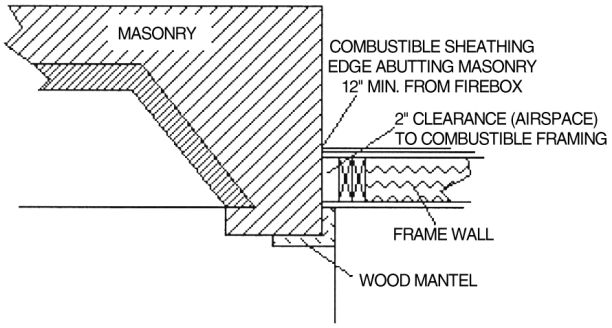
Exception: When the bottom of the firebox opening is raised not less than 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than $^3/_8$-inch-thick (9.5 mm) brick, concrete, stone, tile or other approved noncombustible material is permitted.

2111.11 Hearth extension dimensions. Hearth extensions shall extend not less than 16 inches (406 mm) in front of, and not less than 8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m^2) or larger, the hearth extension shall extend not less than 20 inches (508 mm) in front of, and not less than 12 inches (305 mm) beyond, each side of the fireplace opening.

2111.12 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 2111.13.

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 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 2111.12, provided such combustible trim or sheathing is not less than 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 $^1/_8$ 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 $1^1/_2$ 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 2111.12
ILLUSTRATION OF EXCEPTION TO FIREPLACE CLEARANCE PROVISION

2111.13 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.

2111.14 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.

2111.14.1 Factory-built fireplaces. Exterior combustion air ducts for factory-built fireplaces shall be listed compo-

nents of the fireplace, and installed according to the fireplace manufacturer's instructions.

2111.14.2 Masonry fireplaces. Listed combustion air ducts for masonry fireplaces shall be installed according to the terms of their listing and manufacturer's instructions.

2111.14.3 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 $^1/_4$-inch (6.4 mm) mesh.

2111.14.4 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.

2111.14.5 Passageway. The combustion air passageway shall be not less than 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.

2111.14.6 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 E1602.
2. Masonry heaters shall be listed and labeled in accordance with UL 1482 or EN 15250 and installed in accordance with the manufacturer's 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 (914 mm) or the distance of the allowed reduction method from the outside surface of a masonry heater in accordance with NFPA 211, Section 12.6, 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. Where the masonry heater wall thickness is at least 8 inches (203 mm) of solid masonry and the wall thickness of the heat exchange channels is not less than 5 inches (127 mm) 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 not less than 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 or EN 15250 and installed in accordance with the manufacturer's instructions.

SECTION 2113
MASONRY CHIMNEYS

2113.1 General. The construction of masonry chimneys consisting of solid masonry units, hollow masonry units grouted solid, stone or concrete shall be in accordance with this section.

2113.2 Footings and foundations. Footings for masonry chimneys shall be constructed of concrete or solid masonry not less than 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 not less than 12 inches (305 mm) below finished grade.

2113.3 Seismic reinforcement. In structures assigned to Seismic Design Category A or B, seismic reinforcement is not required. In structures assigned to Seismic Design Category C or D, masonry chimneys shall be reinforced and anchored in accordance with Sections 2113.3.1, 2113.3.2 and 2113.4. In structures assigned to Seismic Design Category E or F, masonry chimneys shall be reinforced in accordance with the requirements of Sections 2101 through 2108 and anchored in accordance with Section 2113.4.

2113.3.1 Vertical reinforcement. 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 2103.3. 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 reinforcement. Vertical reinforcement shall be placed enclosed within $^1/_4$-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 not less than 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 chimneys and foundations shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade with two $^3/_{16}$-inch by 1-inch (4.8 mm by 25 mm) straps embedded not less than 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 not less than four floor joists with two $^1/_2$-inch (12.7 mm) bolts.

Exception: Seismic anchorage is not required for the following;

1. In structures assigned to Seismic Design Category A or B.
2. Where the masonry fireplace is constructed completely within the exterior walls.

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 not less than 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 C1283.

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 arrestor shall meet all of the following requirements:

1. *The net free area of the spark arrestor shall not be less than four times the net free area of the outlet of the chimney.*
2. *The spark arrestor 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 $^1/_2$ inch (13 mm) nor block the passage of spheres having a diameter less than $^3/_8$ 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.

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 be not 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 C315.
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 not less than 8 inches (203 mm) thick, or with stone masonry not less than 12 inches (305 mm) thick.

2113.11.2.3 Lining. Concrete and masonry chimneys shall be lined with an approved medium-duty refractory brick not less than $4^1/_2$ inches (114 mm) thick laid on the $4^1/_2$-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.

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 not less than 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 not less than 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, not less than $4^1/_2$ inches (114 mm) thick laid on the $4^1/_2$-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.

2113.11.3.4 Termination height. Concrete and masonry chimneys for high-heat appliances shall extend not less than 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 C1283 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 C199 with tight mortar joints left smooth on the inside and installed to maintain an airspace 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 not less than 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 be not less than the area of the largest connector plus 50 percent of the areas of additional chimney connectors.

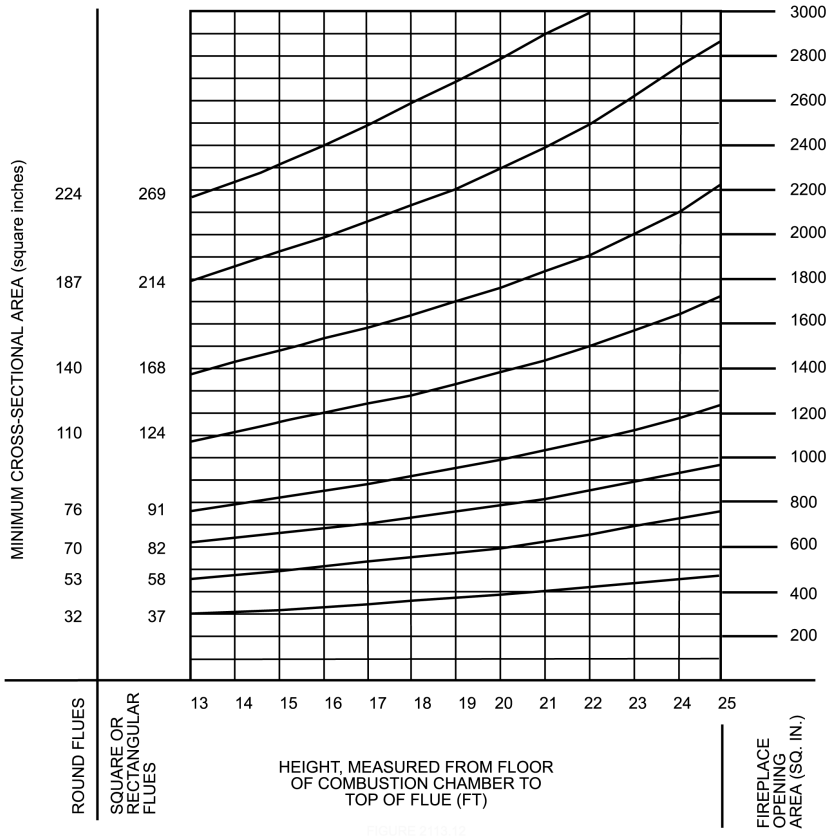
Exceptions:

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 *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 not less than $^1/_{12}$ of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of not less than $^1/_{10}$ 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 not less than $^1/_{10}$ 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 not less than $^1/_8$ 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 not less than 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.



For SI: 1 inch = 25.4 mm, 1 square inch = 645 mm^2.

FIGURE 2113.16
FLUE SIZES FOR MASONRY CHIMNEYS

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
$10^{3}/_{4}$	90
12	113
15	176
18	254

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2.

a. Flue sizes are based on ASTM C315.

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 mm^2.

2113.17 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.

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 not less than 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be not less than 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 not less than 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).

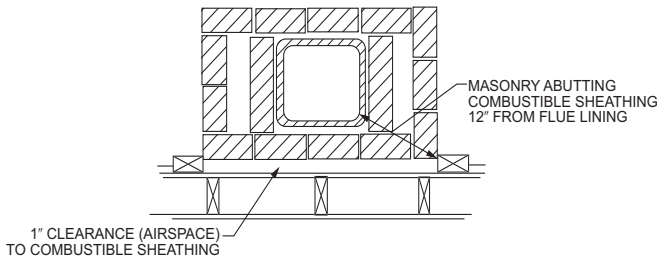


FIGURE 2113.19
ILLUSTRATION OF EXCEPTION THREE
CHIMNEYCLEARANCE PROVISION

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.

SECTION 2114
ADDITIONAL REQUIREMENTS FOR COMMUNITY COLLEGES [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 Air entrainment. *Air-entraining substances shall not be used in grout unless tests are conducted to determine compliance with the requirements of this code.*

2114.3 Grouted masonry.

2114.3.1 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 $^1/_4$ inch (6.4 mm), mortar droppings and other foreign material.*

All cells shall be solidly filled with grout.

> ***Exception:*** *Reinforced hollow-unit masonry laid in running bond used for freestanding site walls or interior nonbearing non-shear wall partitions may be grouted only in cells containing vertical and horizontal reinforcement.*

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 $^1/_2$ 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 $1^1/_2$ 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 $^1/_2$ inch (12.7 mm) below the top of the masonry.

The construction documents shall completely describe grouting procedures, subject to approval of DSA.

2114.4 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.*

2114.5 Specified compressive strength. *The specified compressive strength, f'_m, assumed in design shall be not less than 2,000 psi (13.79 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 2114.6.2.*

In no case shall the f'_m assumed in design exceed 3,000 psi (20.68 MPa).

2114.6 Additional testing requirements.

2114.6.1 Mortar and grout tests. *At the beginning of all masonry work, at least one test sample of the mortar shall be taken on three successive working days and at least at one-week intervals thereafter. Where mortar is based on a proportion specification, mortar shall be sampled and tested during construction in accordance with ASTM C780 Annex 4 and 5 to verify the proportions specified in ASTM C270, Table 2. Where mortar is based on a property specification, mortar shall be laboratory prepared and tested prior to construction in accordance with ASTM C780 to verify the properties specified in ASTM C270, Table 1 and field sampled and tested during construction in accordance with ASTM C780 to verify the proportions with the laboratory tests. Mortar sampling and testing is not required for approved preblended mortars in conformance with ASTM C270.*

Samples of grout shall be taken for each mix design, each day grout is placed, and not less than every 5,000 square feet of masonry wall area. The grout shall meet the minimum strength requirement given in ASTM C476/TMS 602 Section 2.2 for mortar and grout. Test specimens for grout shall be made as set forth in ASTM C1019.

Additional samples shall be taken whenever any change in materials or job conditions occur, as determined by the building official. When the prism test method is used during construction, the tests in this section are not required.

> ***Exception:*** *For non-bearing non-shear masonry walls not exceeding total wall height of 12 feet above wall base, mortar test shall be permitted to be limited to those at the beginning of masonry work for each mix design.*

2114.6.2 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 masonry wall area or fraction thereof. The approved agency shall perform or observe the coring of the masonry walls and sample locations shall be subject to approval of the registered design professional.*

Core samples shall comply with the following:

1. *Cored no sooner than 7 days after grouting of the selected area;*
2. *Be a minimum of $3^3/_4$" inches (76 mm) in nominal diameter; and*
3. *Sampled in such a manner as to exclude any masonry unit webs, mortar joint, or reinforcing steel. If all cells contain reinforcement, alternate core locations or means to detect void or delamination shall be selected by the registered design professional and approved by the building official.*

Visual examination of all cores shall be made by an approved agency and the condition of the cores reported as required by the California Administrative Code. Shear test shall test both joints between the grout core and the outside wythes or face shell of the masonry 28 days after grouting of the sample area using a shear test apparatus acceptable to the enforcement agency. Core samples shall not be soaked before testing. Core samples to be tested shall be stored in sealed plastic bags or non-absorbent containers immediately after coring and for at least 5 days prior to testing. The average unit shear value for each pair of cores (4 shear tests) from each 5,000 square feet of wall area (or less) on the cross section of the cores shall not be less than 2.5 $\sqrt{f'_m}$ psi.

All cores shall be submitted to an approved agency for examination, even where the core specimens failed during the cutting operation. The approved agency 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.

Exceptions:

1. *Core sampling and testing is not required for non-bearing non-shear masonry walls, not exceeding total wall height of 12 feet above wall base, built with single-wythe hollow unit concrete masonry that attaches opposite face shells using webs cast as single unit, when designed using an f'_m not exceeding 2,000 psi (13.79 MPa).*
2. *An infrared thermographic survey or other non-destructive test procedures, shall be permitted to be approved as an alternative system to detect voids or delamination in grouted masonry in-lieu of core sampling and testing.*

2114.7 Modifications to TMS 402/ACI 530/ASCE 5.

2114.7.1 *Modify TMS 402/ACI 530/ASCE 5, Section 7.4.4 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 shall be considered as continuous reinforcement.*

   Horizontal reinforcing bars in bond beams 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.
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 $^3/_8$ 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 $^1/_2$-inch (13 mm) diameter for 6-inch (152 mm) nominal masonry, $^3/_4$-inch (19 mm) diameter for 8-inch (203 mm) nominal masonry, $^7/_8$-inch (22 mm) diameter for 10-inch (254 mm) nominal masonry, and 1-inch (25mm) diameter for 12-inch (304.8 mm) nominal masonry.*

2114.8 Additional requirements for allowable stress design.

2114.8.1 TMS 402/ACI 530/ASCE 5 *Modify by adding Section 8.1.7 as follows:*

8.1.7 – 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 2114.8.1.

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.*

2114.8.2 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.

2114.9 Glass unit masonry construction. *Masonry glass block walls or panels shall be designated for seismic forces. Stresses in glass block shall not be utilized.*

TABLE 2114.8.1
MINIMUM THICKNESS OF MASONRY WALLS[1, 2]

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

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 21*A* – 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	BSC-CG	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																		

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*A*

MASONRY

SECTION 2101*A*
GENERAL

2101*A*.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 TMS 402/ACI 530/ASCE 5 as well as applicable requirements of this chapter.

2101*A*.2.6 Masonry veneer. Masonry veneer shall comply with the provisions of Chapter 14.

2101*A*.3 Special inspection. The special inspection of masonry shall be as defined in Chapter 17*A*, or an itemized testing and inspection program shall be provided that meets or exceeds the requirements of Chapter 17*A*.

SECTION 2102*A*
DEFINITIONS AND NOTATIONS

2102*A*.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.

AREA.

Gross cross-sectional.
Net cross-sectional.

AUTOCLAVED AERATED CONCRETE (AAC).

BED JOINT.

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.

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.

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.

STONE MASONRY.

Ashlar stone masonry.
Rubble stone masonry.

STRENGTH.

Design strength.
Nominal strength.
Required strength.

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.*
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 C1386, 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*A*
MASONRY CONSTRUCTION MATERIALS

2103*A*.1 Masonry units. Concrete masonry units, clay or shale masonry units *and* glass unit masonry shall comply with Article 2.3 of TMS 602/ACI 503.1/ASCE 6. Architectural cast stone shall conform to ASTM C1364.

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 E119 or UL 263 and shall comply with the requirements of Table 602.

2103.1.1 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*A*.2 Mortar. Mortar for masonry construction shall comply with Section 2103*A*.2.1, 2103*A*.2.2, 2103*A*.2.3 or 2103*A*.2.4.

2103*A*.2.1 Masonry mortar. Mortar for use in masonry construction shall conform to Articles 2.1 and 2.6 A of TMS 602/ACI 530.1/ASCE 6.

2103*A*.2.2 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C887. Surface bonding of concrete masonry units shall comply with ASTM C946.

2103*A*.2.3 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*A*.2.3.

TABLE 2103*A*.2.3
CERAMIC TILE MORTAR COMPOSITIONS

LOCATION	MORTAR	COMPOSITION
Walls	Scratchcoat	1 cement; $^1/_5$ hydrated lime; 4 dry or 5 damp sand
	Setting bed and leveling coat	1 cement; $^1/_2$ hydrated lime; 5 damp sand to 1 cement 1 hydrated lime, 7 damp sand
Floors	Setting bed	1 cement; $^1/_{10}$ hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand
Ceilings	Scratchcoat and sand bed	1 cement; $^1/_2$ hydrated lime; $2^1/_2$ dry sand or 3 damp sand

2103*A*.2.3.1 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*A*.2.3.2 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*A*.2.3.3 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*A*.2.3.4 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*A*.2.3.5 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*A*.2.3.6 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 be not 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*A*.2.3.7 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*A*.2.4 Mortar for adhered masonry veneer. Mortar for use with adhered masonry veneer shall conform to ASTM C270 for Type N or S, or shall comply with ANSI A118.4 for latex-modified Portland cement mortar.

2103*A*.3 Grout. Grout shall comply with Article 2.2 of TMS 602/ACI 530.1/ASCE 6.

2103A.3.1 Aggregate. *Coarse grout shall be used in grout spaces between wythes of 2 inches (51 mm) or more in width as determined in accordance with TMS 602 Table 7, footnote 3, and in all grouted cells of hollow unit masonry construction.*

2103*A*.4 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.5 Air entrainment. *Air-entraining substances shall not be used in grout unless tests are conducted to determine compliance with the requirements of this code.*

SECTION 2104*A* CONSTRUCTION

2104*A*.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104*A*.1.1 *through 2104A.1.3* and with TMS 602/ACI 530.1/ASCE 6.

2104*A*.1.1 Support on wood. Masonry shall not be supported on wood girders or other forms of wood construction except as permitted in Section 2304*A*.12.

2104*A*.1.2 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.1.3 Grouted masonry.

2104A.1.3.1 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 $^1/_4$ 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 $^1/_2$ 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.

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 $1^1/_2$ 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 $^1/_2$ 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.1.3.1.1 Reinforced grouted masonry.

2104A.1.3.1.1.1 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.1.3.1.1.1.1 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 $2^1/_2$ inches (64 mm). All reinforcement and wire ties shall be embedded in the grout. The thickness of the grout between masonry units and reinforcment 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. *Toothing of masonry walls is prohibited. Racking is to be held to a minimum.*

2104A.1.3.1.1.1.2 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 $3^1/_2$ inches (89 mm). All reinforcent and wire ties shall be embedded in the grout. The thickness of the grout between masonry units and reinforcent 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.1.3.1.2 Reinforced hollow-unit masonry.

2104A.1.3.1.2.1 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.*

Exception: *Reinforced hollow-unit masonry laid in running bond used for freestanding site walls or interior nonbearing non-shear wall partitions may be grouted only in cells containing vertical and horizontal reinforcement.*

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 grout space dimension of 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), as determined in accordance with TMS 602 Table 7, footnote 3.*
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 $1^1/_2$ inches (38 mm) and the width shall be 3 inches (76 mm) minimum.*

2104A.1.3.1.2.2 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 reinforce-*

ment shall be fully embedded in grout in an uninterrupted pour.

2104A.1.3.1.2.3 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 double 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 2105*A*
QUALITY ASSURANCE

2105.1 General. A quality assurance program shall be used to ensure that the constructed masonry is in compliance with the approved construction documents.

The quality assurance program shall comply with the inspection and testing requirements of Chapter 17 and TMS 602/ACI 530.1/ASCE 6.

2105A.2 Compressive strength, f'_m. *The specified compressive strength, f'_m, assumed in design shall be 2,000 psi (13.79 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.*

Exception: *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 2,000 psi (13.79 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 using prism test method and core shear testing in accordance with Section 2105A.4. Substantiation for the specified compressive strength prior to the start of construction shall be obtained by using prism test method and Section 2105A.3.

2105A.3 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 shall be taken on three successive working days and at least at one-week intervals thereafter. Samples of grout shall be taken for each mix design, each day grout is placed, and not less than every 5,000 square feet of masonry wall area. They shall meet the minimum strength requirement given in ASTM C270 Table 1 and ASTM C476/TMS 602 Section 2.2 for mortar and grout respectively. Additional samples shall be taken whenever any change in materials or job conditions occur, as determined by the building official. When the prism test method 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 C1586 and ASTM C1019.

Exceptions:

1. ***[DSA-SS & OSHPD 1 & 4]*** *For non-bearing non-shear masonry walls not exceeding total wall height of 12' above wall base, mortar test shall be permitted to be limited to those at the beginning of masonry work for each mix design.*
2. ***[DSA-SS]*** *Mortar sampling and testing shall be as follows: At the beginning of all masonry work, mortar test samples shall be taken on three successive working days and at least at one-week intervals thereafter. Where mortar is based on a proportion specification, mortar shall be sampled and tested during construction in accordance with ASTM C780 Annex 4 and 5 to verify the proportions specified in ASTM C270, Table 2. Where mortar is based on a property specification, mortar shall be laboratory prepared and tested prior to construction in accordance with ASTM C780 to verify the properties specified in ASTM C270, Table 1 and field sampled and tested during construction in accordance with ASTM C780 to verify the proportions with the laboratory tests. Mortar sampling and testing is not required for approved preblended mortars in conformance with ASTM C270.*

2105A.4 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 masonry wall area or fraction thereof. The approved agency shall perform or observe the coring of the masonry walls and sample locations shall be subject to approval of the registered design professional.*

Core samples shall comply with the following:

1. *Cored no sooner than 7 days after grouting of the selected area;*
2. *Be a minimum of $3^3/_4$" in nominal diameter; and*
3. *Sampled in such a manner as to exclude any masonry unit webs, mortar joint, or reinforcing steel. If all cells contain reinforcement, alternate core locations or means to detect void or delamination shall be selected by the registered design professional and approved by the building official.*

Visual examination of all cores shall be made by an approved agency and the condition of the cores reported as required by the California Administrative Code. Shear test

both joints between the grout core and the outside wythes or face shell of the masonry 28 days after grouting of the sample area using a shear test apparatus acceptable to the enforcement agency. Core samples shall not be soaked before testing. Core samples to be tested shall be stored in sealed plastic bags or non-absorbent containers immediately after coring and for at least 5 days prior to testing. The average unit shear value for each pair of cores (4 shear tests) from each 5,000 square feet of wall area (or less) on the cross section of core shall not be less than 2.5 $\sqrt{f'_m}$ psi.

All cores shall be submitted to an approved agency for examination, even where the core specimens failed during the cutting operation. The approved agency 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.

Exceptions:

1. *Core sampling and testing is not required for nonbearing non-shear masonry walls, not exceeding total wall height of 12 feet above wall base, built with single-wythe hollow unit concrete masonry that attaches opposite face shells using webs cast as single unit, when designed using an f'_m not exceeding 2,000 psi (13.79 MPa).*
2. *An infrared thermographic survey or other nondestructive test procedures, shall be permitted to be approved as an alternative system to detect voids or delamination in grouted masonry in-lieu of core sampling and testing.*

SECTION 2106*A*
SEISMIC DESIGN

2106*A*.1 Seismic design requirements for masonry. Masonry structures and components shall comply with the requirements in Chapter 7 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 7.4.4 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 shall be considered as continuous reinforcement.*

   Horizontal reinforcing bars in bond beams 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.
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 $^3/_8$ 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 $^1/_2$-inch (13 mm) diameter for 6-inch (152 mm) nominal masonry, $^3/_4$-inch (19 mm) diameter for 8-inch (203 mm) nominal masonry, $^7/_8$-inch (22 mm) diameter for 10-inch (254 mm) nominal*

masonry, and 1-inch (25mm) diameter for 12-inch (304.8 mm) nominal masonry.

SECTION 2107*A*
ALLOWABLE STRESS DESIGN

2107*A*.1 General. The design of masonry structures using allowable stress design shall comply with Section 2106*A* and the requirements of Chapters 1 through 8 of TMS 402/ACI 530/ASCE 5 except as modified by Sections 2107*A*.2 through *2107A.6*.

2107*A*.2 TMS 402/ACI 530/ASCE 5, Section *8.1.6.7.1.1*, lap splices. In lieu of Section *8.1.6.7.1.1,* it shall be permitted to design lap splices in accordance with Section 2107A.*2.1.*

2107*A*.2.1 Lap splices. The minimum length of lap splices for reinforcing bars in tension or compression, l_d, shall be

$l_d = 0.002 d_b f_s$ **(Equation 21*A*-1)**

For SI: $l_d = 0.29 d_b f_s$

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.

2107*A*.3 TMS 402/ACI 530/ASCE 5, Section *8.1.6*, splices of reinforcement. Modify Section *8.1.6* 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 A706 steel reinforcement. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section *2.1.7.7.3.*

2107*A*.4 TMS 402/ACI 530/ASCE 5, Section 8.3.6, maximum bar size. Add the following to Chapter 8:

8.3.6 – 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 8.1.7, as follows:*

8.1.7 - 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. <

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 8.3.4.4 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 8-23.

TABLE 2107A.5
MINIMUM THICKNESS OF MASONRY WALLS[1, 2]

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.*

SECTION 2108*A*
STRENGTH DESIGN OF MASONRY

2108*A*.1 General. The design of masonry structures using strength design shall comply with Section 2106*A* and the requirements of Chapters 1 through 7 and Chapter 9 of TMS 402/ACI 530/ASCE 5, except as modified by Sections 2108*A*.2 through 2108*A*.3. <

2108*A*.2 TMS 402/ACI 530/ASCE 5, Section 9.3.3.3, development. Modify the second paragraph of Section 9.3.3.3 as follows:

The required development length of reinforcement shall be determined by Equation (9-16), but shall not be less than 12 inches (305 mm) and need not be greater than 72 d_b.

2108*A*.3 TMS 402/ACI 530/ASCE 5, Section 9.3.3.4, splices. Modify items (c) and (d) of Section 9.3.3.4 as follows:

9.3.3.4 (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 A706 steel reinforcement. Welded splices shall not be permitted in plastic hinge zones of intermediate or special reinforced walls.

9.3.3.4 (d) – Mechanical splices shall be classified as Type 1 or 2 in accordance with Section 18.2.7.1 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. Type 2 mechanical splices are permitted in any location within a member.

SECTION 2109*A*
EMPIRICAL DESIGN OF MASONRY
Not permitted by OSHPD and DSA.

SECTION 2110*A*
GLASS UNIT MASONRY

2110*A*.1 General. Glass unit masonry construction shall comply with Chapter 13 of TMS402/ACI 530/ASCE 5 and this section.

Masonry glass block walls or panels shall be designed for seismic forces. Stresses in glass block shall not be utilized.

2110*A*.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 $^3/_4$ 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 and ramps or exit passageways.
2. Glass-block assemblies as permitted in Section 404.6, Exception 2.

SECTION 2111*A*
MASONRY FIREPLACES

2111*A*.1 General. The construction of masonry fireplaces, consisting of concrete or masonry, shall be in accordance with this section. **

2111*A*.2 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.

2111*A*.3 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*A*.3.1 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*A*.4 Seismic reinforcement. In structures assigned to Seismic Design Category A or B, seismic reinforcement is not required. In structures assigned to Seismic Design Category C or D, masonry fireplaces shall be reinforced and anchored in accordance with Sections 2111*A*.4.1, 2111*A*.4.2 and 2111*A*.5. In structures assigned to Seismic Design Category E or F, masonry fireplaces shall be reinforced in accordance with the requirements of Sections 2101*A* through 2108*A*.

2111*A*.4.1 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*A*.3. 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*A*.4.2 Horizontal reinforcing. Vertical reinforcement shall be placed enclosed within $^1/_4$-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*A*.5 Seismic anchorage. Masonry fireplaces and foundations shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade with two $^3/_{16}$-inch by 1-inch (4.8 mm by 25 mm) straps 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 $^1/_2$-inch (12.7 mm) bolts.

Exception: Seismic anchorage is not required for the following:

1. In structures assigned to Seismic Design Category A or B.
2. Where the masonry fireplace is constructed completely within the exterior walls.

2111*A*.6 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 be not greater than $^1/_4$ 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 C27 or ASTM C1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C199.

2111*A*.6.1 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 $^1/_4$ 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*A*.7 Firebox dimensions. The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall be not 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 be not less than the cross-sectional area of the flue.

Exception: Rumford fireplaces shall be permitted provided that the depth of the fireplace is not less than 12 inches (305 mm) and at least one-third of the width of the fireplace opening, and the throat is not less than 12 inches (305 mm) above the lintel, and at least $^1/_{20}$ the cross-sectional area of the fireplace opening.

2111*A*.8 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 not less than 8 inches (203 mm) above the top of the fireplace opening.

2111*A*.8.1 Damper. Masonry fireplaces shall be equipped with a ferrous metal damper located not less than 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*A*.9 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 C199. When a lining of firebrick not less than 2 inches (51 mm) thick, or a lining of vitrified clay not less than $^5/_8$ 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 C1261 and shall be laid with refractory mortar conforming to ASTM C199. Vitrified clay linings shall conform to ASTM C315.

2111*A*.9.1 Smoke chamber dimensions. The inside height of the smoke chamber from the fireplace throat to the beginning of the flue shall be not 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*A*.10 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*A*.10.1 Hearth thickness. The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

2111*A*.10.2 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 not less than 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than $^3/_8$ inch thick (9.5 mm) brick, concrete, stone, tile or other approved noncombustible material is permitted.

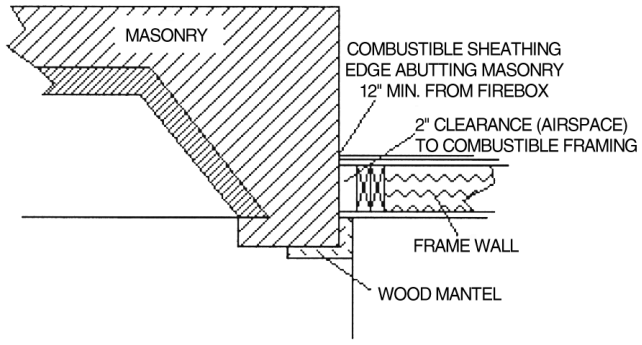
2111*A*.11 Hearth extension dimensions. Hearth extensions shall extend not less than 16 inches (406 mm) in front of, and not less than 8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m^2) or larger, the hearth extension shall extend not less than 20 inches (508 mm) in front of, and not less than 12 inches (305 mm) beyond, each side of the fireplace opening.

2111*A*.12 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 2111*A*.13.

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 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 2111*A*.12, provided such combustible trim or sheathing is not less than 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 $^1/_8$ 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 $1^1/_2$ 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 2111*A*.12
ILLUSTRATION OF EXCEPTION TO FIREPLACE CLEARANCE PROVISIONS

2111*A*.13 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*A*.14 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*A*.14.1 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*A*.14.2 Masonry fireplaces. Listed combustion air ducts for masonry fireplaces shall be installed according to the terms of their listing and manufacturer's instructions.

2111*A*.14.3 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 $^1/_4$ inch (6.4 mm) mesh.

2111*A*.14.4 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*A*.14.5 Passageway. The combustion air passageway shall be not less than 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*A*.14.6 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*A*
MASONRY HEATERS

2112*A*.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*A*.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 E1602.

2. Masonry heaters shall be listed and labeled in accordance with UL 1482 or EN 15250 and installed in accordance with the manufacturer's instructions.

2112*A*.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*A*.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*A*.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*A*.

2112*A*.5 Masonry heater clearance. Combustible materials shall not be placed within 36 inches (914 mm) or the distance of the allowed reduction method from the outside surface of a masonry heater in accordance with NFPA 211, Section 12.6, 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. Where the masonry heater wall thickness is at least 8 inches (203 mm) of solid masonry and the wall thickness of the heat exchange channels is not less than 5 inches (127 mm) 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 not less than 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 or EN 15250 and installed in accordance with the manufacturer's instructions.

SECTION 2113*A*
MASONRY CHIMNEYS

2113*A*.1 General. The construction of masonry chimneys consisting of solid masonry units, hollow masonry units grouted solid, stone or concrete shall be in accordance with this section.

2113*A*.2 Footings and foundations. Footings for masonry chimneys shall be constructed of concrete or solid masonry not less than 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 not less than 12 inches (305 mm) below finished grade.

2113*A*.3 Seismic reinforcement. In structures assigned to Seismic Design Category A or B, seismic reinforcement is not required. In structures assigned to Seismic Design Category C or D, masonry chimneys shall be reinforced and anchored in accordance with Sections 2113*A*.3.1, 2113*A*.3.2 and 2113*A*.4. In structures assigned to Seismic Design Category E or F, masonry chimneys shall be reinforced in accordance with the requirements of Sections 2101 through 2108 and anchored in accordance with Section 2113*A*.4.

2113*A*.3.1 Vertical reinforcement. 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*A*.3. 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*A*.3.2 Horizontal reinforcement. Vertical reinforcement shall be placed enclosed within $^1/_4$-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 not less than every 18 inches (457 mm) of vertical height. Two such ties shall be provided at each bend in the vertical bars.

2113*A*.4 Seismic anchorage. Masonry chimneys and foundations shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade with two $^3/_{16}$-inch by 1-inch (4.8 mm by 25 mm) straps embedded not less than 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 not less than four floor joists with two $^1/_2$-inch (12.7 mm) bolts.

Exception: Seismic anchorage is not required for the following;

1. In structures assigned to Seismic Design Category A or B.
2. Where the masonry fireplace is constructed completely within the exterior walls.

2113*A*.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*A*.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*A*.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*A*.5.

2113*A*.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*A*.9 Termination. Chimneys shall extend not less than 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*A*.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 C1283.

2113*A*.9.2 Spark arrestors. ***[SFM]*** *All chimneys attached to any appliance or fireplace that burns solid fuel shall be equipped with an approved spark arrestor.* 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.*
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 $^1/_2$ inch (12.7 mm) and shall not block the passage of spheres having a diameter of less than $^3/_8$ 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.

2113*A*.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 be not less than four times the net free area of the outlet of the chimney flue it serves.

2113*A*.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*A*.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*A*.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*A*.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 C315.
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*A*.11.1.1 Flue linings for specific appliances. Flue linings other than those covered in Section 2113*A*.11.1 intended for use with specific appliances shall comply with Sections 2113*A*.11.1.2 through 2113*A*.11.1.4 and Sections 2113*A*.11.2 and 2113*A*.11.3.

2113*A*.11.1.2 Gas appliances. Flue lining systems for gas appliances shall be in accordance with the *California Mechanical Code*.

2113*A*.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*A*.11.1 and pellet vents listed for installation within masonry chimneys (see Section 2113*A*.11.1.5 for marking).

2113*A*.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*A*.11.1 and listed chimney liners complying with UL 641 (see Section 2113*A*.11.1.5 for marking).

2113*A*.11.1.5 Notice of usage. When a flue is relined with a material not complying with Section 2113*A*.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*A*.11.2 Concrete and masonry chimneys for medium-heat appliances.

2113*A*.11.2.1 General. Concrete and masonry chimneys for medium-heat appliances shall comply with Sections 2113*A*.1 through 2113*A*.5.

2113*A*.11.2.2 Construction. Chimneys for medium-heat appliances shall be constructed of solid masonry units or of concrete with walls not less than 8 inches (203 mm) thick, or with stone masonry not less than 12 inches (305 mm) thick.

2113*A*.11.2.3 Lining. Concrete and masonry chimneys shall be lined with an approved medium-duty refractory brick not less than $4^1/_2$ inches (114 mm) thick laid on the $4^1/_2$-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.

2113*A*.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*A*.11.2.5 Termination height. Concrete and masonry chimneys for medium-heat appliances shall extend not less than 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm).

2113*A*.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*A*.11.3 Concrete and masonry chimneys for high-heat appliances.

2113*A*.11.3.1 General. Concrete and masonry chimneys for high-heat appliances shall comply with Sections 2113*A*.1 through 2113*A*.5.

2113*A*.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 not less than 8 inches (203 mm) thick with a minimum airspace of 2 inches (51 mm) between the walls.

2113*A*.11.3.3 Lining. The inside of the interior wall shall be lined with an approved high-duty refractory brick, not less than $4^1/_2$ inches (114 mm) thick laid on the $4^1/_2$-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.

2113*A*.11.3.4 Termination height. Concrete and masonry chimneys for high-heat appliances shall extend not less than 20 feet (6096 mm) higher than any portion of any building within 50 feet (15 240 mm).

2113*A*.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*A*.12 Clay flue lining (installation). Clay flue liners shall be installed in accordance with ASTM C1283 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 C199 with tight mortar joints left smooth on the inside and installed to maintain an airspace 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*A*.13 Additional requirements.

2113*A*.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*A*.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*A*.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 not less than 4 inches (102 mm).

2113*A*.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 be not 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 *California Mechanical Code*.

2113*A*.16 Flue area (masonry fireplace). Flue sizing for chimneys serving fireplaces shall be in accordance with Section 2113*A*.16.1 or 2113*A*.16.2.

2113*A*.16.1 Minimum area. Round chimney flues shall have a minimum net cross-sectional area of not less than $^1/_{12}$ of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of not less than $^1/_{10}$ 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 not less than $^1/_{10}$ 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 not less than $^1/_8$ of the fireplace opening.

2113*A*.16.2 Determination of minimum area. The minimum net cross-sectional area of the flue shall be determined in accordance with Figure 2113*A*.16. A flue size providing not less than the equivalent net cross-sectional area shall be used. Cross-sectional areas of clay flue linings are as provided in Tables 2113*A*.16(1) and 2113*A*.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*A*.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 mm^2.
a. Flue sizes are based on ASTM C315.

TABLE 2113*A*.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 mm^2.

2113*A*.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.

2113*A*.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 not less than 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be not less than 6 inches (152 mm). The cleanout shall be provided with a noncombustible cover.

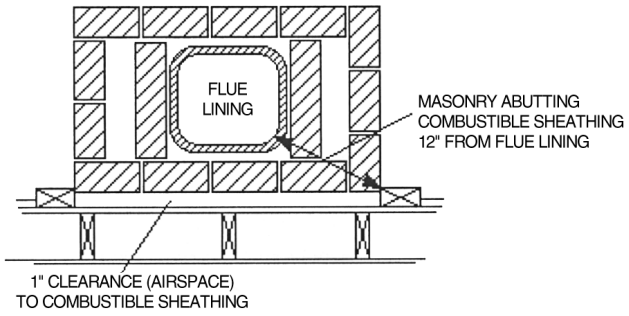
Exception: Chimney flues serving masonry fireplaces, where cleaning is possible through the fireplace opening.

2113*A*.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*A*.20.

Exceptions:

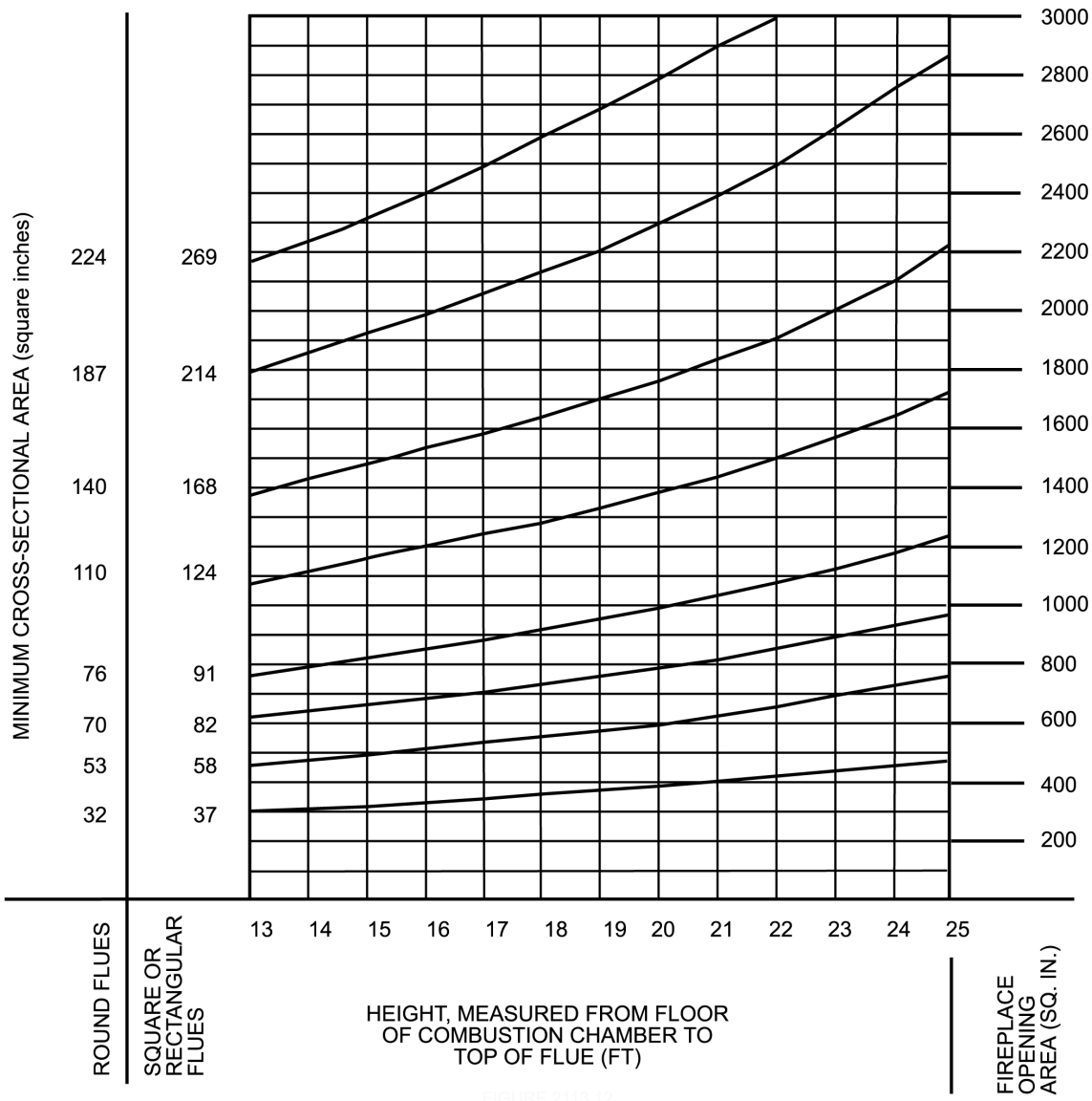
1. Masonry chimneys equipped with a chimney lining system listed and labeled for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, are permitted to have combustible material in contact with their exterior surfaces.
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*A*.19, provided such combustible trim or sheathing is not less than 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*A*.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..



For SI: 1 inch = 25.4 mm.

FIGURE 2113*A*.19
ILLUSTRATION OF EXCEPTION THREE
CHIMNEY CLEARANCE PROVISIONS



For SI: 1 inch = 25.4 mm, 1 square inch = 645 mm^2.

FIGURE 2113*A*.16
FLUE SIZES FOR MASONRY CHIMNEYS

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	BSC-CG	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												
Adopt only those sections that are listed below																					
Chapter / Section																					
2201.1.1									X												
2201.1.2									X												
2201.1.3									X												
2201.1.4									X												
2212									X												

CHAPTER 22

STEEL

SECTION 2201
GENERAL

2201.1 Scope. The provisions of this chapter govern the quality, design, fabrication and erection of steel construction.

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 ELEMENT, STRUCTURAL.

SECTION 2203
IDENTIFICATION AND PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

2203.1 Identification. Identification of structural steel elements shall be in accordance with AISC 360. Identification of cold-formed steel members shall be in accordance with AISI S100. Identification of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S200 or AISI S220, as applicable. 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 elements shall be in accordance with AISC 360. Painting of open-web steel joists and joist girders shall be in accordance with SJI CJ, SJI JG, SJI K and SJI LH/DLH. 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 be in accordance with AISI S200 or AISI S220, as applicable.

SECTION 2204
CONNECTIONS

2204.1 Welding. The details of design, workmanship and technique for welding and qualification of welding personnel shall be in accordance with the specifications listed in Sections 2205, 2206, 2207, 2208, 2210 and 2211. For special inspection of welding, see Section 1705.2.

2204.2 Bolting. The design, installation and inspection of bolts shall be in accordance with the requirements of Sections 2205, 2206, 2207, 2210 and 2211. For special inspection of the installation of high-strength bolts, see Section 1705.2.

2204.3 Anchor rods. Anchor rods shall be set in accordance with the approved 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 elements in buildings, structures and portions thereof shall be in accordance with AISC 360.

2205.2 Seismic design. Where required, the seismic design, fabrication and erection of buildings, structures and portions thereof shall be in accordance with Section 2205.2.1 or 2205.2.2, as applicable.

2205.2.1 Structural steel seismic force-resisting systems. The design, detailing, fabrication and erection of structural steel seismic force-resisting systems shall be in accordance with the provisions of Section 2205.2.1.1 or 2205.2.1.2, as applicable.

2205.2.1.1 Seismic Design Category B or C. 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 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 systems" 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.

2205.2.1.2 Seismic Design Category D, E or F. 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.

2205.2.2 Structural steel elements. The design, detailing, fabrication and erection of structural steel elements in seismic force-resisting systems other than those covered in Section 2205.2.1, including struts, collectors, chords and foundation elements, shall be in accordance with AISC 341 where either of the following applies:

1. The structure is assigned to Seismic Design Category D, E or F, except as permitted in ASCE 7, Table 15.4-1.
2. A response modification coefficient, *R*, greater than 3 in accordance with ASCE 7, Table 12.2-1, is used for the design of the structure assigned to Seismic Design Category B or C.

SECTION 2206
COMPOSITE STRUCTURAL STEEL AND CONCRETE STRUCTURES

2206.1 General. Systems of structural steel elements acting compositely with reinforced concrete shall be designed in accordance with AISC 360 and ACI 318, excluding ACI 318 Chapter 14.

2206.2 Seismic design. Where required, the seismic design, fabrication and erection of composite steel and concrete systems shall be in accordance with Section 2206.2.1.

2206.2.1 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
2. SJI K
3. SJI LH/DLH
4. SJI JG

2207.1.1 Seismic design. 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 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, bridging design that differs from the SJI specifications listed in Section 2207.1, 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.

1.6. Connection forces.

2. Special considerations including:

2.1. Profiles for joist and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.

2.2. Oversized or other nonstandard web openings.

2.3. Extended ends.

3. Live and total load deflection criteria for joists and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.

2207.3 Calculations. The steel joist and joist girder manufacturer shall design the steel joists and steel joist girders in accordance with the SJI specifications listed in Section 2207.1 to support the load requirements of Section 2207.2. The registered design professional shall be permitted to require submission of the steel joist and joist girder calculations as prepared by a registered design professional responsible for the product design. Where 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 the design calculations submitted under seal and signature, the following shall be included:

1. Bridging design that differs from the SJI specifications listed in Section 2207.1, such as cantilevered conditions and net uplift.

2. Connection design for:

2.1. Connections that differ from the SJI specifications listed in Section 2207.1, such as flush-framed or framed connections.

2.2. Field splices.

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 approved construction documents and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2207.2. Steel joist placement plans shall include, at a minimum, the following:

1. Listing of applicable loads as stated in Section 2207.2 and used in the design of the steel joists and joist girders as specified in the approved construction documents.

2. Profiles for joist and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.

3. Connection requirements for:

3.1. Joist supports.

3.2. Joist girder supports.

3.3. Field splices.

3.4. Bridging attachments.

4. Live and total load deflection criteria for joists and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.

5. Size, location and connections for 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 to the owner or the owner's authorized agent for submittal to the building official as specified in Section 1704.5 stating that work was performed in accordance with approved construction documents and with SJI specifications listed in Section 2207.1.

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 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 Section 15.5.3 of ASCE 7.

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.

2210.1.1.3 Composite slabs on steel decks. Composite slabs of concrete and steel deck shall be permitted to be designed and constructed in accordance with SDI-C.

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, or, 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 and nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is not greater than 0.1180 inches (2.997 mm) shall be in accordance with AISI S200 and Sections 2211.2 through 2211.7, or AISI S220, 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 or the owner's authorized agent 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 be in accordance with Section 1705.2.

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 Structural wall stud design. Structural 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 FOR COMMUNITY COLLEGES [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 $^1/_8$ 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 A4. *Replace Section A4.1 item (3) as follows:*

(3) *Locations and dimensions of protected zones, including provision by the owner or owner's designated representative for construction to permanently mark and maintain the protection.*

2212.2.2 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.

4. *The slenderness ratio (KL/r) of diagonal bracing members shall not exceed $4\sqrt{E/F_y}$, except tension-only bracing.*

(2) *The load effect required for collectors using the load combinations stipulated in the applicable building code.*

2212.2.3 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.

2212.2.4 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.*

2212.2.5 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).

2212.2.6 Section F1. *Add Section F1.4c as follows:*

4c. Multi-tiered braced frames: *Braced frames configured with two or more tiers of bracing between diaphragm levels or locations of out-of-plane support shall comply with the additional requirements of Section F2.4e.*

2212.2.7 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:

The required strength of the collector need not exceed the forces determined using load combination stipulated by the applicable building code, including the amplified seismic load, applied to the building model in which all compression braces have been removed.

2212.2.8 Section F2. *Add Section F2.4e as follows:*

4c. Multi-tiered braced frames*: Braced frames configured with two or more tiers of bracing between diaphragm levels or locations of out-of-plane support shall comply with the additional requirements of this section:*

(1) Braces shall be used in symmetrical pairs at every tier level.

(2) Horizontal beams at intermediate tier levels for V- and inverted V-brace configurations shall have out-of-plane strength, stiffness, and beam-to-column connections adequate to resist torsional moments arising from brace buckling when braces are designed to buckle out-of-plane.

(3) Columns shall be restrained against rotation about their longitudinal axis at each intermediate tier level and shall resist out-of-plane bending moments due to second-order effects, geometric imperfections, and out-of-plane brace buckling.

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. *Web extension to beam web two-sided fillet weld welds are sized to develop expected strength of the beam web and shall not be less than a $^1/_4$ inch fillet weld, and*
3. *The built-up box column wall thickness shall not be less than 1.25 inches and the HSS column wall thickness shall not be less than $^1/_2$ 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 in accordance with 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 in accordance with the requirements of the AWS D1.1.*

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 22*A* – 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	BSC-CG	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																					

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 22*A*

STEEL

SECTION 2201*A*
GENERAL

2201*A*.1 Scope. The provisions of this chapter govern the quality, design, fabrication and erection of steel construction.

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 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.*

SECTION 2202*A*
DEFINITIONS

2202*A*.1 Definitions. The following terms are defined in Chapter 2:

STEEL CONSTRUCTION, COLD-FORMED.

STEEL JOIST.

STEEL ELEMENT, STRUCTURAL.

SECTION 2203*A*
IDENTIFICATION AND PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

2203*A*.1 Identification. Identification of structural steel elements shall be in accordance with AISC 360. Identification of cold-formed steel members shall be in accordance with AISI S100. Identification of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S200 or AISI S220, as applicable. 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*A*.2 Protection. Painting of structural steel elements shall be in accordance with AISC 360. Painting of open-web steel joists and joist girders shall be in accordance with SJI CJ, SJI JG, SJI K and SJI LH/DLH. 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 be in accordance with AISI S200 or AISI S220, as applicable.

SECTION 2204*A*
CONNECTIONS

2204*A*.1 Welding. The details of design, workmanship and technique for welding and qualification of welding personnel shall be in accordance with the specifications listed in Sections 2205*A*, 2206*A*, 2207*A*, 2208*A*, 2210*A* and 2211*A*. Special inspection of welding shall be provided where required by Section 1705*A*.2.

2204*A*.2 Bolting. The design, installation and inspection of bolts shall be in accordance with the requirements of Sections 2205*A*, 2206*A*, 2207*A*, 2210*A* and 2211*A*. For special inspection of the installation of high-strength bolts, see Section 1705*A*.2.

2204*A*.3 Anchor rods. Anchor rods shall be set in accordance with the approved 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.4 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 $^1/_8$ 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 2205*A*
STRUCTURAL STEEL

2205*A*.1 General. The design, fabrication and erection of structural steel elements in buildings, structures and portions thereof shall be in accordance with AISC 360.

Exceptions: [OSHPD 1 & 4]

1. *For members designed on the basis of tension, the slenderness ratio (L/r) shall not exceed 300, except for design of hangers and bracing in accordance with NFPA 13 and for rod hangers in tension.*
2. *For members designed on the basis of compression, the slenderness ratio (KL/r) shall not exceed 200, except for design of hangers and bracing in accordance with NFPA 13.*

2205*A*.2 Seismic design. Where required, the seismic design, fabrication and erection of buildings, structures and portions thereof shall be in accordance with Section 2205*A*.2.1 or 2205*A*.2.2, as applicable. <

2205A.2.1 Structural steel seismic force-resisting system. The design, detailing, fabrication and erection of structural steel seismic force-resisting systems shall be in accordance with the provisions of Section 2205*A*.2.1.1 or 2205*A*.2.1.2, as applicable.

2205*A*.2.1.1 Seismic Design Category B or C. *Not permitted by DSA-SS and OSHPD.* <

2205*A*.2.1.2 Seismic Design Category D, E or F. Structures assigned to Seismic Design Category D, E or F shall be designed and detailed in accordance with AISC 341. <

2205A.2.2 Structural steel elements. The design, detailing, fabrication and erection of structural steel elements in seismic force-resisting systems other than those covered in Section 2205*A*.2.1, including struts, collectors, chords and foundation elements, shall be in accordance with AISC 341. <

2205A.3 Modifications to AISC 341. [DSA-SS]

2205A.3.1 Section A4. *Replace Section A4.1 item (3) as follows:*

(3) Locations and dimensions of protected zones, including provision by the owner or owner's designated representative for construction to permanently mark and maintain the protection.

2205A.3.2 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.*
4. *The slenderness ratio (KL/r) of diagonal bracing members shall not exceed $4\sqrt{E/F_Y}$, except tension-only bracing.*

(2) The load effect required for collectors using the load combinations stipulated in the applicable building code.

2205A.3.3 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.3.4 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.3.5 Section F1. *Add Section F1.4c as follows:*

4c. Multi-tiered braced frames: *Braced frames configured with two or more tiers of bracing between diaphragm levels or locations of out-of-plane support shall comply with the additional requirements of Section F2.4e.*

2205A.3.6 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.3.7 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.

The required strength of the collector need not exceed the forces determined using load combination stipulated by the applicable building code, including the amplified seismic load, applied to the building model in which all compression braces have been removed.

2205A.3.8 Section F2. *Add Section F2.4e as follows:*

4c. Multi-tiered braced frames: *Braced frames configured with two or more tiers of bracing between diaphragm levels or locations of out-of-plane support shall comply with the additional requirements of this section:*

(1) Braces shall be used in symmetrical pairs at every tier level.

(2) Horizontal beams at intermediate tier levels for V- and inverted V-brace configurations shall have out-of-plane strength, stiffness, and beam-to-column connections adequate to resist torsional moments arising from brace buckling when braces are designed to buckle out-of-plane.

(3) Columns shall be restrained against rotation about their longitudinal axis at each intermediate tier level and shall resist out-of-plane bending moments due to second-order effects, geometric imperfections, and out-of-plane brace buckling.

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 E2. *Replace Section E2.6c Item # a by the following:*

(a) Use of IMF connections designed in accordance with ANSI/AISC 358 shall be as modified in Section 2205A.5.2.

2205A.4.3 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.4.4 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.5.

2205A.4.5 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.4.6 Section F3. *Modify Section F3.6e Item 2 as follows:*

Exception is not permitted.

2205A.4.7 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.4.8 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. *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.*

2205A.5.2 Moment Connection - Chapter 11. *The welded side plate steel moment connection shall be permitted provided:*

1. *The beams shall consist of either rolled or built-up wide flange sections.*
2. *The biaxial dual-strong axis and column minor axis configurations of the moment connection shall be considered as an alternative system.*
3. *For SMF and IMF systems, U-shaped cover plates shall be used and the hinge-to-hinge span to beam depth, L_h/d, shall be greater than or equal to 5.*
4. *The width-to-thickness ratios for beam flanges shall not be less than 3.*
5. *The spacing for lateral bracing of wide flange beams, L_b, shall include the length of the side plate at beam ends.*
6. *The extension of the side plates beyond the face of the column shall be within the range of 0.77d to 1.0d.*
7. *The gap-to-side plate thickness ratio shall range from 2.1 to 2.3.*

SECTION 2206*A*
COMPOSITE STRUCTURAL STEEL AND CONCRETE STRUCTURES

2206*A*.1 General. Systems of structural steel elements acting compositely with reinforced concrete shall be designed in accordance with AISC 360 and ACI 318, excluding ACI 318 Chapter 14.

2206*A*.2 Seismic design. Where required, the seismic design, fabrication and erection of composite steel and concrete systems shall be in accordance with Section 2206*A*.2.1.

2206*A*.2.1 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. *Web extension to beam web two-sided fillet weld welds are sized to develop expected strength of the beam web and shall not be less than a $^1/_4$ inch fillet weld, and*
3. *The built-up box column wall thickness shall not be less than 1.25 inches and the HSS column wall thickness shall not be less than $^1/_2$ inch.*

SECTION 2207*A*
STEEL JOISTS

2207*A*.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
2. SJI K
3. SJI LH/DLH
4. SJI JG

2207*A*.1.1 Seismic design. Where required, the seismic design of buildings shall be in accordance with the additional provisions of Section 2205*A*.2 or 2211*A*.6.

2207*A*.2 Design. The registered design professional shall indicate on the construction documents the steel joist and steel joist girder designations from the specifications listed in Section 2207*A*.1; and shall indicate the requirements for joist and joist girder design, layout, end supports, anchorage, bridging design that differs from the SJI specifications listed in Section 2207*A*.1, 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.
   - 1.6. Connection forces.
2. Special considerations including:
   - 2.1. Profiles for joist and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207*A*.1.
   - 2.2. Oversized or other nonstandard web openings.
   - 2.3. Extended ends.
3. Live and total load deflection criteria for joists and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207*A*.1.

2207*A*.3 Calculations. The steel joist and joist girder manufacturer shall design the steel joists and steel joist girders in accordance with the SJI specifications listed in Section 2207*A*.1 to support the load requirements of Section 2207*A*.2. The registered design professional shall be permitted to require submission of the steel joist and joist girder calculations as prepared by a registered design professional responsible for the product design. Where 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 the design calculations submitted under seal and signature, the following shall be included:

1. Bridging design that differs from the SJI specifications listed in Section 2207*A*.1, such as cantilevered conditions and net uplift.
2. Connection design for:
   - 2.1. Connections that differ from the SJI specifications listed in Section 2207*A*.1, such as flush-framed or framed connections.
   - 2.2. Field splices.
   - 2.3. Joist headers.

2207*A*.4 Steel joist drawings. Steel joist placement plans shall be provided to show the steel joist products as specified on the approved construction documents and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2207*A*.2. Steel joist placement plans shall include, at a minimum, the following:

1. Listing of applicable loads as stated in Section 2207*A*.2 and used in the design of the steel joists and joist girders as specified in the approved construction documents.
2. Profiles for joist and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207*A*.1.
3. Connection requirements for:
   - 3.1. Joist supports.
   - 3.2. Joist girder supports.
   - 3.3. Field splices.
   - 3.4. Bridging attachments.
4. Live and total load deflection criteria for joists and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207*A*.1.
5. Size, location and connections for 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 to the owner or the owner's authorized agent for submittal to the building official as specified in Section 1704.5 stating that work was performed in accordance with approved construction documents and with SJI specifications listed in Section 2207*A*.1.

2207A.6 Joist chord bracing. *The chords of all joists shall be laterally supported at all points where the chords change direction.*

SECTION 2208*A*
STEEL CABLE STRUCTURES

2208*A*.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 2209*A*
STEEL STORAGE RACKS

2209*A*.1 Storage racks. The design, testing and utilization of 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 Section 15.5.3 of ASCE 7.

SECTION 2210*A*
COLD-FORMED STEEL

2210*A*.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*A*. Where required, the seismic design of cold-formed steel structures shall be in accordance with the additional provisions of Section 2210*A*.2.

2210*A*.1.1 Steel decks. The design and construction of cold-formed steel decks shall be in accordance with this section.

2210*A*.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*A*.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.*

2210*A*.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 SDI-C.

2210*A*.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. >

SECTION 2211*A*
COLD-FORMED STEEL LIGHT-FRAME CONSTRUCTION

2211*A*.1 General. The design and installation of structural and nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is not greater than 0.1180 inches (2.997 mm) shall be in accordance with AISI S200 and Sections 2211*A*.2 through 2211*A*.7, or AISI S220, as applicable.

2211*A*.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*A*.3 Truss design. Cold-formed steel trusses shall be designed in accordance with AISI S214, Sections 2211*A*.3.1 through 2211*A*.3.4 and accepted engineering practice.

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.

2211*A*.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. <

2211*A*.3.2 Deferred submittals. *Not permitted by DSA-SS and OSHPD.*

2211*A*.3.3 Trusses spanning 60 feet or greater. The owner or the owner's authorized agent 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 be in accordance with Section 1705*A*.2.

2211*A*.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*A*.2.5 and 1705*A*.2, as applicable.

2211*A*.4 Structural wall stud design. Structural 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.

2211*A*.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*A*.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.

2211*A*.7 Prescriptive framing. *Not permitted by DSA-SS and OSHPD.*

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 $3^1/_2$. 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:*

$$\frac{\sum S_{bi}F_{ybi}}{\sum S_{cj}F_{ycj}} \geq 1.4 \qquad \textbf{(Equation 22A-1)}$$

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 $^3/_{16}$ 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 in accordance with ASTM F606, 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	BSC-CG	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**								
Adopt only those sections that are listed below			**X**																**X**		
Chapter / Section																					
2301.1				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								
2303.1.3.1								X	X	X	X		X								
2301.1.4								X	X	X	X		X								
2303.1.4.1								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																	
2304.3.4								X	X	X	X		X								
2304.4.1								X	X												
2304.5																					
2304.6.1										X			X								
2304.10.1.1								X		X	X		X								
2304.12.1.1.1																			X		
2304.12.1.2, Exception								X	X	X	X		X								
2304.12.1.4.1								X		X	X		X								
2304.12.8																			X		
2305.1.2								X	X	X	X		X								
2308.1				X	X																
2308.2.7								X	X		X										
2309.1.1								X	X		X										

The state agency does not adopt sections identified with 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 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, and 22, the provisions in Chapters 16A, 17A, 18A, 19A, 21A, and 22A, respectively shall apply instead.*

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.*

2301.1.4 Prohibition. [DSA-SS & DSA-SS/CC & OSHPD 1, 2 & 4] *The following design methods, systems, and materials are not permitted by DSA and OSHPD:*

1. *Straight-sheathed horizontal lumber diaphragms.*
2. *Gypsum-based sheathing shear walls and portland cement plaster shear walls.*
3. *Shear wall foundation anchor bolt washers in accordance with exception to AWC SDPWS Section 4.3.6.4.3.*
4. *Wood structural panel shear walls and diaphragms using staples as fasteners.*
5. *Unblocked shear walls.*
6. *Any wood structural panel sheathing used for diaphragms and shear walls that are part of the seismic force-resisting system, not applied directly to framing members.*
7. *Single and double diagonally sheathed lumber walls used to resist seismic forces.*
8. *Log structures in accordance with ICC 400.*
9. *Cross-laminated timber used as part of the seismic force-resisting system, unless approved as an alternative system in accordance with Section 104.11.*

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.
4. AWC WFCM in accordance with Section 2309.
5. The design and construction of log structures in accordance with the provisions of ICC 400.

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.

CROSS-LAMINATED TIMBER.

DIAPHRAGM, UNBLOCKED.

DRAG STRUT.

ENGINEERED WOOD RIM BOARD.

FIBERBOARD.

GABLE.

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.

➡

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 lumber, 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 D5055.

2303.1.3 Structural glued-laminated timber. Glued-laminated timbers shall be manufactured and identified as required in ANSI/AITC A190.1 and ASTM D3737.

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.

2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.

2303.1.4.1 Additional requirements. [DSA-SS & DSA-SS/CC & OSHPD 1, 2 & 4] *Requirements in Section 2303.1.3.1 shall apply to glued cross-laminated timber.*

2303.1.5 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.

2303.1.6 Fiberboard. Fiberboard for its various uses shall conform to ASTM C208. Fiberboard sheathing, when used structurally, shall be identified by an approved agency as conforming to ASTM C208.

2303.1.6.1 Jointing. To ensure tight-fitting assemblies, edges shall be manufactured with square, shiplapped, beveled, tongue-and-groove or U-shaped joints.

2303.1.6.2 Roof insulation. Where used as roof insulation in all types of construction, fiberboard shall be protected with an approved roof covering.

2303.1.6.3 Wall insulation. Where installed and fireblocked 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.

2303.1.6.3.1 Protection. Fiberboard wall insulation applied on the exterior of foundation walls shall be protected below ground level with a bituminous coating.

2303.1.7 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 $^{7}/_{32}$-inch (5.6 mm) or $^{1}/_{4}$-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.

2303.1.8 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.

2303.1.8.1 Floor underlayment. Particleboard floor underlayment shall conform to Type PBU of ANSI A208.1. Type PBU underlayment shall not be less than $^{1}/_{4}$-inch (6.4 mm) thick and shall be installed in accordance with the instructions of the Composite Panel Association.

2303.1.9 Preservative-treated wood. Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.12 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.

2303.1.9.1 Identification. Wood required by Section 2304.12 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.

2303.1.9.2 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.

2303.1.10 Structural composite lumber. Structural capacities for structural composite lumber shall be established and monitored in accordance with ASTM D5456.

2303.1.11 Structural log members. Stress grading of structural log members of nonrectangular shape, as typically used in log buildings, shall be in accordance with ASTM D3957. 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.

2303.1.12 Round timber poles and piles. Round timber poles and piles shall comply with ASTM D3200 and ASTM D25, respectively.

2303.1.13 Engineered wood rim board. Engineered wood rim boards shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672. Structural capacities shall be in accordance with ANSI/APA PRR 410 or established in accordance with ASTM

D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

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 E84 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 $10^{1}/_{2}$ 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 2303.2.5 through 2303.2.8.
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 D2898).

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 softwood plywood shall be determined in accordance with ASTM D5516. The test data developed by ASTM D5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D6305. 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 D5664. The test data developed by ASTM D5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D6841. 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 D2898.

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 D3201 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;
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 or the owner's authorized agent 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 draw-

ing. 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 placement 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.*

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. Joist hangers shall be in accordance with ASTM D7147.

2303.6 Nails and staples. Nails and staples shall conform to requirements of ASTM F1667. 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 $1^1/_2$-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 concrete 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 $^5/_8$ 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, chimneys and fireplaces, and 6 inches (152 mm) away from flue openings.

2304.6 Exterior wall sheathing. Wall sheathing on the outside of exterior walls, including gables, and the connection of the sheathing to framing shall be designed in accordance with the general provisions of this code and shall be capable of resisting wind pressures in accordance with Section 1609.

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 sheathing, connections and framing spacing shall be in accordance with Table 2304.6.1 for the applicable wind speed and exposure category where used in enclosed buildings with a mean roof height not greater than 30 feet (9144 mm) and a topographic factor (K_{zt}) of 1.0.

2304.7 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 2304.10.1. 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.

2304.8 Floor and roof sheathing. Structural floor sheathing and structural roof sheathing shall comply with Sections 2304.8.1 and 2304.8.2, respectively.

2304.8.1 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 2304.8(1), 2304.8(2), 2304.8(3) or 2304.8(4) shall be deemed to meet the requirements of this section.

2304.8.2 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 2304.8(1), 2304.8(2), 2304.8(3) or 2304.8(5) shall be deemed to meet the requirements of this section. Wood structural panel roof sheathing shall be bonded by exterior glue.

2304.9 Lumber decking. Lumber decking shall be designed and installed in accordance with the general provisions of this code and Sections 2304.9.1 through 2304.9.5.3.

2304.9.1 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.

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}[d] (MPH)		
Size	Penetration (inches)				Edges (inches o.c.)	Field (inches o.c.)	Wind exposure category		
							B	C	D
6d common (2.0" × 0.113")	1.5	24/0	3/8	16	6	12	110	90	85
		24/16	7/16	16	6	12	110	100	90
						6	150	125	110
8d common (2.5" × 0.131")	1.75	24/16	7/16	16	6	12	130	110	105
						6	150	125	110
				24	6	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 on center or 24 on center shall be permitted as an alternative to panels with a 24/16 span rating. Wall-16 and plywood siding 16 on center shall be used with studs spaced a maximum of 16 inches on center.

d. V_{asd} shall be determined in accordance with Section 1609.3.1.

TABLE 2304.8(1)
ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHING[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	3/4	25/32	3/4	25/32
16	5/8	11/16	5/8	11/16
Roofs				
24	5/8	11/16	3/4	25/32

For SI: 1 inch = 25.4 mm.

a. Installation details shall conform to Sections 2304.8.1 and 2304.8.2 for floor and roof sheathing, respectively.

b. Floor or roof sheathing complying with this table shall be deemed to meet the design criteria of Section 2304.7.

c. Maximum 19-percent moisture content.

TABLE 2304.8(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

2304.9.2 Layup patterns. Lumber decking is permitted to be laid up following one of five standard patterns as defined in Sections 2304.9.2.1 through 2304.9.2.5. Other patterns are permitted to be used provided they are substantiated through engineering analysis.

2304.9.2.1 Simple span pattern. All pieces shall be supported on their ends (i.e., by two supports).

2304.9.2.2 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.

2304.9.2.3 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.

TABLE 2304.8(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 3/32, 1 1/8	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Applies to panels 24 inches or wider.

b. Floor and roof sheathing complying with this table shall be deemed to meet the design criteria of Section 2304.8.

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 2304.8(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/m^2.

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 complying with this table shall be deemed to meet the design criteria of Section 2304.8.

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 2304.8(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	7/16	24	20	30
	15/32	24	35[c]	45[c]
	1/2	24	40[c]	50[c]
	19/32, 5/8	24	70	80
	23/32, 3/4	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	7/16	16	40	50
	15/32	24	20	25
	1/2	24	25	30
	19/32	24	40[c]	50[c]
	5/8	24	45[c]	55[c]
	23/32, 3/4	24	60[c]	65[c]

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Roof sheathing complying with this table shall be deemed to meet the design criteria of Section 2304.8.

b. Uniform load deflection limitations 1/180 of span under live load plus dead load, 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.

2304.9.2.4 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.

2304.9.2.5 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 2304.9.3.3, 2304.9.4.3 or 2304.9.5.3.

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.

2304.9.3 Mechanically laminated decking. Mechanically laminated decking shall comply with Sections 2304.9.3.1 through 2304.9.3.3.

2304.9.3.1 General. Mechanically laminated decking consists of square-edged dimension lumber laminations set on edge and nailed to the adjacent pieces and to the supports.

2304.9.3.2 Nailing. The length of nails connecting laminations shall be not less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center or less, side nails shall be installed not more than 30 inches (762 mm) on center 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) on center, side nails shall be installed not more than 18 inches (457 mm) on center 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) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support.

2304.9.3.3 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.

2304.9.4 Two-inch sawn tongue-and-groove decking. Two-inch (51 mm) sawn tongue-and-groove decking shall comply with Sections 2304.9.4.1 through 2304.9.4.3.

2304.9.4.1 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.

2304.9.4.2 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.

2304.9.4.3 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.

2304.9.5 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 2304.9.5.1 through 2304.9.5.3.

2304.9.5.1 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.

2304.9.5.2 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 predrilled 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.

2304.9.5.3 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.

2304.10 Connectors and fasteners. Connectors and fasteners shall comply with the applicable provisions of Sections 2304.10.1 through 2304.10.7.

2304.10.1 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 2304.10.1.

2304.10.1.1 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 A153. The coating weights for mechanically deposited zinc coated fasteners shall be in accordance with ASTM B695, Class 55 minimum.*

2304.10.2 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.

2304.10.3 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 ASTM D7147.

2304.10.4 Other fasteners. Clips, staples, glues and other approved methods of fastening are permitted where approved.

2304.10.5 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 2304.10.5.1 through 2304.10.5.4. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A153.

2304.10.5.1 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 B695, 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 A653, 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.

TABLE 2304.10.1
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Roof		
1. Blocking between ceiling joists, rafters or trusses to top plate or other framing below	3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	Each end, toenail
Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common ($2^1/_2$″ × 0.131″) 2-3″ × 0.131″ nails 2-3″ 14 gage staples	Each end, toenail
	2-16 d common ($3^1/_2$″ × 0.162″) 3-3″ × 0.131″ nails 3-3″ 14 gage staples	End nail
Flat blocking to truss and web filler	16d common ($3^1/_2$″ × 0.162″) @ 6″ o.c. 3″ × 0.131″ nails @ 6″ o.c. 3″ × 14 gage staples @ 6″ o.c	Face nail
2. Ceiling joists to top plate	3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	Each joist, toenail
3. Ceiling joist not attached to parallel rafter, laps over partitions (no thrust) (see Section 2308.7.3.1, Table 2308.7.3.1)	3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131" nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	Face nail
4. Ceiling joist attached to parallel rafter (heel joint) (see Section 2308.7.3.1, Table 2308.7.3.1)	Per Table 2308.7.3.1	Face nail
5. Collar tie to rafter	3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	Face nail
6. Rafter or roof truss to top plate (See Section 2308.7.5, Table 2308.7.5)	3-10 common (3″ × 0.148″); or 3-16d box ($3^1/_2$″ × 0.135″); or 4-10d box (3" × 0.128″); or 4-3″ × 0.131 nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	Toenail[c]
7. Roof rafters to ridge valley or hip rafters; or roof rafter to 2-inch ridge beam	2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown; or	End nail
	3-10d common ($3^1/_2$″ × 0.148″); or 3-16d box ($3^1/_2$″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	Toenail

(continued)

TABLE 2304.10.1—continued
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
8. Stud to stud (not at braced wall panels)	16d common ($3^1/_2$″ × 0.162″);	24″ o.c. face nail
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	16″ o.c. face nail
9. Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d common ($3^1/_2$″ × 0.162″); or	16″ o.c. face nail
	16d box ($3^1/_2$″ × 0.135″); or	12″ o.c. face nail
	3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	12″ o.c. face nail
10. Built-up header (2″ to 2″ header)	16d common ($3^1/_2$″ × 0.162″); or	16″ o.c. each edge, face nail
	16d box ($3^1/_2$″ × 0.135")	12″ o.c. each edge, face nail
11. Continuous header to stud	4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toenail
12. Top plate to top plate	16d common ($3^1/_2$″ × 0.162″); or	16″ o.c. face nail
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$″ crown	12″ o.c. face nail
13. Top plate to top plate, at end joints	8-16d common ($3^1/_2$″ × 0.162″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails; or 12-3″ 14 gage staples, $^7/_{16}$″ crown	Each side of end joint, face nail (minimum 24" lap splice length each side of end joint)
14. Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$″ × 0.162″); or	16" o.c. face nail
	16d box ($3^1/_2$″ × 0.135″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$″ crown	12" o.c. face nail
15. Bottom plate to joist, rim joist, band joist or blocking at braced wall panels	2-16d common ($3^1/_2$″ × 0.162″); or 3-16d box ($3^1/_2$″ × 0.135″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	16" o.c. face nail
16. Stud to top or bottom plate	4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown; or	Toenail
	2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	End nail
17. Top or bottom plate to stud	2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	End nail
18. Top plates, laps at corners and intersections	2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	Face nail

(continued)

TABLE 2304.10.1—continued
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
19. 1″ brace to each stud and plate	2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$″ crown	Face nail
20. 1″ × 6″ sheathing to each bearing	2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
21. 1″ × 8″ and wider sheathing to each bearing	3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″)	Face nail
Floor		
22. Joist to sill, top plate, or girder	3-8d common ($2^1/_2$″ × 0.131″); or floor 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	Toenail
23. Rim joist, band joist, or blocking to top plate, sill or other framing below	8d common ($2^1/_2$″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$″ crown	6" o.c., toenail
24. 1″ × 6″ subfloor or less to each joist	2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
25. 2″ subfloor to joist or girder	2-16d common ($3^1/_2$″ × 0.162″)	Face nail
26. 2″ planks (plank & beam – floor & roof)	2-16d common ($3^1/_2$″ × 0.162″)	Each bearing, face nail
27. Built-up girders and beams, 2″ lumber layers	20d common (4″ × 0.192″)	32" o.c., face nail at top and bottom staggered on opposite sides
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$″ crown	24" o.c. face nail at top and bottom staggered on opposite sides
	And: 2-20d common (4″ × 0.192″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	Ends and at each splice, face nail
28. Ledger strip supporting joists or rafters	3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	Each joist or rafter, face nail
29. Joist to band joist or rim joist	3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	End nail
30. Bridging or blocking to joist, rafter or truss	2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$″ crown	Each end, toenail

(continued)

TABLE 2304.10.1—continued
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION	
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing[a]			
		Edges (inches)	**Intermediate supports (inches)**
31. $^{3}/_{8}$″ – $^{1}/_{2}$″	6d common or deformed (2″ × 0.113″) (subfloor and wall)	6	12
	8d box or deformed ($2^{1}/_{2}$″ × 0.113″) (roof)	6	12
	$2^{3}/_{8}$″ × 0.113″ nail (subfloor and wall)	6	12
	$1^{3}/_{4}$″ 16 gage staple, $^{7}/_{16}$″ crown (subfloor and wall)	4	8
	$2^{3}/_{8}$″ × 0.113″ nail (roof)	4	8
	$1^{3}/_{4}$″ 16 gage staple, $^{7}/_{16}$″ crown (roof)	3	6
32. $^{19}/_{32}$″ – $^{3}/_{4}$″	8d common ($2^{1}/_{2}$″ × 0.131″); or 6d deformed (2″ × 0.113″)	6	12
	$2^{3}/_{8}$″ × 0.113″ nail; or 2″ 16 gage staple, $^{7}/_{16}$″ crown	4	8
33. $^{7}/_{8}$″ – $1^{1}/_{4}$″	10d common (3″ × 0.148″); or 8d deformed ($2^{1}/_{2}$″ × 0.131″)	6	12
Other exterior wall sheathing			
34. $^{1}/_{2}$″ fiberboard sheathing[b]	$1^{1}/_{2}$″ galvanized roofing nail ($^{7}/_{16}$″ head diameter); or $1^{1}/_{4}$″ 16 gage staple with $^{7}/_{16}$″ or 1″ crown	3	6
35. $^{25}/_{32}$″ fiberboard sheathing[b]	$1^{3}/_{4}$″ galvanized roofing nail ($^{7}/_{16}$″ diameter head); or $1^{1}/_{2}$″ 16 gage staple with $^{7}/_{16}$″ or 1″ crown	3	6
Wood structural panels, combination subfloor underlayment to framing			
36. $^{3}/_{4}$″ and less	8d common ($2^{1}/_{2}$″ × 0.131″); or 6d deformed (2″ × 0.113″)	6	12
37. $^{7}/_{8}$″ – 1″	8d common ($2^{1}/_{2}$″ × 0.131″); or 8d deformed ($2^{1}/_{2}$″ × 0.131″)	6	12
38. $1^{1}/_{8}$″ – $1^{1}/_{4}$″	10d common (3″ × 0.148″); or 8d deformed ($2^{1}/_{2}$″ × 0.131″)	6	12
Panel siding to framing			
39. $^{1}/_{2}$″ or less	6d corrosion-resistant siding ($1^{7}/_{8}$″ × 0.106″); or 6d corrosion-resistant casing (2″ × 0.099″)	6	12
40. $^{5}/_{8}$″	8d corrosion-resistant siding ($2^{3}/_{8}$″ × 0.128″); or 8d corrosion-resistant casing ($2^{1}/_{2}$″ × 0.113″)	6	12

(continued)

TABLE 2304.10.1—continued
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION	
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing[a]			
		Edges (inches)	Intermediate supports (inches)
Interior paneling			
41. $^1/_4''$	4d casing ($1^1/_2'' \times 0.080''$); or 4d finish ($1^1/_2'' \times 0.072''$)	6	12
42. $^3/_8''$	6d casing ($2'' \times 0.099''$); or 6d finish (Panel supports at 24 inches)	6	12

For SI: 1 inch = 25.4 mm.

a. Nails spaced at 6 inches at intermediate 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.

b. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

c. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule and the ceiling joist is fastened to the top plate in accordance with this schedule, the number of toenails in the rafter shall be permitted to be reduced by one nail.

2304.10.5.2 Fastenings for wood foundations. Fastenings, including nuts and washers, for wood foundations shall be as required in AWC PWF.

2304.10.5.3 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 B695, Class 55 minimum.

2304.10.5.4 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 2304.10.5.3 shall apply.

2304.10.6 Load path. Where wall framing members are not continuous from the foundation sill to the 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 0.0329-inch (0.836 mm) base metal thickness.

2304.10.7 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.

2304.11 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 2304.11.1 through 2304.11.5.

2304.11.1 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.

2304.11.1.1 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.

2304.11.2 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.

2304.11.3 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.

2304.11.4 Floor decks. Floor decks and covering shall not extend closer than $^1/_2$ inch (12.7 mm) to walls. Such $^1/_2$-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.

2304.11.5 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.

2304.12 Protection against decay and termites. Wood shall be protected from decay and termites in accordance with the applicable provisions of Sections 2304.12.1 through 2304.12.7.

2304.12.1 Locations requiring water-borne preservatives or naturally durable wood. Wood used above ground in the locations specified in Sections 2304.12.1.1 through 2304.12.1.5, 2304.12.3 and 2304.12.5 shall be naturally durable wood or preservative-treated wood using water-borne preservatives, in accordance with AWPA U1 for above-ground use.

2304.12.1.1 Joists, girders and subfloor. Wood joists or wood structural floors that are closer than 18 inches (457 mm) or wood girders that 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 shall be of naturally durable or preservative-treated wood.

2304.12.1.1.1 [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.*

2304.12.1.2 Wood supported by exterior foundation walls. Wood framing members, including wood sheathing, that are in contact with 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.*

2304.12.1.3 Exterior walls below grade. Wood framing members and furring strips in direct contact with the interior of exterior masonry or concrete walls below grade shall be of naturally durable or preservative-treated wood.

2304.12.1.4 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.

2304.12.1.4.1 Additional requirements. [DSA-SS and OSHPD 1, 2 & 4] *Stud walls or partitions at shower or toilet rooms with more than two plumbing fixtures, excluding floor drains, 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.*

2304.12.1.5 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.

2304.12.2 Other locations. Wood used in the locations specified in Sections 2304.12.2.1 through 2304.12.2.5 shall be naturally durable wood or preservative-treated wood in accordance with AWPA U1. Preservative-treated wood used in interior locations shall be protected with two coats of urethane, shellac, latex epoxy or varnish unless water-borne preservatives are used. Prior to application of the protective finish, the wood shall be dried in accordance with the manufacturer's recommendations.

2304.12.2.1 Girder ends. The ends of wood girders entering exterior masonry or concrete walls shall be provided with a $^1/_2$-inch (12.7 mm) airspace on top, sides and end, unless naturally durable or preservative-treated wood is used.

2304.12.2.2 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.

Exception: Posts or columns that are not exposed to the weather, are supported by concrete piers or metal pedestals projected at least 1 inch (25 mm) above the slab or deck and 8 inches (152 mm) above exposed earth and are separated by an impervious moisture barrier.

2304.12.2.3 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.

2304.12.2.4 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.

** **2304.12.2.5 Supporting members for permeable floors and roofs.** 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.

2304.12.3 Wood in contact with the ground or fresh water. Wood used in contact with exposed earth shall be naturally durable for both decay and termite resistance or preservative treated in accordance with AWPA U1 for soil or fresh water use.

Exception: Untreated wood is permitted where such wood is continuously and entirely below the groundwater level or submerged in fresh water.

2304.12.3.1 Posts or columns. Posts and columns that are supporting permanent structures and embedded in concrete that is exposed to the weather or in direct contact with the earth shall be of preservative-treated wood.

* **2304.12.4 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 2304.12.2.1 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.

2304.12.5 Wood used in retaining walls and cribs. Wood installed in retaining or crib walls shall be preservative treated in accordance with AWPA U1 for soil and fresh water use.

2304.12.6 Attic ventilation. For attic ventilation, see Section 1203.2.

2304.12.7 Under-floor ventilation (crawl space). For under-floor ventilation (crawl space), see Section 1203.4.

2304.12.8 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.

2304.12.9 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.

2304.13 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 AWC 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] *See Section 2301.1.4 for modifications to AWC SDPWS.*

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.

$$\Delta = \frac{5vL^3}{8EAb} + \frac{vL}{4Gt} + 0.188Le_n + \frac{\Sigma(\Delta_c X)}{2b} \qquad \textbf{(Equation 23-1)}$$

For SI: $\Delta = \frac{0.052vL^3}{EAb} + \frac{vL}{4Gt} + \frac{Le_n}{1627} + \frac{\Sigma(\Delta_c X)}{2b}$

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).

$\Sigma(\Delta_c X)$ = 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).

TABLE 2305.2(2)
VALUES OF *Gt* FOR USE IN CALCULATING DEFLECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS AND DIAPHRAGMS

PANEL TYPE	SPAN RATING	VALUES OF *Gt* (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]	OSB
Sheathing	24/0	25,000	32,500	37,500	77,500	32,500	42,500	41,500	77,500
	24/16	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	32/16	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	40/20	28,500	37,000	43,000	88,500	37,000	48,000	47,500	88,500
	48/24	31,000	40,500	46,500	96,000	40,500	52,500	51,000	96,000
Single Floor	16 o.c.	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	20 o.c.	28,000	36,500	42,000	87,000	36,500	47,500	46,000	87,000
	24 o.c.	30,000	39,000	45,000	93,000	39,000	50,500	49,500	93,000
	32 o.c.	36,000	47,000	54,000	110,000	47,000	61,000	59,500	110,000
	48 o.c.	50,500	65,500	76,000	155,000	65,500	85,000	83,500	155,000

		Other			Structural I		
	Thickness (in.)	A-A, A-C	Marine	All Other Grades	A-A, A-C	Marine	All Other Grades
Sanded Plywood	1/4	24,000	31,000	24,000	31,000	31,000	31,000
	11/32	25,500	33,000	25,500	33,000	33,000	33,000
	3/8	26,000	34,000	26,000	34,000	34,000	34,000
	15/32	38,000	49,500	38,000	49,500	49,500	49,500
	1/2	38,500	50,000	38,500	50,000	50,000	50,000
	19/32	49,000	63,500	49,000	63,500	63,500	63,500
	5/8	49,500	64,500	49,500	64,500	64,500	64,500
	23/32	50,500	65,500	50,500	65,500	65,500	65,500
	3/4	51,000	66,500	51,000	66,500	66,500	66,500
	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 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.

2305.3 Shear wall deflection. The deflection of wood-frame shear walls shall be determined in accordance with AWC 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.

$$\Delta = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n + d_a\frac{h}{b} \qquad \textbf{(Equation 23-2)}$$

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)].

G_t = 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).

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 Wood Council.

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

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 AWC STJR.

2306.1.2 Plank and beam flooring. The design of plank and beam flooring is permitted to be in accordance with the AWC *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 2304.9.2 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 AWC SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AWC 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.

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 AWC SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AWC 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 AWC SDPWS.

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 AWC NDS and AWC SDPWS.

TABLE 2306.1.4
ALLOWABLE LOADS FOR LUMBER DECKING

PATTERN	ALLOWABLE AREA LOAD[a, b]	
	Flexure	Deflection
Simple span	$\sigma_b = \frac{8F_b' d^2}{l^2 6}$	$\sigma_\Delta = \frac{384\Delta E'}{5l^4}\frac{d^3}{12}$
Two-span continuous	$\sigma_b = \frac{8F_b' d^2}{l^2 6}$	$\sigma_\Delta = \frac{185\Delta E'}{l^4}\frac{d^3}{12}$
Combination simple- and two-span continuous	$\sigma_b = \frac{8F_b' d^2}{l^2 6}$	$\sigma_\Delta = \frac{131\Delta E'}{l^4}\frac{d^3}{12}$
Cantilevered pieces intermixed	$\sigma_b = \frac{20F_b' d^2}{3l^2 6}$	$\sigma_\Delta = \frac{105\Delta E'}{l^4}\frac{d^3}{12}$
Controlled random layup		
Mechanically laminated decking	$\sigma_b = \frac{20F_b' d^2}{3l^2 6}$	$\sigma_\Delta = \frac{100\Delta E'}{l^4}\frac{d^3}{12}$
2-inch decking	$\sigma_b = \frac{20F_b' d^2}{3l^2 6}$	$\sigma_\Delta = \frac{100\Delta E'}{l^4}\frac{d^3}{12}$
3-inch and 4-inch decking	$\sigma_b = \frac{20F_b' d^2}{3l^2 6}$	$\sigma_\Delta = \frac{116\Delta E'}{l^4}\frac{d^3}{12}$

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.

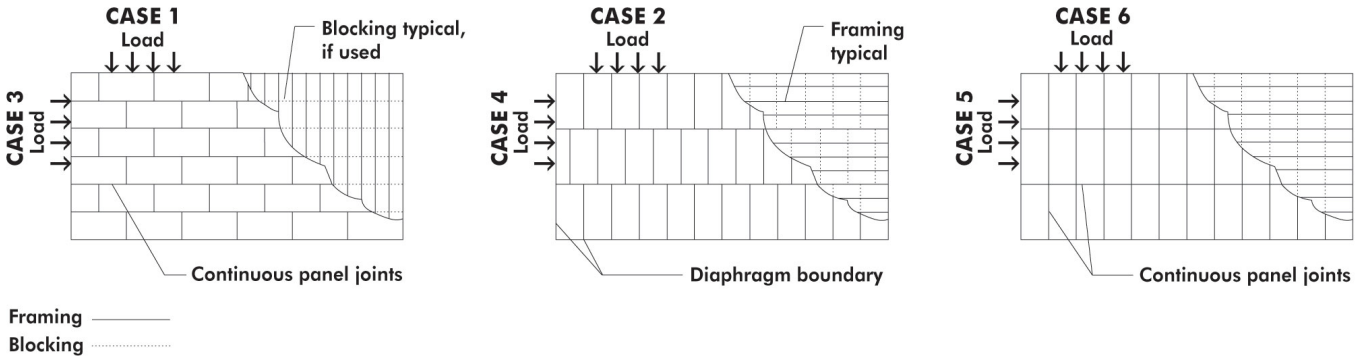
b. d = Actual decking thickness.
l = Span of decking.
F_b' = Allowable bending stress adjusted by applicable factors.
E' = Modulus of elasticity adjusted by applicable factors.

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]	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6)
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]					
					6	6	4	3		
Structural I grades	$1^1/_2$ 16 gage	1	$^3/_8$	2	175	235	350	400	155	115
				3	200	265	395	450	175	130
			$^{15}/_{32}$	2	175	235	350	400	155	120
				3	200	265	395	450	175	130
Sheathing, single floor and other grades covered in DOC PS 1 and PS 2	$1^1/_2$ 16 gage	1	$^3/_8$	2	160	210	315	360	140	105
				3	180	235	355	400	160	120
			$^7/_{16}$	2	165	225	335	380	150	110
				3	190	250	375	425	165	125
			$^{15}/_{32}$	2	160	210	315	360	140	105
				3	180	235	355	405	160	120
			$^{19}/_{32}$	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[f]



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 on center along intermediate framing members (6 inches on center where supports are spaced 48 inches on center).

c. Framing at adjoining panel edges shall be 3 inches nominal or wider.

d. Staples shall have a minimum crown width of $^{7}/_{16}$ 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[f]	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[d]					
						Fastener Spacing Per Line at Boundaries (inches)					
						4			$2^1/_2$	2	
						Fastener Spacing Per Line at Other Panel Edges (inches)					
						6	4	4	3	3	2
Structural I grades	14 gage staples	2	$^{15}/_{32}$	3	2	600	600	860	960	1,060	1,200
				4	3	860	900	1,160	1,295	1,295	1,400
			$^{19}/_{32}$	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	$^{15}/_{32}$	3	2	540	540	735	865	915	1,080
				4	3	735	810	1,005	1,105	1,105	1,195
			$^{19}/_{32}$	3	2	600	600	865	960	1,065	1,200
				4	3	865	900	1,130	1,430	1,370	1,485
			$^{23}/_{32}$	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.

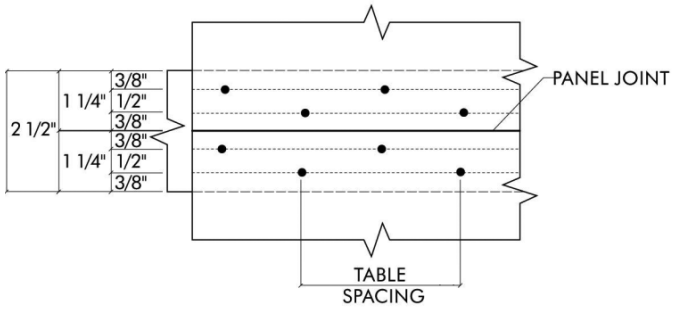
f. Staples shall have a minimum crown width of $^7/_{16}$ inch, and shall be installed with their crowns parallel to the long dimension of the framing members.

g. High-load diaphragms shall be subject to special inspection in accordance with Section 1705.5.1.

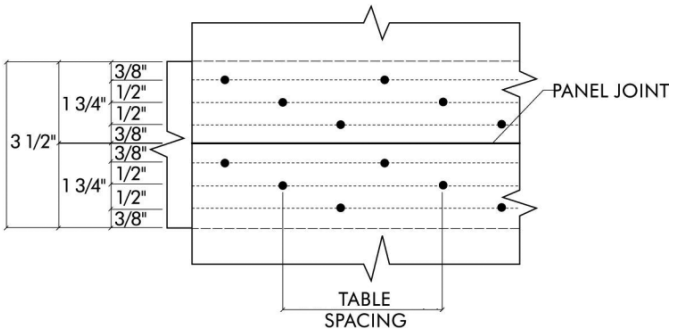
h. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

(continued)

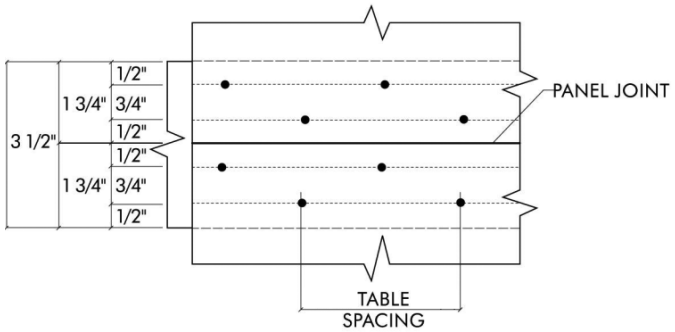
TABLE 2306.2(2)—continued
ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS UTILIZING MULTIPLE ROWS OF STAPLES (HIGH-LOAD DIAPHRAGMS) WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE FOR WIND OR SEISMIC LOADING



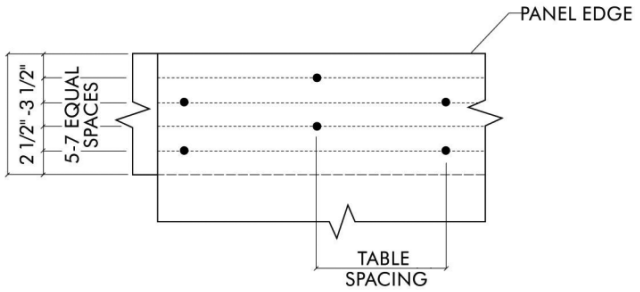
3" NOMINAL—TWO LINES



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[a] 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 1/2" OR 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	2[d]		6	4	3	2[d]
Structural I sheathing	3/8	1	1 1/2 16 Gage	155	235	315	400	2 16 Gage	155	235	310	400
	7/16			170	260	345	440		155	235	310	400
	15/32			185	280	375	475		155	235	300	400
Sheathing, plywood siding[e] except Group 5 Species, ANSI/APA PRP 210 siding	5/16[c] or 1/4[c]	1	1 1/2 16 Gage	145	220	295	375	2 16 Gage	110	165	220	285
	3/8			140	210	280	360		140	210	280	360
	7/16			155	230	310	395		140	210	280	360
	15/32			170	255	335	430		140	210	280	360
	19/32		1 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 3/8-inch and 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. 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 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)[a]		
		4	3	2
1/2″ or 25/32″ Structural	No. 11 gage galvanized staple, 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 be not less than 1 1/2 inches for 25/32-inch sheathing or 1 1/4 inches for 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	$^7/_8$″	Unblocked	6	180	No. 16 gage galv. staple, $^7/_8$″ legs
2. Gypsum lath, plain or perforated	$^3/_8$″ lath and $^1/_2$″ plaster	Unblocked	5	100	No. 16 gage galv. staple, $1^1/_8$″ long
3. Gypsum sheating	$^1/_2$″ 2′ 8′	Unblocked	4	75	No. 16 gage galv. staple, $1^3/_4$″ long
	$^1/_2$″ 4′	Blocked[d] Unblocked	4 7	175 100	
4. Gypsum board, gypsum veneer base or water-resistant gypsum backing board	$^1/_2$″	Unblocked[d]	7	75	No. 16 gage galv. staple, $1^1/_2$″ long
		Unblocked[d]	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked[e]	7	125	
		Blocked[e]	4	150	
	$^5/_8$″	Unblocked[d]	7	115	No. 16 gage galv. staple, $1^1/_2$″ legs, $1^5/_8$″ long
			4	145	
		Blocked[e]	7	145	
			4	175	
		Blocked[e] Two-ply	Base ply: 9 Face ply: 7	250	No. 16 gage galv. staple $1^5/_8$″ long No. 15 gage galv. staple, $2^1/_4$″ 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 $^7/_{16}$ 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 $^3/_4$ inch, measured outside the legs.

SECTION 2308
CONVENTIONAL LIGHT-FRAME CONSTRUCTION

2308.1 General. The requirements of this section are intended for conventional light-frame construction. Other construction methods are permitted to be used, provided a satisfactory design is submitted showing compliance with other provisions of this code. Interior nonload-bearing partitions, ceilings and curtain walls of conventional light-frame construction are not subject to the limitations of Section 2308.2.

2308.1.1 Portions exceeding limitations of conventional light-frame construction. When portions of a building of otherwise conventional light-frame construction exceed the limits of Section 2308.2, those 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. The extent of such design need only demonstrate compliance of the nonconventional light-framed elements with other applicable provisions of this code and shall be compatible with the performance of the conventional light-framed system.

2308.1.2 Connections and fasteners. Connectors and fasteners used in conventional construction shall comply with the requirements of Section 2304.10.

2308.2 Limitations. Buildings are permitted to be constructed in accordance with the provisions of conventional light-frame construction, subject to the limitations in Sections 2308.2.1 through 2308.2.6.

2308.2.1 Stories. Structures of conventional light-frame construction shall be limited in story height in accordance with Table 2308.2.1.

2308.2.2 Allowable floor-to-floor height. Maximum floor-to-floor height shall not exceed 11 feet, 7 inches (3531 mm). Exterior bearing wall and interior braced wall heights shall not exceed a stud height of 10 feet (3048 mm).

TABLE 2308.2.1
ALLOWABLE STORY HEIGHT

SEISMIC DESIGN CATEGORY	ALLOWABLE STORY ABOVE GRADE PLANE
A and B	Three stories
C	Two stories
D and E[a]	One story

For SI: 1 inch = 25.4 mm.

a. For the purposes of this section, for buildings assigned to Seismic Design Category D or E, cripple walls shall be considered to be a story unless cripple walls are solid blocked and do not exceed 14 inches in height.

2308.2.3 Allowable loads. Loads shall be in accordance with Chapter 16 and shall not exceed the following:

1. Average dead loads shall not exceed 15 psf (718 N/m^2) for combined roof and ceiling, exterior walls, floors and partitions.

   Exceptions:

   1. Subject to the limitations of Section 2308.6.10, stone or masonry veneer up to the lesser of 5 inches (127 mm) thick or 50 psf (2395 N/m^2) 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.

2. Live loads shall not exceed 40 psf (1916 N/m^2) for floors.
3. Ground snow loads shall not exceed 50 psf (2395 N/m^2).

2308.2.4 Ultimate wind speed. V_{ult} shall not exceed 130 miles per hour (57 m/s) (3-second gust).

Exceptions:

1. V_{ult} shall not exceed 140 mph (61.6 m/s) (3-second gust) for buildings in Exposure Category B that are not located in a hurricane-prone region.
2. Where V_{ult} exceeds 130 mph (3-second gust), the provisions of either AWC WFCM or ICC 600 are permitted to be used.

2308.2.5 Allowable roof span. Ceiling joist and rafter framing constructed in accordance with Section 2308.7 and trusses shall not span more than 40 feet (12 192 mm) between points of vertical support. A ridge board in accordance with Section 2308.7 or 2308.7.3.1 shall not be considered a vertical support.

2308.2.6 Risk category limitation. 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 or E.

2308.2.7 Additional requirements [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:*

1. *The design and construction shall also comply with Section 2304 and Section 2305.*
2. *In conjunction with the use of provisions in Section 2308.6 (Wall bracing), engineering analysis shall be furnished that demonstrates compliance of lateral-force-resisting systems with Section 2305.*
3. *In addition to the use of provisions in Section 2308.4 (Floor framing), engineering analysis shall be furnished that demonstrates compliance of floor framing elements and connections with Section 2301.2, Item 1 or 2.*
4. *In addition to the use of provisions in Section 2308.5 (Wall construction), engineering analysis shall be furnished that demonstrates compliance of wall framing elements and connections with Section 2301.2, Item 1 or 2.*
5. *In addition to the use of provisions in Section 2308.7 (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.*

2308.3 Foundations and footings. Foundations and footings shall be designed and constructed in accordance with Chapter 18. Connections to foundations and footings shall comply with this section.

2308.3.1 Foundation plates or sills. 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 $^1/_2$-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. Bolts shall be spaced not more than 6 feet (1829 mm) on center and there shall be not less than 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.

Exceptions:

1. Along braced wall lines in structures assigned to Seismic Design Category E, steel bolts with a minimum nominal diameter of $^5/_8$ inch (15.9 mm) or approved anchor straps load-rated in accordance with Section 2304.10.3 and spaced to provide equivalent anchorage shall be used.
2. Bolts in braced wall lines in structures over two stories above grade shall be spaced not more than 4 feet (1219 mm) on center.

2308.3.2 Braced wall line sill plate anchorage in Seismic Design Categories D and E. Sill plates along braced

wall lines in buildings assigned to Seismic Design Category D or E 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 2304.10.3. 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 $^3/_{16}$ inch (4.76 mm) larger than the bolt diameter and a slot length not to exceed $1^3/_4$ inches (44 mm), provided a standard cut washer is placed between the plate washer and the nut.

2308.4 Floor framing. Floor framing shall comply with this section.

2308.4.1 Girders. Girders for single-story construction or girders supporting loads from a single floor shall be not 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) on center. 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.

2308.4.1.1 Allowable girder spans. The allowable spans of girders that are fabricated of dimension lumber shall not exceed the values set forth in Table 2308.4.1.1(1) or 2308.4.1.1(2).

2308.4.2 Floor joists. Floor joists shall comply with this section.

2308.4.2.1 Span. Spans for floor joists shall be in accordance with Table 2308.4.2.1(1) or 2308.4.2.1(2) or the AWC STJR.

2308.4.2.2 Bearing. The ends of each joist shall have not less than $1^1/_2$ inches (38 mm) of bearing on wood or metal, or not less than 3 inches (76 mm) on masonry, except where supported on a 1-inch by 4-inch (25 mm by 102 mm) ribbon strip and nailed to the adjoining stud.

2308.4.2.3 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 be not less than 2 inches (51 mm) in thickness and the full depth of the joist. 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).

2308.4.2.4 Notches and holes. Notches on the ends of joists shall not exceed one-fourth the joist depth. 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. 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.

2308.4.3 Engineered wood products. Engineered wood products shall be installed in accordance with manufacturer's recommendations. Cuts, notches and holes bored in trusses, structural composite lumber, structural glued-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.

2308.4.4 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) in length shall be supported by framing anchors or joist hangers unless bearing on a beam, partition or wall. Tail joists over 12 feet (3658 mm) in length 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).

2308.4.4.1 Openings in floor diaphragms in Seismic Design Categories B, C, D and E. Openings in horizontal diaphragms in Seismic Design Categories B, C, D and E with a dimension that is greater than 4 feet (1219 mm) shall be constructed with metal ties and blocking in accordance with this section and Figure 2308.4.4.1(1). Metal ties shall be not less than 0.058 inch [1.47 mm (16 galvanized gage)] in thickness by $1^1/_2$ inches (38 mm) in width and shall have a yield stress not less than 33,000 psi (227 Mpa). Blocking shall extend not less than the dimension of the opening in the direction of the tie and blocking. Ties shall be attached to blocking in accordance with the manufacturer's instructions but with not less than eight 16d common nails on each side of the header-joist intersection.

Openings in floor diaphragms in Seismic Design Categories D and E shall not have any dimension exceeding 50 percent of the distance between braced wall lines or an area greater than 25 percent of the area between orthogonal pairs of braced wall lines [see Figure 2308.4.4.1(2)]; or the portion of the structure containing the opening shall be designed in accordance with accepted engineering practice to resist the forces specified in Chapter 16, to the extent such irregular opening affects the performance of the conventional framing system.

2308.4.4.2 Vertical offsets in floor diaphragms in Seismic Design Categories D and E. In Seismic Design Categories D and E, portions of a floor level shall not be vertically offset such that the framing members on either side of the offset cannot be lapped or tied together in an approved manner in accordance with Figure 2308.4.4.2 unless the portion of the structure containing the irregular offset is designed in accordance with accepted engineering practice.

Exception: Framing supported directly by foundations need not be lapped or tied directly together.

TABLE 2308.4.1.1(1)
HEADER AND GIRDER SPANS[a, b] 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)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]											
		30						50					
		Building width[c] (feet)											
		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof and ceiling	2-2 × 4	3-6	1	3-2	1	2-10	1	3-2	1	2-9	1	2-6	1
	2-2 × 6	5-5	1	4-8	1	4-2	1	4-8	1	4-1	1	3-8	2
	2-2 × 8	6-10	1	5-11	2	5-4	2	5-11	2	5-2	2	4-7	2
	2-2 × 10	8-5	2	7-3	2	6-6	2	7-3	2	6-3	2	5-7	2
	2-2 × 12	9-9	2	8-5	2	7-6	2	8-5	2	7-3	2	6-6	2
	3-2 × 8	8-4	1	7-5	1	6-8	1	7-5	1	6-5	2	5-9	2
	3-2 × 10	10-6	1	9-1	2	8-2	2	9-1	2	7-10	2	7-0	2
	3-2 × 12	12-2	2	10-7	2	9-5	2	10-7	2	9-2	2	8-2	2
	4-2 × 8	9-2	1	8-4	1	7-8	1	8-4	1	7-5	1	6-8	1
	4-2 × 10	11-8	1	10-6	1	9-5	2	10-6	1	9-1	2	8-2	2
	4-2 × 12	14-1	1	12-2	2	10-11	2	12-2	2	10-7	2	9-5	2
Roof, ceiling and one center-bearing floor	2-2 × 4	3-1	1	2-9	1	2-5	1	2-9	1	2-5	1	2-2	1
	2-2 × 6	4-6	1	4-0	1	3-7	2	4-1	1	3-7	2	3-3	2
	2-2 × 8	5-9	2	5-0	2	4-6	2	5-2	2	4-6	2	4-1	2
	2-2 × 10	7-0	2	6-2	2	5-6	2	6-4	2	5-6	2	5-0	2
	2-2 × 12	8-1	2	7-1	2	6-5	2	7-4	2	6-5	2	5-9	3
	3-2 × 8	7-2	1	6-3	2	5-8	2	6-5	2	5-8	2	5-1	2
	3-2 × 10	8-9	2	7-8	2	6-11	2	7-11	2	6-11	2	6-3	2
	3-2 × 12	10-2	2	8-11	2	8-0	2	9-2	2	8-0	2	7-3	2
	4-2 × 8	8-1	1	7-3	1	6-7	1	7-5	1	6-6	1	5-11	2
	4-2 × 10	10-1	1	8-10	2	8-0	2	9-1	2	8-0	2	7-2	2
	4-2 × 12	11-9	2	10-3	2	9-3	2	10-7	2	9-3	2	8-4	2
Roof, ceiling and one clear span floor	2-2 × 4	2-8	1	2-4	1	2-1	1	2-7	1	2-3	1	2-0	1
	2-2 × 6	3-11	1	3-5	2	3-0	2	3-10	2	3-4	2	3-0	2
	2-2 × 8	5-0	2	4-4	2	3-10	2	4-10	2	4-2	2	3-9	2
	2-2 × 10	6-1	2	5-3	2	4-8	2	5-11	2	5-1	2	4-7	3
	2-2 × 12	7-1	2	6-1	3	5-5	3	6-10	2	5-11	3	5-4	3
	3-2 × 8	6-3	2	5-5	2	4-10	2	6-1	2	5-3	2	4-8	2
	3-2 × 10	7-7	2	6-7	2	5-11	2	7-5	2	6-5	2	5-9	2
	3-2 × 12	8-10	2	7-8	2	6-10	2	8-7	2	7-5	2	6-8	2
	4-2 × 8	7-2	1	6-3	2	5-7	2	7-0	1	6-1	2	5-5	2
	4-2 × 10	8-9	2	7-7	2	6-10	2	8-7	2	7-5	2	6-7	2
	4-2 × 12	10-2	2	8-10	2	7-11	2	9-11	2	8-7	2	7-8	2
Roof, ceiling and two center-bearing floors	2-2 × 4	2-7	1	2-3	1	2-0	1	2-6	1	2-2	1	1-11	1
	2-2 × 6	3-9	2	3-3	2	2-11	2	3-8	2	3-2	2	2-10	2
	2-2 × 8	4-9	2	4-2	2	3-9	2	4-7	2	4-0	2	3-8	2
	2-2 × 10	5-9	2	5-1	2	4-7	3	5-8	2	4-11	2	4-5	3
	2-2 × 12	6-8	2	5-10	3	5-3	3	6-6	2	5-9	3	5-2	3
	3-2 × 8	5-11	2	5-2	2	4-8	2	5-9	2	5-1	2	4-7	2
	3-2 × 10	7-3	2	6-4	2	5-8	2	7-1	2	6-2	2	5-7	2
	3-2 × 12	8-5	2	7-4	2	6-7	2	8-2	2	7-2	2	6-5	3
	4-2 × 8	6-10	1	6-0	2	5-5	2	6-8	1	5-10	2	5-3	2
	4-2 × 10	8-4	2	7-4	2	6-7	2	8-2	2	7-2	2	6-5	2
	4-2 × 12	9-8	2	8-6	2	7-8	2	9-5	2	8-3	2	7-5	2
Roof, ceiling, and two clear span floors	2-2 × 4	2-1	1	1-8	1	1-6	2	2-0	1	1-8	1	1-5	2
	2-2 × 6	3-1	2	2-8	2	2-4	2	3-0	2	2-7	2	2-3	2
	2-2 × 8	3-10	2	3-4	2	3-0	3	3-10	2	3-4	2	2-11	3

(continued)

TABLE 2308.4.1.1(1)—continued
HEADER AND GIRDER SPANS[a, b] 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)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]											
		30						50					
		Building width[c] (feet)											
		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof, ceiling, and two clear span floors	2-2 × 10	4-9	2	4-1	3	3-8	3	4-8	2	4-0	3	3-7	3
	2-2 × 12	5-6	3	4-9	3	4-3	3	5-5	3	4-8	3	4-2	3
	3-2 × 8	4-10	2	4-2	2	3-9	2	4-9	2	4-1	2	3-8	2
	3-2 × 10	5-11	2	5-1	2	4-7	3	5-10	2	5-0	2	4-6	3
	3-2 × 12	6-10	2	5-11	3	5-4	3	6-9	2	5-10	3	5-3	3
	4-2 × 8	5-7	2	4-10	2	4-4	2	5-6	2	4-9	2	4-3	2
	4-2 × 10	6-10	2	5-11	2	5-3	2	6-9	2	5-10	2	5-2	2
	4-2 × 12	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 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine Fir. No. 1 or better grade lumber shall be used for Southern Pine.

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 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

TABLE 2308.4.1.1(2)
HEADER AND GIRDER SPANS[a, b] 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	2-2 × 4	3-1	1	2-8	1	2-5	1
	2-2 × 6	4-6	1	3-11	1	3-6	1
	2-2 × 8	5-9	1	5-0	2	4-5	2
	2-2 × 10	7-0	2	6-1	2	5-5	2
	2-2 × 12	8-1	2	7-0	2	6-3	2
	3-2 × 8	7-2	1	6-3	1	5-7	2
	3-2 × 10	8-9	1	7-7	2	6-9	2
	3-2 × 12	10-2	2	8-10	2	7-10	2
	4-2 × 8	9-0	1	7-8	1	6-9	1
	4-2 × 10	10-1	1	8-9	1	7-10	2
	4-2 × 12	11-9	1	10-2	2	9-1	2
Two floors	2-2 × 4	2-2	1	1-10	1	1-7	1
	2-2 × 6	3-2	2	2-9	2	2-5	2
	2-2 × 8	4-1	2	3-6	2	3-2	2
	2-2 × 10	4-11	2	4-3	2	3-10	3
	2-2 × 12	5-9	2	5-0	3	4-5	3
	3-2 × 8	5-1	2	4-5	2	3-11	2
	3-2 × 10	6-2	2	5-4	2	4-10	2
	3-2 × 12	7-2	2	6-3	2	5-7	3
	4-2 × 8	6-1	1	5-3	2	4-8	2
	4-2 × 10	7-2	2	6-2	2	5-6	2
	4-2 × 12	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.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine Fir. No. 1 or better grade lumber shall be used for Southern Pine.

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.

TABLE 2308.4.2.1(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			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
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	11-10	15-7	19-10	24-2	11-10	15-7	18-7	22-0
	Southern Pine	#2	11-3	14-11	18-1	21-4	10-9	13-8	16-2	19-1
	Southern Pine	#3	9-2	11-6	14-0	16-6	8-2	10-3	12-6	14-9
	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	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern Pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern Pine	#3	7-11	10-10	12-1	14-4	7-1	8-11	10-10	12-10
	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

(continued)

TABLE 2308.4.2.1(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			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
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
	Southern Pine	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Southern Pine	#1	10-1	13-4	16-5	19-6	9-11	12-7	14-8	17-5
	Southern Pine	#2	9-6	12-1	14-4	16-10	8-6	10-10	12-10	15-1
	Southern Pine	#3	7-3	9-1	11-0	13-1	6-5	8-2	9-10	11-8
	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	19-8
	Southern Pine	#1	9-4	12-4	14-8	17-5	8-10	11-3	13-1	15-7
	Southern Pine	#2	8-6	10-10	12-10	15-1	7-7	9-8	11-5	13-6
	Southern Pine	#3	6-5	8-2	9-10	11-8	5-9	7-3	8-10	10-5
	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 = 0.0479 kPa.
Note: Check sources for availability of lumber in lengths greater than 20 feet.

TABLE 2308.4.2.1(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			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
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	10-9	14-2	18-0	21-11	10-9	14-2	16-11	20-1
	Southern Pine	#2	10-3	13-6	16-2	19-1	9-10	12-6	14-9	17-5
	Southern Pine	#3	8-2	10-3	12-6	14-9	7-5	9-5	11-5	13-6
	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	9-9	12-10	16-1	19-1	9-9	12-7	14-8	17-5
	Southern Pine	#2	9-4	11-10	14-0	16-6	8-6	10-10	12-10	15-1
	Southern Pine	#3	7-1	8-11	10-10	12-10	6-5	8-2	9-10	11-8
	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

(continued)

TABLE 2308.4.2.1(2)—continued
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			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
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	9-2	12-1	14-8	17-5	9-0	11-5	13-5	15-11
	Southern Pine	#2	8-6	10-10	12-10	15-1	7-9	9-10	11-8	13-9
	Southern Pine	#3	6-5	8-2	9-10	11-8	5-11	7-5	9-0	10-8
	Spruce-Pine-Fir	SS	9-0	11-10	15-1	18-4	9-0	11-10	15-1	17-9
	Spruce-Pine-Fir	#	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
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	18-0
	Southern Pine	#1	8-6	11-3	13-1	15-7	8-1	10-3	12-0	14-3
	Southern Pine	#2	7-7	9-8	11-5	13-6	7-0	8-10	10-5	12-4
	Southern Pine	#3	5-9	7-3	8-10	10-5	5-3	6-8	8-1	9-6
	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 = 0.0479 kPa.
Note: Check sources for availability of lumber in lengths greater than 20 feet.
a. End bearing length shall be increased to 2 inches.

2308.4.5 Joists 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.

2308.4.6 Lateral support. Floor and ceiling framing with a nominal depth-to-thickness ratio not less than 5 to 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 to 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, or 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.

2308.4.7 Structural floor sheathing. Structural floor sheathing shall comply with the provisions of Section 2304.8.1.

2308.4.8 Under-floor ventilation. For under-floor ventilation, see Section 1203.4.

2308.4.9 Floor framing supporting braced wall panels. Where braced wall panels are supported by cantilevered floors or are set back from the floor joist support, the floor framing shall comply with Section 2308.6.7.

2308.4.10 Anchorage of exterior means of egress components in Seismic Design Categories D and E. Exterior egress balconies, exterior stairways and ramps and similar means of egress components in structures assigned to Seismic Design Category D or E shall be positively anchored to the primary structure at not more than 8 feet (2438 mm) on center or shall be designed for lateral forces. Such attachment shall not be accomplished by use of toenails or nails subject to withdrawal.

2308.5 Wall construction. Walls of conventional light-frame construction shall be in accordance with this section.

2308.5.1 Stud size, height and spacing. The size, height and spacing of studs shall be in accordance with Table 2308.5.1.

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 2308.4.1.1(1) or 2308.4.1.1(2).

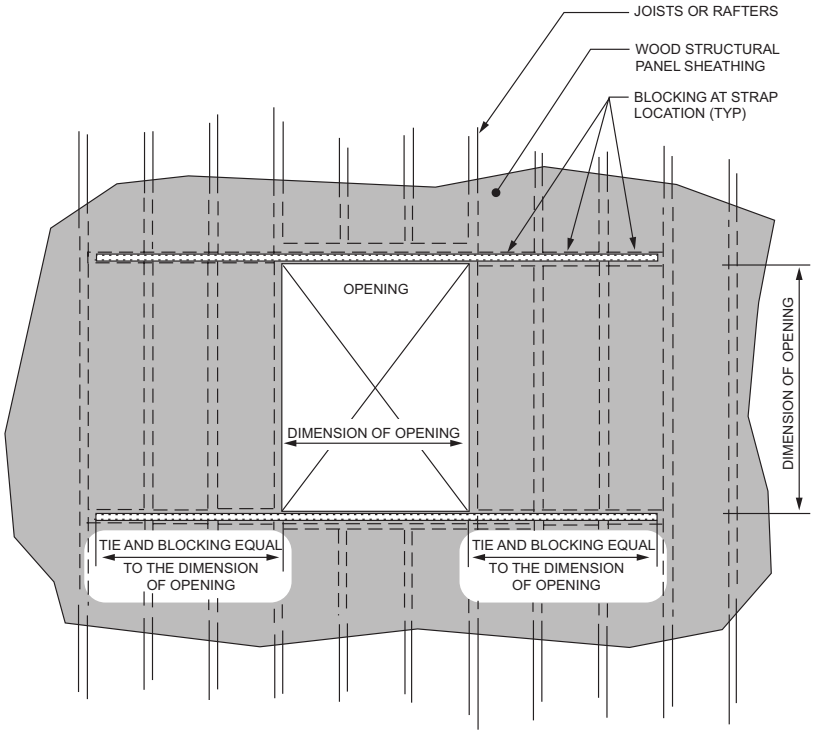


FIGURE 2308.4.4.1(1)
OPENINGS IN FLOOR AND ROOF DIAPHRAGMS

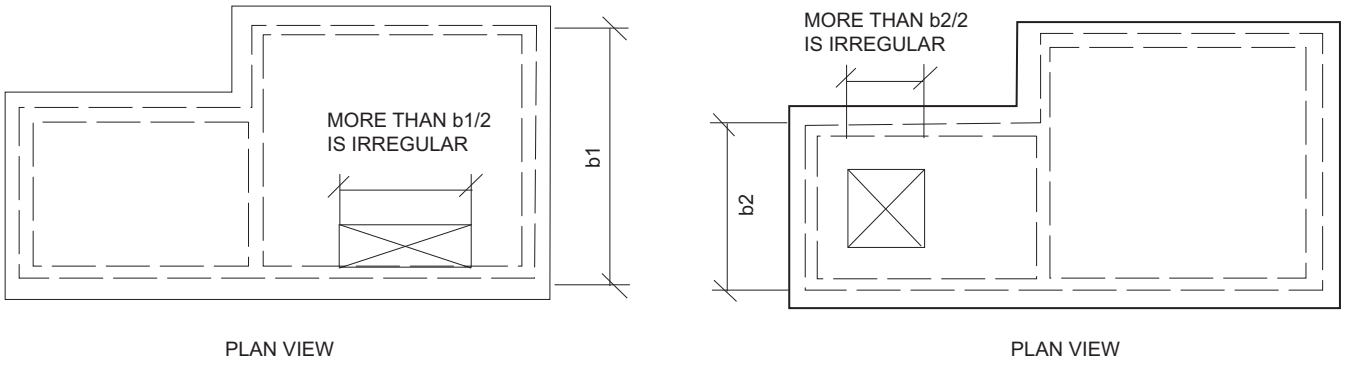
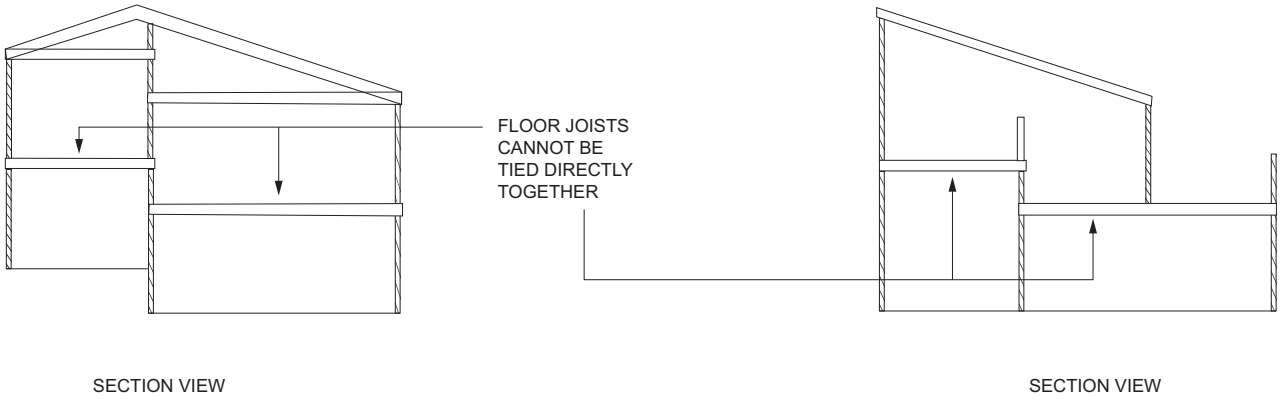


FIGURE 2308.4.4.1(2)
OPENING LIMITATIONS FOR FLOOR AND ROOF DIAPHRAGMS



FIGUR 2308.4.4.2
PORTIONS OF FLOOR LEVEL OFFSET VERTICALLY

TABLE 2308.5.1
SIZE, HEIGHT AND SPACING OF WOOD STUDS[c]

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)
		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.

c. Utility-grade studs shall not be spaced more than 16 inches on center or support more than a roof and ceiling, or exceed 8 feet in height for exterior walls and load-bearing walls or 10 feet for interior nonload-bearing walls.

2308.5.2 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.

Exceptions:

1. In interior nonbearing walls and partitions, studs are permitted to be set with the long dimension parallel to the wall.
2. At corners, two studs are permitted, provided that wood spacers or backup cleats of $^3/_8$-inch-thick (9.5 mm) wood structural panel, $^3/_8$-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.

2308.5.3 Plates and sills. Studs shall have plates and sills in accordance with this section.

2308.5.3.1 Bottom plate or sill. Studs shall have full bearing on a plate or sill. Plates or sills shall be not less than 2 inches (51 mm) nominal in thickness and have a width not less than the width of the wall studs.

2308.5.3.2 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 not less than 48 inches (1219 mm), and shall be nailed in accordance with Table 2304.10.1. Plates shall be a nominal 2 inches (51 mm) in depth and have a width not less than the width of the studs.

Exception: A single top plate is permitted, provided that the plate is adequately tied at corners and intersecting walls by not less than the equivalent of 3-inch by 6-inch (76 mm by 152 mm) by 0.036-inch-thick (0.914 mm) galvanized steel plate that is nailed to each wall or segment of wall by six 8d [$2^1/_2$" × 0.113" (64-mm by 2.87 mm)] box nails or equivalent on each side of the joint. For the butt-joint splice between adjacent single top plates, not less than the equivalent of a 3-inch by 12-inch (76 mm by 304 mm) by 0.036-inch-thick (0.914 mm) galvanized steel plate that is nailed to each wall or segment of wall by 12 8d [$2^1/_2$-inch × 0.113-inch (64 mm by 2.87 mm)] box nails on each side of the joint shall be required, provided that the rafters, joists or trusses are centered over the studs with a tolerance of not more than 1 inch (25 mm). The top plate shall not be required over headers that are in the same plane and in line with the upper surface of the adjacent top plates and are tied to adjacent wall sections as required for the butt joint splice between adjacent single top plates.

Where bearing studs are spaced at 24-inch (610 mm) intervals, 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 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.

2308.5.4 Nonload-bearing walls and partitions. In nonload-bearing walls and partitions, that are not part of a braced wall panel, studs shall be spaced not more than 24 inches (610 mm) on center. In interior nonload-bearing walls and partitions, studs are permitted to be set with the long dimension parallel to the wall. Where studs are set with the long dimensions parallel to the wall, use of utility grade lumber or studs exceeding 10 feet (3048 mm) is not permitted. Interior nonload-bearing partitions shall be capped with not 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 not less than 16 inches (406 mm) in length and equal in size to the plate or by $^1/_2$-inch by $1^1/_2$-inch (12.7 mm by 38 mm) metal ties with spliced sections fastened with two 16d nails on each side of the joint.

2308.5.5 Openings in walls and partitions. Openings in exterior and interior walls and partitions shall comply with Sections 2308.5.5.1 through 2308.5.5.3.

2308.5.5.1 Openings in exterior bearing walls. Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) 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 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than $1^1/_2$ inches (38 mm) for the full width of the lintel.

2308.5.5.2 Openings in interior bearing partitions. Headers shall be provided over each opening in interior bearing partitions as required in Section 2308.5.5.1. The spans in Table 2308.4.1.1(2) are permitted to be used. Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1) or 2308.4.1.1(2), as applicable.

2308.5.5.3 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 bearing length of not less than $1^1/_2$ inches (38 mm) for the full width of the lintel.

2308.5.6 Cripple walls. Foundation cripple walls shall be framed of studs that are not less than the size of the studding above and not less than 14 inches (356 mm) in length, 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. See Section 2308.6.6 for cripple wall bracing.

2308.5.7 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 that is 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.

2308.5.8 Pipes in walls. Stud partitions containing plumbing, heating or other pipes shall be framed and the joists underneath spaced to provide proper clearance for the piping. Where a partition containing piping runs parallel to the floor joists, the joists underneath such partitions shall be doubled and spaced to permit the passage of 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 $1^1/_2$ inches (38 mm) in width shall be fastened to each plate across and to each side of the opening with not less than six 16d nails.

2308.5.9 Cutting and notching. In exterior walls and bearing partitions, wood studs are permitted to be cut or notched to a depth not exceeding 25 percent of the width of the stud. 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.

2308.5.10 Bored holes. Bored holes not greater than 40 percent of the stud width are permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the stud width 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 a bored hole be nearer than $^5/_8$ 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.

2308.5.11 Exterior wall sheathing. Except where stucco construction that complies with Section 2510 is installed, the outside of exterior walls, including gables, of enclosed buildings shall be sheathed with one of the materials of the nominal thickness specified in Table 2308.5.11 with fasteners in accordance with the requirements of Section 2304.10 or fasteners designed in accordance with accepted engineering practice. Alternatively, sheathing materials and fasteners complying with Section 2304.6 shall be permitted.

2308.6 Wall bracing. Buildings shall be provided with exterior and interior braced wall lines as described in Sections 2308.6.1 through 2308.6.10.2.

2308.6.1 Braced wall lines. For the purpose of determining the amount and location of bracing required along each story level of a building, braced wall lines shall be designated as straight lines through the building plan in both the longitudinal and transverse direction and placed in accordance with Table 2308.6.1 and Figure 2308.6.1. Braced wall line spacing shall not exceed the distance specified in Table 2308.6.1. In structures assigned to Seismic Design Category D or E, braced wall lines shall intersect perpendicularly to each other.

2308.6.2 Braced wall panels. Braced wall panels shall be placed along braced wall lines in accordance with Table 2308.6.1 and Figure 2308.6.1 and as specified in Table 2308.6.3(1). A braced wall panel shall be located at each end of the braced wall line and at the corners of intersecting braced wall lines or shall begin within the maximum distance from the end of the braced wall line in accordance with Table 2308.6.1. Braced wall panels in a braced wall line shall not be offset from each other by more than 4 feet (1219 mm). Braced wall panels shall be clearly indicated on the plans.

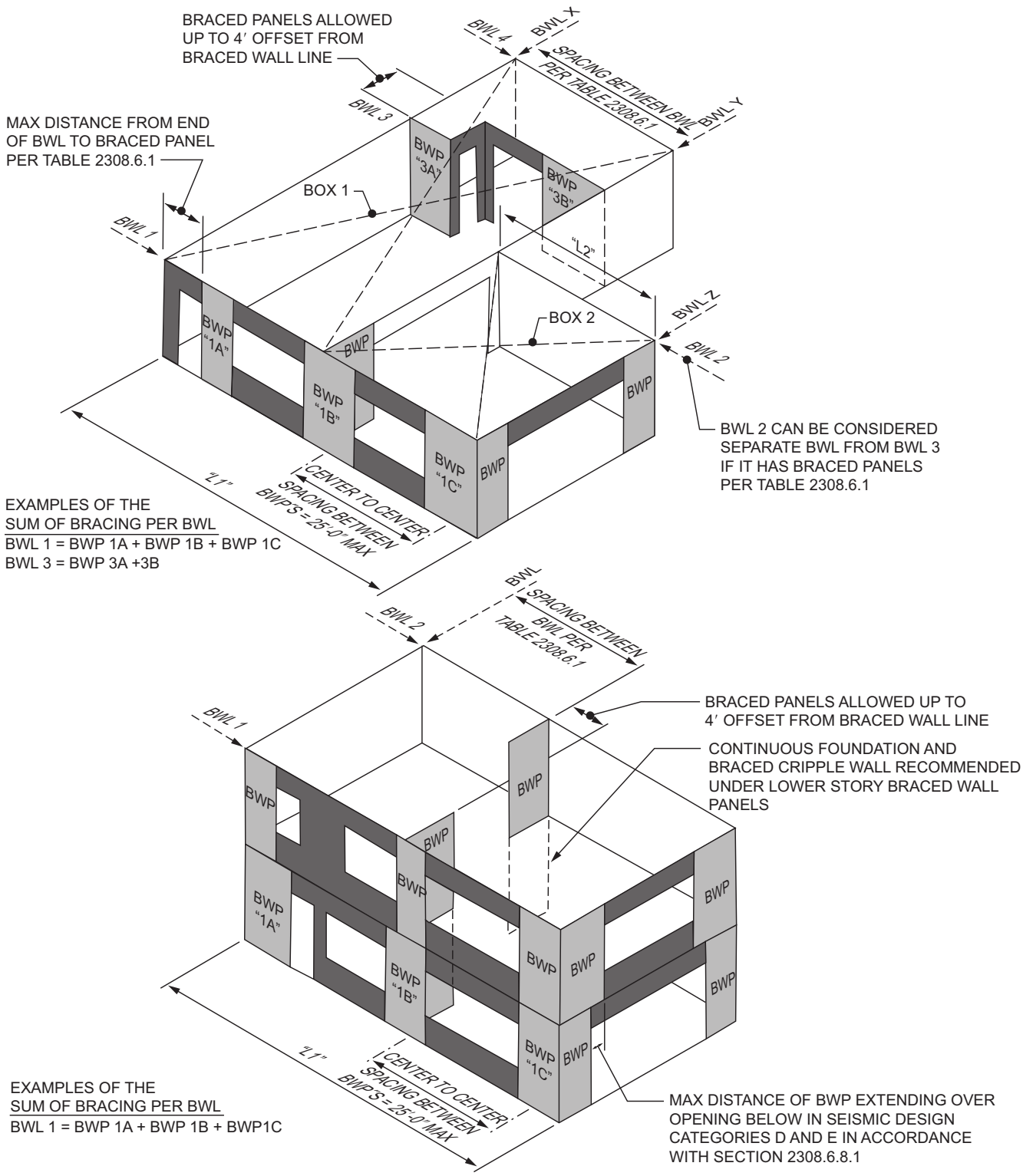
2308.6.3 Braced wall panel methods. Construction of braced wall panels shall be by one or a combination of the methods in Table 2308.6.3(1). Braced wall panel length shall be in accordance with Section 2308.6.4 or 2308.6.5.

**

TABLE 2308.5.11
MINIMUM THICKNESS OF WALL SHEATHING

SHEATHING TYPE	MINIMUM THICKNESS	MAXIMUM WALL STUD SPACING
Diagonal wood boards	$^5/_8$ inch	24 inches on center
Structural fiberboard	$^1/_2$ inch	16 inches on center
Wood structural panel	In accordance with Tables 2308.6.3(2) and 2308.6.3(3)	—
M-S “Exterior Glue” and M-2 “Exterior Glue” particleboard	In accordance with Section 2306.3 and Table 2308.6.3(4)	—
Gypsum sheathing	$^1/_2$ inch	16 inches on center
Reinforced cement mortar	1 inch	24 inches on center
Hardboard panel siding	In accordance with Table 2308.6.3(5)	—

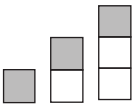
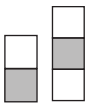
For SI: 1 inch = 25.4 mm.



For SI: 1 foot = 304.8 mm.

FIGURE 2308.6.1
BASIC COMPONENTS OF THE LATERAL BRACING SYSTEM

TABLE 2308.6.1[a]
WALL BRACING REQUIREMENTS

SEISMIC DESIGN CATEGORY	STORY CONDITION (SEE SECTION 2308.2)	MAXIMUM SPACING OF BRACED WALL LINES	BRACED PANEL LOCATION, SPACING (O.C.) AND MINIMUM PERCENTAGE (X)			MAXIMUM DISTANCE OF BRACED WALL PANELS FROM EACH END OF BRACED WALL LINE
			Bracing method[b]			
			LIB	DWB, WSP	SFB, PBS, PCP, HPS, GB[c, d]	
A and B		35′- 0″	Each end and ≤ 25′- 0″ o.c.	Each end and ≤ 25′- 0″ o.c.	Each end and ≤ 25′- 0″ o.c.	12′- 6″
		35′- 0″	Each end and ≤ 25′- 0″ o.c.	Each end and ≤ 25′- 0″ o.c.	Each end and ≤ 25′- 0″ o.c.	12′- 6″
		35′- 0″	NP	Each end and ≤ 25′- 0″ o.c.	Each end and ≤ 25′- 0″ o.c.	12′- 6″
C		35′- 0″	NP	Each end and ≤ 25′- 0″ o.c.	Each end and ≤ 25′- 0″ o.c.	12′- 6″
		35′- 0″	NP	Each end and ≤ 25′- 0″ o.c. (minimum 25% of wall length)[e]	Each end and ≤ 25′- 0″ o.c. (minimum 25% of wall length)[e]	12′- 6″
D and E		25′- 0″	NP	S_{DS} < 0.50: Each end and ≤ 25′- 0″ o.c. (minimum 21% of wall length)[e]	S_{DS} < 0.50: Each end and ≤ 25′- 0″ o.c. (minimum 43% of wall length)[e]	8′- 0″
				0.5 ≤ S_{DS} < 0.75: Each end and ≤ 25′- 0″ o.c. (minimum 32% of wall length)[e]	0.5 ≤ S_{DS} < 0.75: Each end and ≤ 25′- 0″ o.c. (minimum 59% of wall length)[e]	
				0.75 ≤ S_{DS} ≤ 1.00: Each end and ≤ 25′- 0″ o.c. (minimum 37% of wall length)[e]	0.75 ≤ S_{DS} ≤ 1.00: Each end and ≤ 25′- 0″ o.c. (minimum 75% of wall length)	
				S_{DS} > 1.00: Each end and ≤ 25′- 0″ o.c. (minimum 48% of wall length)[e]	S_{DS} > 1.00: Each end and ≤ 25′- 0″ o.c. (minimum 100% of wall length)[e]	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

NP = Not Permitted.

a. This table specifies minimum requirements for braced wall panels along interior or exterior braced wall lines.

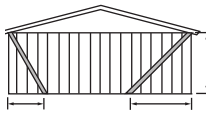
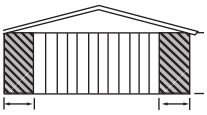
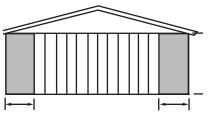
b. See Section 2308.6.3 for full description of bracing methods.

c. For Method GB, gypsum wallboard applied to framing supports that are spaced at 16 inches on center.

d. The required lengths shall be doubled for gypsum board applied to only one face of a braced wall panel.

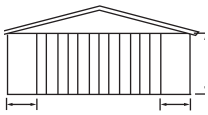
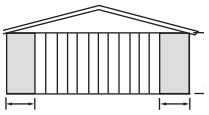
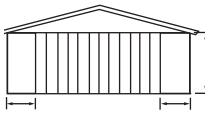
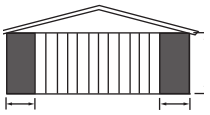
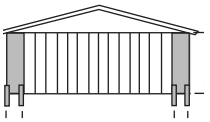
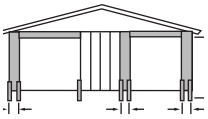
e. Percentage shown represents the minimum amount of bracing required along the building length (or wall length if the structure has an irregular shape).

TABLE 2308.6.3(1)
BRACING METHODS

METHODS, MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
			Fasteners	Spacing
LIB[a] Let-in-bracing	1″ × 4″ wood or approved metal straps attached at 45° to 60° angles to studs at maximum of 16″ o.c.		Table 2304.10.1	Wood: per stud plus top and bottom plates
			Metal strap: installed in accordance with manufacturer's recommendations	Metal strap: installed in accordance with manufacturer's recommendations
DWB Diagonal wood boards	$^3/_4$″ thick (1″ nominal) × 6″ minimum width to studs at maximum of 24″ o.c.		Table 2304.10.1	Per stud
WSP Wood structural panel	$^3/_8$″ in accordance with Table 2308.6.3(2) or 2308.6.3(3)		Table 2304.10.1	6″ edges 12″ field
SFB Structural fiberboard sheathing	$1/_2$″ in accordance with Table 2304.10.1 to studs at maximum 16″ o.c.		Table 2304.10.1	3″ edges 6″ field

(continued)

TABLE 2308.6.3(1)—continued
BRACING METHODS

METHODS, MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
			Fasteners	Spacing
GB Gypsum board (Double sided)	1/2″ or 5/8″ by a minimum of 4′ wide to studs at maximum of 24″ o.c.		Section 2506.2 for exterior and interior sheathing: 5d annular ringed cooler nails (1 5/8″ × 0.086″) or 1 1/4″ screws (Type W or S) for 1/2″ gypsum board or 1 5/8″ screws (Type W or S) for 5/8″ gypsum board	For all braced wall panel locations: 7″ o.c. along panel edges (including top and bottom plates) and 7″ o.c. in the field
PBS Particleboard sheathing	3/8″ or 1/2″ in accordance with Table 2308.6.3(4) to studs at maximum of 16″ o.c.		6d common (2″ long × 0.113″ dia.) nails for 3/8″ thick sheathing or 8d common (2 1/2″ long × 0.131″ dia.) nails for 1/2″ thick sheathing	3″ edges 6″ field
PCP Portland cement plaster	Section 2510 to studs at maximum of 16″ o.c.		1 1/2″ long, 11 gage, 7/16″ dia. head nails or 7/8″ long, 16 gage staples	6″ o.c. on all framing members
HPS Hardboard panel siding	7/16″ in accordance with Table 2308.6.3(5)		Table 2304.10.1	4″ edges 8″ field
ABW Alternate braced wall	3/8″		Figure 2308.6.5.1 and Section 2308.6.5.1	Figure 2308.6.5.1
PFH Portal frame with hold-downs	3/8″		Figure 2308.6.5.2 and Section 2308.6.5.2	Figure 2308.6.5.2

For SI: 1 foot = 304.8 mm, 1 degree = 0.01745 rad.
a. Method LIB shall have gypsum board fastened to at least one side with nails or screws.

TABLE 2308.6.3(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 2308.6.3(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 Section 2308.6.4.

TABLE 2308.6.3(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 2308.6.3 parallel or perpendicular to studs
M-S "Exterior Glue" and M-2 "Exterior Glue"	$^3/_8$	16	—
	$^1/_2$	16	16

For SI: 1 inch = 25.4 mm.

TABLE 2308.6.3(5)
HARDBOARD SIDING

SIDING	MINIMUM NOMINAL THICKNESS (inch)	2 × 4 FRAMING MAXIMUM SPACING	NAIL SIZE[a, b, d]	NAIL SPACING	
				General	Bracing panels[c]
1. Lap siding					
Direct to studs	$^3/_8$	16″ o.c.	8d	16″ o.c.	Not applicable
Over sheathing	$^3/_8$	16″ o.c.	10d	16″ o.c.	Not applicable
2. Square edge panel siding					
Direct to studs	$^3/_8$	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	$^3/_8$	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	$^3/_8$	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	$^3/_8$	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:

	Panel Siding (inch)	Lap Siding (inch)
Shank diameter	0.092	0.099
Head diameter	0.225	0.240

c. Where used to comply with Section 2308.6.

d. Nail length must accommodate the sheathing and penetrate framing $1^1/_2$ inches.

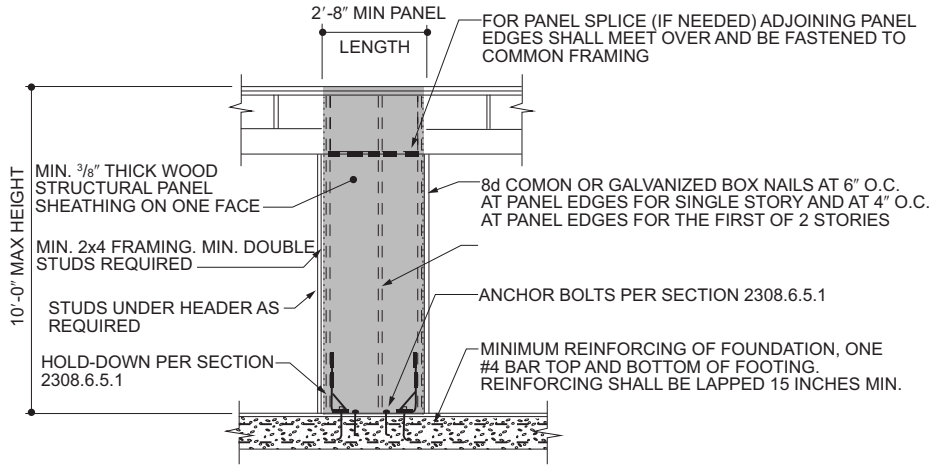
2308.6.4 Braced wall panel construction. For Methods DWB, WSP, SFB, PBS, PCP and HPS, each panel must be not less than 48 inches (1219 mm) in length, covering three stud spaces where studs are spaced 16 inches (406 mm) on center and covering two stud spaces where studs are spaced 24 inches (610 mm) on center. Braced wall panels less than 48 inches (1219 mm) in length shall not contribute toward the amount of required bracing. Braced wall panels that are longer than the required length shall be credited for their actual length. For Method GB, each panel must be not less than 96 inches (2438 mm) in length where applied to one side of the studs or 48 inches (1219 mm) in length where applied to both sides.

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 in accordance with Section 2308.6.7 and top plates shall be connected to the framing above in accordance with Section 2308.6.7.2. Where joists are perpendicular to braced wall lines above, blocking shall be provided under and in line with the braced wall panels.

2308.6.5 Alternative bracing. An alternate braced wall (ABW) or a portal frame with hold-downs (PFH) described in this section is permitted to substitute for a 48-inch (1219 mm) braced wall panel of Method DWB, WSP, SFB, PBS, PCP or HPS. For Method GB, 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 2308.6.1 is permitted to be replaced by one panel constructed in accordance with Method ABW or PFH

2308.6.5.1 Alternate braced wall (ABW). An ABW shall be constructed in accordance with this section and Figure 2308.6.5.1. 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 $^3/_8$-inch (3.2 mm) minimum-thickness wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Table 2304.10.1 and blocked at wood structural panel edges. Two anchor bolts installed in accordance with Section 2308.3.1 shall be provided in each panel. Anchor bolts shall be placed at each panel outside quarter points. Each panel end stud shall have a hold-down device fastened to the foundation, capable of providing an approved uplift capacity of not less than 1,800 pounds (8006 N). The hold-down device shall be installed in accordance with the manufacturer's recommendations. The ABW 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.

Where the ABW is installed at the first story of two-story buildings, 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 be not less than 3,000 pounds (13 344 N).



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

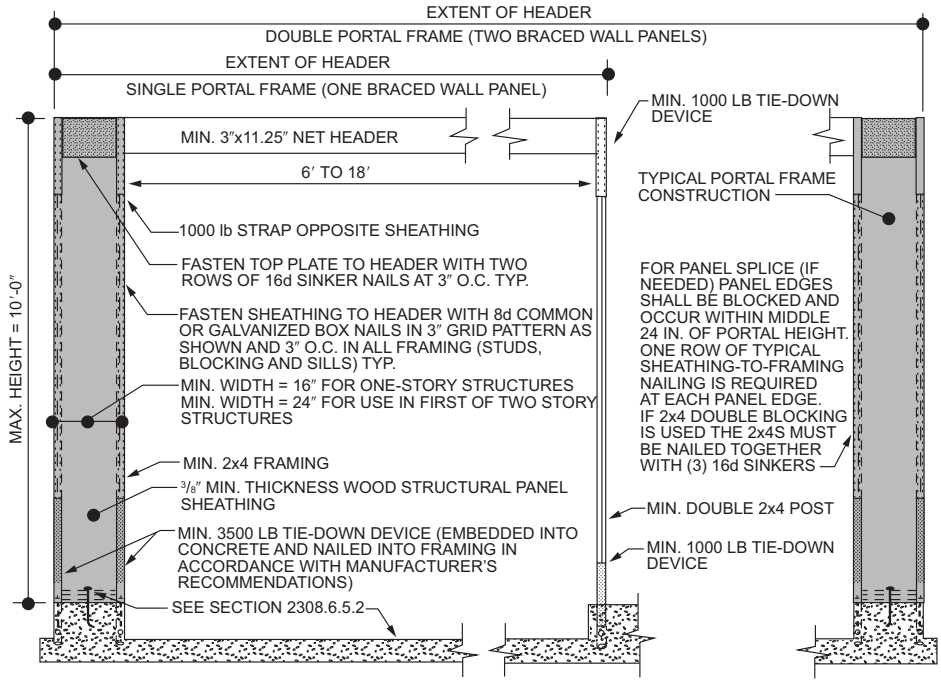
FIGURE 2308.6.5.1
ALTERNATE BRACED WALL PANEL (ABW)

2308.6.5.2 Portal frame with hold-downs (PFH). A PFH shall be constructed in accordance with this section and Figure 2308.6.5.2. The adjacent door or window opening shall have a full-length header.

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 $^3/_8$-inch (9.5 mm) minimum-thickness wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Figure 2308.6.5.2. The wood structural panel sheathing shall extend up over the solid sawn or glued-laminated header and shall be nailed in accordance with Figure 2308.6.5.2. A built-up header consisting of at least two 2-inch by 12-inch (51 mm by 305 mm) boards, fastened in accordance with Item 24 of Table 2304.10.1 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 $^5/_8$ inch (15.9 mm) diameter and installed in accordance with Section 2308.3.1 shall be provided in the center of each sill plate. The studs at each end of the panel shall have a hold-down device fastened to the foundation with an uplift capacity of not less than 3,500 pounds (15 570 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 (4400 N) shall fasten the header to the bearing studs. The bearing studs shall also have a hold-down device fastened to the foundation with an uplift capacity of not less than 1,000 pounds (4400 N). The hold-down devices shall be an embedded strap type, installed in accordance with the manufacturer's recommendations. The PFH 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.

Where a PFH is installed at the first story of two-story buildings, each panel shall have a length of not less than 24 inches (610 mm).



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N.

FIGURE 2308.6.5.2
PORTAL FRAME WITH HOLD-DOWNS (PFH)

2308.6.6 Cripple wall bracing. Cripple walls shall be braced in accordance with Section 2308.6.6.1 or 2308.6.6.2.

2308.6.6.1 Cripple wall bracing in Seismic Design Categories A, B and C. For the purposes of this section, cripple walls in Seismic Design Categories A, B and C having a stud height exceeding 14 inches (356 mm) shall be considered a story and shall be braced in accordance with Table 2308.6.1. Spacing of edge nailing for required cripple wall bracing shall not exceed 6 inches (152 mm) on center 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.

2308.6.6.2 Cripple wall bracing in Seismic Design Categories D and E. For the purposes of this section, cripple walls in Seismic Design Categories D and E having a stud height exceeding 14 inches (356 mm) shall be considered a story and shall be braced in accordance with Table 2308.6.1. 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 2308.6.1. Where the cripple wall sheathing type used is Method WSP or DWB and this additional length of bracing cannot be provided, the capacity of WSP or DWB sheathing shall be increased by reducing the spacing of fasteners along the perimeter of each piece of sheathing to 4 inches (102 mm) on center.

2308.6.7 Connections of braced wall panels. Braced wall panel joints shall occur over studs or blocking. Braced wall panels shall be fastened to studs, top and bottom plates and at panel edges. Braced wall panels shall be applied to nominal 2-inch-wide [actual $1^1/_2$-inch (38 mm)] or larger stud framing.

2308.6.7.1 Bottom plate connection. Braced wall line bottom plates shall be connected to joists or full-depth blocking below in accordance with Table 2304.10.1, or to foundations in accordance with Section 2308.6.7.3.

2308.6.7.2 Top plate connection. Where joists or rafters are used, braced wall line top plates shall be fastened over the full length of the braced wall line to joists, rafters, rim boards or full-depth blocking above in accordance with Table 2304.10.1, as applicable, based on the orientation of the joists or rafters to the braced wall line. Blocking shall be not less than 2 inches (51 mm) in nominal thickness and shall be fastened to the braced wall line top plate as specified in Table 2304.10.1. Notching or drilling of holes in blocking in accordance with the requirements of Section 2308.4.2.4 or 2308.7.4 shall be permitted.

At exterior gable end walls, braced wall panel sheathing in the top story shall be extended and fastened to the 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 not less than 2 inches (51 mm) in nominal thickness and equal to the depth of the truss at the wall line and shall be fastened to the braced wall line top plate as specified in Table 2304.10.1. Notching or drilling of holes in blocking in accordance with the requirements of Section 2308.4.2.4 or 2308.7.4 shall be permitted.

Exception: Where the roof sheathing is greater than $9^1/_4$ inches (235 mm) above the top plate, solid blocking is not required where the framing members are connected using one of the following methods:

1. In accordance with Figure 2308.6.7.2(1).
2. In accordance with Figure 2308.6.7.2(2).
3. Full-height engineered blocking panels designed for values listed in AWC WFCM.
4. A design in accordance with accepted engineering methods.

2308.6.7.3 Sill anchorage. Where foundations are required by Section 2308.6.8, braced wall line sills shall be anchored to concrete or masonry foundations. Such anchorage shall conform to the requirements of Section 2308.3. The anchors shall be distributed along the length of the braced wall line. Other anchorage devices having equivalent capacity are permitted.

2308.6.7.4 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 that is not less than the connections required by Section 2308.3.

2308.6.8 Braced wall line and diaphragm support. Braced wall lines and floor and roof diaphragms shall be supported in accordance with this section.

2308.6.8.1 Foundation requirements. Braced wall lines shall be supported by continuous foundations.

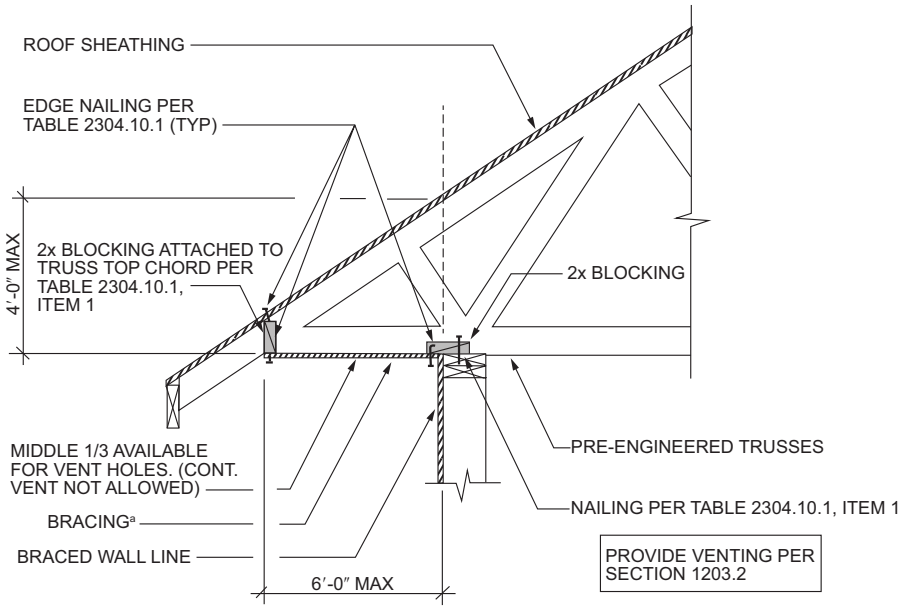
Exception: For structures with a maximum plan dimension not more than 50 feet (15 240 mm), continuous foundations are required at exterior walls only.

For structures in Seismic Design Categories D and E, exterior braced wall panels shall be in the same plane vertically with the foundation or the portion of the structure containing the offset shall be designed in

accordance with accepted engineering practice and Section 2308.1.1.

Exceptions:

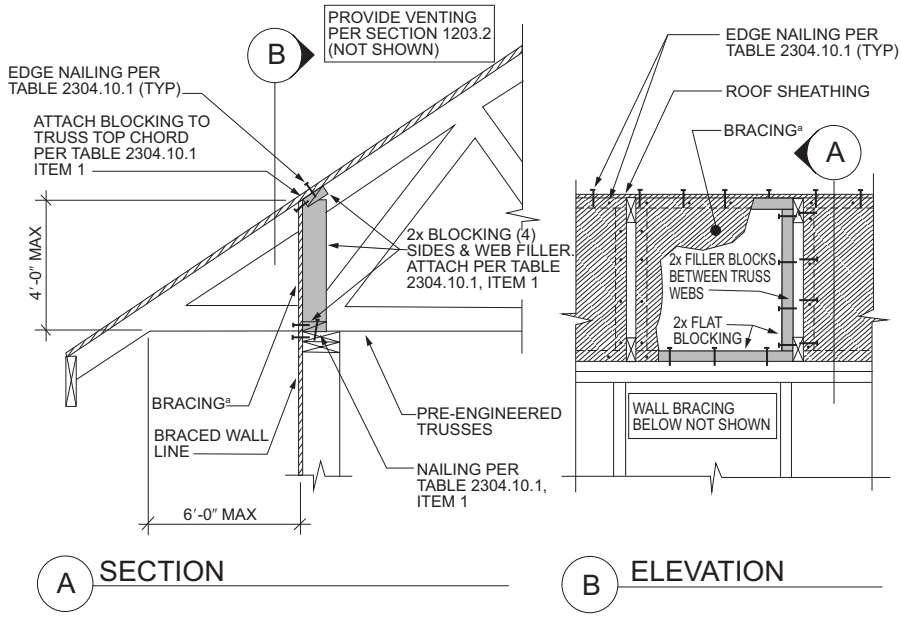
1. Exterior braced wall panels shall be permitted to be located not more than 4 feet (1219 mm) from the foundation below where supported by a floor constructed in accordance with all of the following:
   1.1. Cantilevers or setbacks shall not exceed four times the nominal depth of the floor joists.
   1.2. Floor joists shall be 2 inches by 10 inches (51 mm by 254 mm) or larger



a. Methods of bracing shall be as described in Table 2308.6.3(1) DWB, WSP, SFB, GB, PBS, PCP or HPS.

For SI: 1 foot = 304.8 mm.

FIGURE 2308.6.7.2(1)
BRACED WALL LINE TOP PLATE CONNECTION



a. Methods of bracing shall be as described in Table 2308.6.3(1) DWB, WSP, SFB, GB, PBS, PCP or HPS.

For SI: 1 foot = 304.8 mm.

FIGURE 2308.6.7.2(2)
BRACED WALL PANEL TOP PLATE CONNECTION

and spaced not more than 16 inches (406 mm) on center.

1.3. The ratio of the back span to the cantilever shall be not less than 2 to 1.

1.4. Floor joists at ends of braced wall panels shall be doubled.

1.5. A continuous rim joist shall be 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 $1^1/_2$ inches (38 mm) in width fastened with six 16d common nails on each side. The metal tie shall have a yield stress not less than 33,000 psi (227 MPa).

1.6. 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. The end of a required braced wall panel shall be allowed to extend not more than 1 foot (305 mm) over an opening in the wall below. This requirement is applicable to braced wall panels offset in plane and braced wall panels offset out of plane as permitted by Exception 1. 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.

2308.6.8.2 Floor and roof diaphragm support in Seismic Design Categories D and E. In structures assigned to Seismic Design Categories D or E, floor and roof diaphragms shall be laterally supported by braced wall lines on all edges and connected in accordance with Section 2308.6.7 [see Figure 2308.6.8.2(1)].

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 2308.6.8.2(2)] provided that the framing members are connected to the braced wall line below in accordance with Section 2308.6.7.

2308.6.8.3 Stepped footings in Seismic Design Categories B, C, D and E. In Seismic Design Categories B, C, D and E, 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:

1. 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.
2. 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 be not less than 0.058 inch [1.47 mm (16 galvanized gage)] by $1^1/_2$ inches (38 mm) in width by 48 inches (1219 mm) with eight 16d common nails on each side of the splice location (see Figure 2308.6.8.3). The metal tie shall have a yield stress not less than 33,000 pounds per square inch (psi) (227 MPa).
3. Where cripple walls occur between the top of the footing and the lowest floor framing, the bracing requirements for a story shall apply.

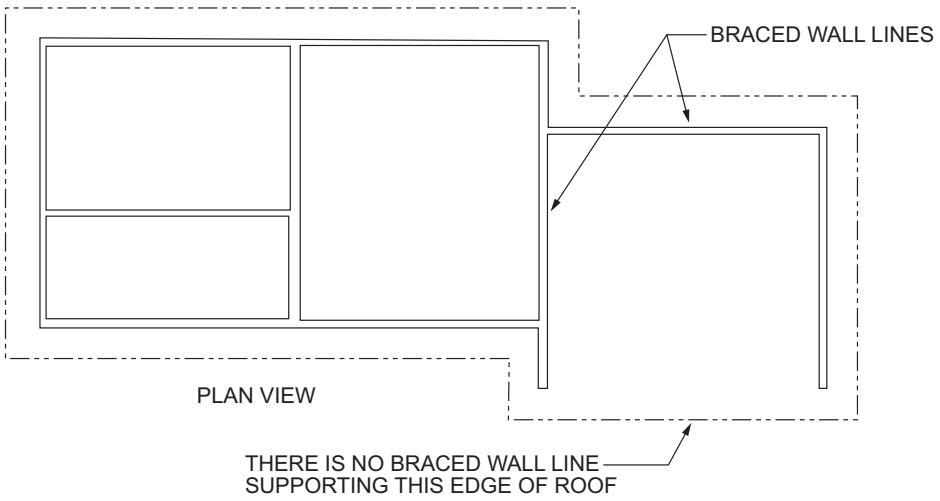
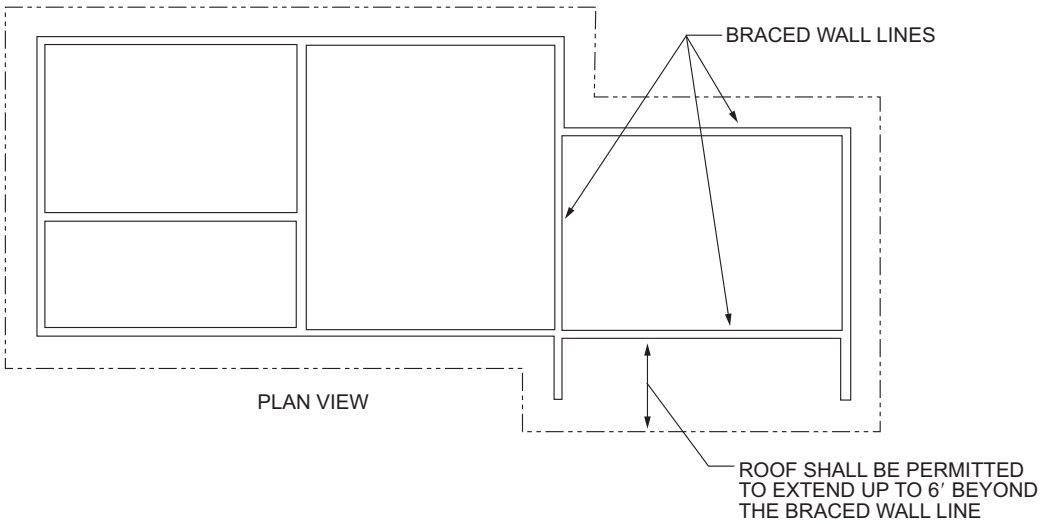
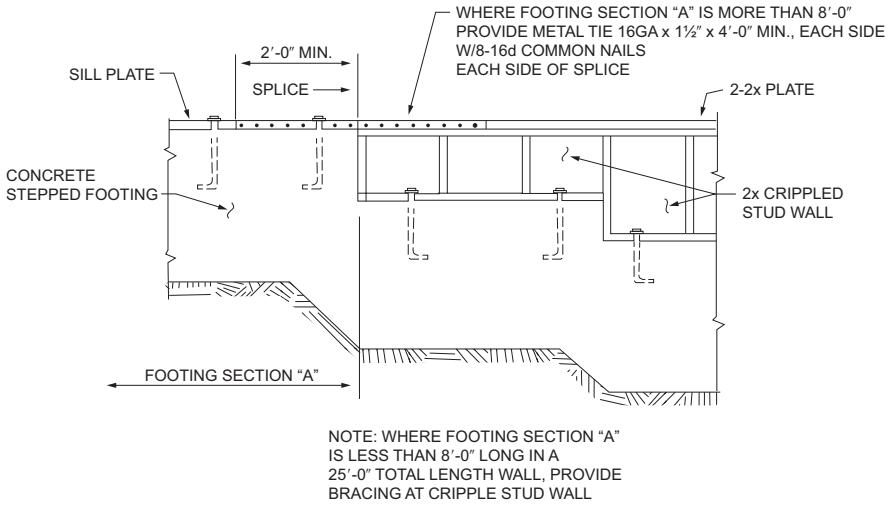


FIGURE 2308.6.8.2(1)
ROOF IN SDC D OR E NOT SUPPORTED ON ALL EDGES



For SI: 1 foot = 304.8 mm.

FIGURE 2308.6.8.2(2)
ROOF EXTENSION IN SDC D OR E BEYOND BRACED WALL LINE



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 2308.6.8.3
STEPPED FOOTING CONNECTION DETAILS

2308.6.9 Attachment of sheathing. Fastening of braced wall panel sheathing shall be not less than that prescribed in Tables 2308.6.1 and 2304.10.1. Wall sheathing shall not be attached to framing members by adhesives.

2308.6.10 Limitations of concrete or masonry veneer. Concrete or masonry veneer shall comply with Chapter 14 and this section.

2308.6.10.1 Limitations of concrete or masonry veneer in Seismic Design Category B or C. In Seismic Design Categories B and C, 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 wood structural panel wall bracing is used and the length of bracing provided is one and one-half times the required length specified in Table 2308.6.1.
2. 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. 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 in accordance with Section 2308.6.1 shall be WSP and the allowable shear capacity in accordance with Section 2306.3 shall be not less than 350 plf (5108 N/m).

3.2. Braced wall panels in the second story shall be located in accordance with Section 2308.6.1 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 2308.6.1 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 with an allowable capacity of 2,000 pounds (8896 N) shall be provided at the ends of each braced wall panel for the second story to the first story connection. Hold-down connectors with an allowable capacity of 3,900 pounds (17 347 N) shall be provided at the ends of each braced wall panel for the first story to the foundation connection. In all cases, the hold-down connector force shall be transferred to the foundation.

3.4. Cripple walls shall not be permitted.

2308.6.10.2 Limitations of concrete or masonry in Seismic Design Categories D and E. In Seismic Design Categories D and E, 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 2308.6.1 shall be WSP and the allowable shear capacity in accordance with Section 2306.3 shall be not less than 350 plf (5108 N/m).
2. The braced wall panels in the first story shall be located at each end of the braced wall line 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. 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.

2308.7 Roof and ceiling framing. The framing details required in this section apply to roofs having a slope of not less than three units vertical in 12 units horizontal (25-percent slope). 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.

2308.7.1 Ceiling joist spans. Spans for ceiling joists shall be in accordance with Table 2308.7.1(1) or 2308.7.1(2). For other grades and species, and other loading conditions, refer to the AWC STJR.

2308.7.2 Rafter spans. Spans for rafters shall be in accordance with Table 2308.7.2(1), 2308.7.2(2), 2308.7.2(3), 2308.7.2(4), 2308.7.2(5) or 2308.7.2(6). For other grades and species and other loading conditions, refer to the AWC STJR. The span of each rafter shall be measured along the horizontal projection of the rafter.

2308.7.3 Ceiling joist and rafter framing. Rafters shall be framed directly opposite each other at the ridge. There shall be a ridge board not less than 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.

2308.7.3.1 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 2304.10.1 and 2308.7.5. Ceiling joists shall be continuous or securely joined where they meet over interior partitions and be fastened to adjacent rafters in accordance with Tables 2304.10.1 and 2308.7.3.1 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 $1^1/_2$ 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) on center. The connections shall be in accordance with Tables 2308.7.3.1 and 2304.10.1, 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 2308.8. Rafter ties shall be spaced not more than 4 feet (1219 mm) on center.

Rafter tie connections shall be based on the equivalent rafter spacing in Table 2308.7.3.1. Rafter-to-ceiling joist connections and rafter tie connections shall be of sufficient size and number to prevent splitting from nailing.

Roof framing member connection to braced wall lines shall be in accordance with Section 2308.6.7.2.

TABLE 2308.7.1(1)
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics Without Storage, Live Load = 10 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	13-2	20-8	Note a	Note a
	Douglas Fir-Larch	#1	12-8	19-11	Note a	Note a
	Douglas Fir-Larch	#2	12-5	19-6	25-8	Note a
	Douglas Fir-Larch	#3	10-10	15-10	20-1	24-6
	Hem-Fir	SS	12-5	19-6	25-8	Note a
	Hem-Fir	#1	12-2	19-1	25-2	Note a
	Hem-Fir	#2	11-7	18-2	24-0	Note a
	Hem-Fir	#3	10-10	15-10	20-1	24-6
	Southern Pine	SS	12-11	20-3	Note a	Note a
	Southern Pine	#1	12-5	19-6	25-8	Note a
	Southern Pine	#2	11-10	18-8	24-7	Note a
	Southern Pine	#3	10-1	14-11	18-9	22-9
	Spruce-Pine-Fir	SS	12-2	19-1	25-2	Note a
	Spruce-Pine-Fir	#1	11-10	18-8	24-7	Note a
	Spruce-Pine-Fir	#2	11-10	18-8	24-7	Note a
	Spruce-Pine-Fir	#3	10-10	15-10	20-1	24-6
16	Douglas Fir-Larch	SS	11-11	18-9	24-8	Note a
	Douglas Fir-Larch	#1	11-6	18-1	23-10	Note a
	Douglas Fir-Larch	#2	11-3	17-8	23-0	Note a
	Douglas Fir-Larch	#3	9-5	13-9	17-5	21-3
	Hem-Fir	SS	11-3	17-8	23-4	Note a
	Hem-Fir	#1	11-0	17-4	22-10	Note a
	Hem-Fir	#2	10-6	16-6	21-9	Note a
	Hem-Fir	#3	9-5	13-9	17-5	21-3
	Southern Pine	SS	11-9	18-5	24-3	Note a
	Southern Pine	#1	11-3	17-8	23-4	Note a
	Southern Pine	#2	10-9	16-11	21-7	25-7
	Southern Pine	#3	8-9	12-11	16-3	19-9
	Spruce-Pine-Fir	SS	11-0	17-4	22-10	Note a
	Spruce-Pine-Fir	#1	10-9	16-11	22-4	Note a
	Spruce-Pine-Fir	#2	10-9	16-11	22-4	Note a
	Spruce-Pine-Fir	#3	9-5	13-9	17-5	21-3

(continued)

TABLE 2308.7.1(1)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics Without Storage, Live Load = 10 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	11-3	17-8	23-3	Note a
	Douglas Fir-Larch	#1	10-10	17-0	22-5	Note a
	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	Note a
	Hem-Fir	#1	10-4	16-4	21-6	Note a
	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	Note a
	Southern Pine	#1	10-7	16-8	22-0	Note a
	Southern Pine	#2	10-2	15-7	19-8	23-5
	Southern Pine	#3	8-0	11-9	14-10	18-0
	Spruce-Pine-Fir	SS	10-4	16-4	21-6	Note a
	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	Note a
	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	Note a
	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	Note a
	Southern Pine	#1	9-10	15-6	20-5	24-0
	Southern Pine	#2	9-3	13-11	17-7	20-11
	Southern Pine	#3	7-2	10-6	13-3	16-1
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Span exceeds 26 feet in length.

TABLE 2308.7.1(2)
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics With Limited Storage, Live Load = 20 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a
	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	Note a
	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	Note a
	Southern Pine	#1	9-10	15-6	20-5	24-0
	Southern Pine	#2	9-3	13-11	17-7	20-11
	Southern Pine	#3	7-2	10-6	13-3	16-1
	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	8-11	14-0	17-9	20-9
	Southern Pine	#2	8-0	12-0	15-3	18-1
	Southern Pine	#3	6-2	9-2	11-6	14-0
	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 2308.7.1(2)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics With Limited Storage, Live Load = 20 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
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	18-2	23-1
	Southern Pine	#1	8-5	12-9	16-2	18-11
	Southern Pine	#2	7-4	11-0	13-11	16-6
	Southern Pine	#3	5-8	8-4	10-6	12-9
	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	7-8	11-5	14-6	16-11
	Southern Pine	#2	6-7	9-10	12-6	14-9
	Southern Pine	#3	5-1	7-5	9-5	11-5
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Span exceeds 26 feet in length.

TABLE 2308.7.2(1)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 psf, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	11-6	18-0	23-9	Note b	Note b	11-6	18-0	23-5	Note b	Note b
	Douglas Fir-Larch	#1	11-1	17-4	22-5	Note b	Note b	10-6	15-4	19-5	23-9	Note b
	Douglas Fir-Larch	#2	10-10	16-7	21-0	25-8	Note b	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	Note b	Note b	10-10	17-0	22-5	Note b	Note b
	Hem-Fir	#1	10 -7	16-8	21-10	Note b	Note b	10-3	14-11	18-11	23-2	Note b
	Hem-Fir	#2	10-1	15-11	20-8	25-3	Note b	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	Note b	Note b	11-3	17-8	23-4	Note b	Note b
	Southern Pine	#1	10-10	17-0	22-5	26-0	26-0	10-6	15-8	19-10	23-2	Note b
	Southern Pine	#2	10-4	15-7	19-8	23-5	26-0	9-0	13-6	17-1	20-3	23-10
	Southern Pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-Pine-Fir	SS	10-7	16-8	21-11	Note b	Note b	10-7	16-8	21-9	Note b	Note b
	Spruce-Pine-Fir	#1	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#2	10-4	16-3	21-0	25-8	Note b	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	Note b	Note b	10-5	16-0	20-3	24-9	Note b
	Douglas Fir-Larch	#1	10-0	15-4	19-5	23-9	Note b	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	Note b	Note b	9-10	15-6	19-11	24-4	Note b
	Hem-Fir	#1	9-8	14-11	18-11	23-2	Note b	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	Note b	Note b	10-3	16-1	21-2	25-7	Note b
	Southern Pine	#1	9-10	15-6	19-10	23-2	26-0	9-1	13-7	17-2	20-1	23-10
	Southern Pine	#2	9-0	13-6	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern Pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	14-10	18-10	23-0	Note b
	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
19.2	Douglas Fir-Larch	SS	9-10	15-5	20-4	25-11	Note b	9-10	14-7	18-6	22-7	Note b
	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	Note b	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	Note b	9-8	15-2	19-7	23-4	Note b
	Southern Pine	#1	9-3	14-3	18-1	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern Pine	#2	8-2	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern Pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-Pine-Fir	SS	9-1	14-3	18-9	23-11	Note b	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

(continued)

TABLE 2308.7.2(1)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 psf, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
24	Douglas Fir-Larch	SS	9-1	14-4	18-10	23-4	Note b	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	Note b	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	Note b	8-11	13-10	17-6	20-10	24-8
	Southern Pine	#1	8-7	12-9	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern Pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern Pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE 2308.7.2(2)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 psf, Ceiling Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-4	21-7	Note b	Note b
	Douglas Fir-Larch	#1	10-0	15-9	20-10	Note b	Note b	10-0	15-4	19-5	23-9	Note b
	Douglas Fir-Larch	#2	9-10	15-6	20-5	25-8	Note b	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	Note b	Note b	9-10	15-6	20-5	Note b	Note b
	Hem-Fir	#1	9-8	15-2	19-11	25-5	Note b	9-8	14-11	18-11	23-2	Note b
	Hem-Fir	#2	9-2	14-5	19-0	24-3	Note b	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	Note b	Note b	10-3	16-1	21-2	Note b	Note b
	Southern Pine	#1	9-10	15-6	20-5	26-0	26-0	9-10	15-6	19-10	23-2	26-0
	Southern Pine	#2	9-5	14-9	19-6	23-5	26-0	9-0	13-6	17-1	20-3	23-10
	Southern Pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-11	25-5	Note b
	Spruce-Pine-Fir	#1	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#2	9-5	14-9	19-6	24-10	Note b	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	Note b	9-6	14-11	19-7	24-9	Note b
	Douglas Fir-Larch	#1	9-1	14-4	18-11	23-9	Note b	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	Note b	8-11	14-1	18-6	23-8	Note b
	Hem-Fir	#1	8-9	13-9	18-1	23-1	Note b	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	Note b	9-4	14-7	19-3	24-7	Note b
	Southern Pine	#1	8-11	14-1	18-6	23-2	26-0	8-11	13-7	17-2	20-1	23-10
	Southern Pine	#2	8-7	13-5	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern Pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-Pine-Fir	SS	8-9	13-9	18-1	23-1	Note b	8-9	13-9	18-1	23-0	Note b
	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
19.2	Douglas Fir-Larch	SS	8-11	14-0	18-5	23-7	Note b	8-11	14-0	18-5	22-7	Note b
	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	Note b	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

(continued)

TABLE 2308.7.2(2)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 psf, Ceiling Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Southern Pine	SS	8-9	13-9	18-2	23-1	Note b	8-9	13-9	18-2	23-1	Note b
	Southern Pine	#1	8-5	13-3	17-5	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern Pine	#2	8-1	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern Pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-Pine-Fir	SS	8-3	12-11	17-1	21-9	Note b	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	Note b	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	Note b	8-1	12-9	16-10	20-10	24-8
	Southern Pine	#1	7-10	12-3	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern Pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern Pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE 2308.7.2(3)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 psf, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-0	15-9	20-9	Note b	Note b	10-0	15-9	20-1	24-6	Note b
	Douglas Fir-Larch	#1	9-8	14-9	18-8	22-9	Note b	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	Note b	9-6	14-10	19-7	24-1	Note b
	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	Note b	Note b	9-10	15-6	20-5	25-4	Note b
	Southern Pine	#1	9-6	14-10	19-0	22-3	26-0	9-0	13-5	17-0	19-11	23-7
	Southern Pine	#2	8-7	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern Pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-Pine-Fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-7	18-8	22-9	Note b
	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	Note b	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	Note b	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	Note b	8-11	14-1	18-5	21-11	25-11
	Southern Pine	#1	8-7	13-0	16-6	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern Pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9
	Southern Pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	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
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

(continued)

TABLE 2308.7.2(3)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 psf, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Southern Pine	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	16-10	20-0	23-7
	Southern Pine	#1	8-0	11-10	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern Pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern Pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	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	20-0	23-7	7-10	11-10	15-0	17-11	21-2
	Southern Pine	#1	7-1	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE 2308.7.2(4)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 psf, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	8-5	13-3	17-6	22-4	26-0	8-5	13-3	17-0	20-9	24-0
	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	13-1	17-2	21-11	Note b	8-4	13-1	17-2	21-5	25-3
	Southern Pine	#1	8-0	12-3	15-6	18-2	21-7	7-7	11-4	14-5	16-10	20-0
	Southern Pine	#2	7-0	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern Pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	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	23-7	7-6	11-10	15-7	18-6	21-10
	Southern Pine	#1	7-1	10-7	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	Spruce-Pine-Fir	SS	7-1	11-2	14-8	18-0	20-11	7-1	10-9	13-8	15-11	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
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

(continued)

TABLE 2308.7.2(4)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 psf, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Southern Pine	SS	7-1	11-2	14-8	18-3	21-7	7-1	11-2	14-2	16-11	20-0
	Southern Pine	#1	6-6	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern Pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern Pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	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	16-4	19-3	6-7	10-0	12-8	15-2	17-10
	Southern Pine	#1	5-10	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern Pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern Pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE 2308.7.2(5)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 psf, Ceiling Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	9-1	14-4	18-10	24-1	Note b	9-1	14-4	18-10	24-1	Note b
	Douglas Fir-Larch	#1	8-9	13-9	18-2	22-9	Note b	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	Note b	8-7	13-6	17-10	22-9	Note b
	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	Note b	8-11	14-1	18-6	23-8	Note b
	Southern Pine	#1	8-7	13-6	17-10	22-3	Note b	8-7	13-5	17-0	19-11	23-7
	Southern Pine	#2	8-3	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern Pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-Pine-Fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	Note b
	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	Note b	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	Note b	8-1	12-9	16-10	21-6	25-11
	Southern Pine	#1	7-10	12-3	16-2	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern Pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9
	Southern Pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	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
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

(continued)

TABLE 2308.7.2(5)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 30 psf, Ceiling Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Southern Pine	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	20-0	23-7
	Southern Pine	#1	7-4	11-7	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern Pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern Pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	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	17-11	21-2
	Southern Pine	#1	6-10	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE 2308.7.2(6)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 psf, Ceiling Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
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	11-10	15-7	19-11	24-3	7-6	11-10	15-7	19-11	24-3
	Southern Pine	#1	7-3	11-5	15-0	18-2	21-7	7-3	11-4	14-5	16-10	20-0
	Southern Pine	#2	6-11	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern Pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	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	21-10
	Southern Pine	#1	6-7	10-4	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	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
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

(continued)

TABLE 2308.7.2(6)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground Snow Load = 50 psf, Ceiling Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Southern Pine	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-11	20-0
	Southern Pine	#1	6-2	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern Pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern Pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	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	15-2	18-0	5-9	9-1	11-9	14-5	15-11
	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	15-2	17-10
	Southern Pine	#1	5-9	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern Pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern Pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	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

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

TABLE 2308.7.3.1
RAFTER TIE CONNECTIONS[g]

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 ($3^1/_2''$ x $0.162''$) 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/m^2.

a. 40d box ($5'' \times 0.162''$) or 16d sinker ($3^1/_4'' \times 0.148''$) nails are permitted to be substituted for 16d common ($3^1/_2'' \times 0.16''$) 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.

2308.7.4 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 more than 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.

2308.7.5 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 2304.10.1 and 2308.7.5.

2308.7.6 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 that are more than 6 feet (1829 mm) in length shall be supported by framing anchors or rafter hangers unless bearing on a beam, partition or wall.

2308.7.6.1 Openings in roof diaphragms in Seismic Design Categories B, C, D and E. In buildings classified as Seismic Design Category B, C, D or E. openings in horizontal diaphragms with a dimension that is greater than 4 feet (1219 mm) shall be constructed with metal ties and blocking in accordance with this section and Figure 2308.4.4.1(1). Metal ties shall be not less than 0.058 inch [1.47 mm (16 galvanized gage)] in thickness by $1^1/_2$ inches (38 mm) in width and shall have a yield stress not less than 33,000 psi (227 Mpa). Blocking shall extend not less than the dimension of the opening in the direction of the tie and blocking. Ties shall be attached to blocking in accordance with the manufacturer's instructions but with not less than eight 16d common nails on each side of the header-joist intersection.

2308.7.7 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 be not less 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 slope of the struts shall be not less than 45 degrees (0.79 rad) from the horizontal.

2308.7.8 Blocking. Roof rafters and ceiling joists shall be supported laterally to prevent rotation and lateral displacement in accordance with Section 2308.4.6 and connected to braced wall lines in accordance with Section 2308.6.7.2.

TABLE 2308.7.5
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.

	Mean Roof Height (feet)									
EXPOSURE	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.

2308.7.9 Engineered wood products. Prefabricated wood I-joists, 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.

2308.7.10 Roof sheathing. Roof sheathing shall be in accordance with Tables 2304.8(3) and 2304.8(5) for wood structural panels, and Tables 2304.8(1) and 2304.8(2) for lumber and shall comply with Section 2304.8.2.

2308.7.11 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.

2308.7.12 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 2308.7.12. 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 not less than 24 inches (610 mm) in adjacent pieces.

2308.7.13 Wood trusses. Wood trusses shall be designed in accordance with Section 2303.4. Connection to braced wall lines shall be in accordance with Section 2308.6.7.2.

2308.7.14 Attic ventilation. For attic ventilation, see Section 1203.2.

2308.8 Design of elements. Combining of engineered elements or systems and conventionally specified elements or systems shall be permitted subject to the limits of Sections 2308.8.1 and 2308.8.2.

2308.8.1 Elements exceeding limitations of conventional construction. Where 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.

2308.8.2 Structural elements or systems not described herein. Where 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.

SECTION 2309
WOOD FRAME CONSTRUCTION MANUAL

2309.1 Wood Frame Construction Manual. Structural design in accordance with the AWC WFCM shall be permitted for buildings assigned to Risk Category I or II subject to the limitations of Section 1.1.3 of the AWC WFCM and the load assumptions contained therein. Structural elements beyond these limitations shall be designed in accordance with accepted engineering practice.

2309.1.1 Additional requirements [DSA-SS & DSA-SS/CC] *The use of the AWC WFCM is permitted provided the design and construction also comply with Sections 2304, 2305, and 2301.2, Item 1 or 2 and engineering analysis is furnished demonstrating compliance.*

TABLE 2308.7.12
ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING

SPAN[a] (feet)	LIVE LOAD (pounds per square foot)	DEFLECTION LIMIT	BENDING STRESS (f) (pounds per square inch)	MODULUS OF ELASTICITY (E) (pounds 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
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 4.5 5.0	40	1/360	840 950 1,060	1,000,000 1,300,000 1,600,000

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kN/m^2, 1 pound per square inch = 0.00689 N/mm^2.

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 2308.7.12. Lumber thickness is $1^1/_2$ inches nominal.

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	BSC-CG	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									

The state agency does not adopt sections identified with 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 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 ensuring 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.*

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 $^{1}/_{175}$ of the glass edge length or $^{3}/_{4}$ 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.

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.**
× 0.0929 for m², × 25.4 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]	1/4"	1/4"[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.**
× 0.0929 for m², × 25.4 for mm					
5. Minimum Glass Frame Lap		1/4"	5/16"	3/8"	1/2"
6. Minimum Glass Edge Clearance		1/8"[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.

2403.4 Interior glazed areas. Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall be not 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 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 due to ultimate design wind speed, V_{ult}, 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 E1300.

The design of vertical glazing shall be based on Equation 24-1.

$$0.6F_{gw} \le F_{ga} \qquad \textbf{(Equation 24-1)}$$

where:

F_{gw} = Wind load on the glass due to ultimate design wind speed, V_{ult}, computed in accordance with Section 1609.

F_{ga} = Short duration load on the glass as determined in accordance with ASTM E1300.

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 combinations of loads determined by Equations 24-2, 24-3 and 24-4.

$$F_g = 0.6W_o - D \qquad \textbf{(Equation 24-2)}$$

$$F_g = 0.6W_i + D + 0.5\,S \qquad \textbf{(Equation 24-3)}$$

$$F_g = 0.3\,W_i + D + S \qquad \textbf{(Equation 24-4)}$$

where:

D = Glass dead load psf (kN/m²).

For glass sloped 30 degrees (0.52 rad) or less from horizontal,

= $13\,t_g$ (For SI: $0.0245\,t_g$).

For glass sloped more than 30 degrees (0.52 rad) from horizontal,

= $13\,t_g \cos\theta$ (For SI: $0.0245\,t_g \cos\theta$).

F_g = Total load, psf (kN/m²) on glass.

S = Snow load, psf (kN/m²) 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) due to ultimate design wind speed, V_{ult}, as calculated in Section 1609.

W_o = Outward wind force, psf (kN/m^2) due to ultimate design wind speed, V_{ult}, as calculated in Section 1609.

θ = Angle of slope from horizontal.

Exception: The performance grade rating of unit skylights and tubular daylighting devices shall be determined in accordance with Section 2405.5.

The design of sloped glazing shall be based on Equation 24-5.

$$F_g \le F_{ga} \quad \textbf{(Equation 24-5)}$$

where:

F_g = Total load on the glass as determined by Equations 24-2, 24-3 and 24-4.

F_{ga} = Short duration load resistance of the glass as determined in accordance with ASTM E1300 for Equations 24-2 and 24-3; or the long duration load resistance of the glass as determined in accordance with ASTM E1300 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:

$$0.6F_{gw} < 0.5\ F_{ge} \quad \textbf{(Equation 24-6)}$$

where:

F_{gw} = Wind load on the glass due to ultimate design wind speed, V_{ult}, computed in accordance with Section 1609.

F_{ge} = Nonfactored load from ASTM E1300 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:

$$F_g < 0.5\ F_{ge} \quad \textbf{(Equation 24-7)}$$

For Equation 24-4:

$$F_g < 0.3\ F_{ge} \quad \textbf{(Equation 24-8)}$$

where:

F_g = Total load on the glass as determined by Equations 24-2, 24-3 and 24-4.

F_{ge} = Nonfactored load in accordance with ASTM E1300.

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 Equation 24-9.

$$F_{gw} < 1.0\ F_{ge} \quad \textbf{(Equation 24-9)}$$

where:

F_{gw} = Wind load on the glass due to ultimate design wind speed, V_{ult}, computed in accordance with Section 1609.

F_{ge} = Nonfactored load in accordance with ASTM E1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between nonfactored load charts in ASTM E1300 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:

$$F_g < 1.0\ F_{ge} \quad \textbf{(Equation 24-10)}$$

For Equation 24-4:

$$F_g < 0.6F_{ge} \quad \textbf{(Equation 24-11)}$$

where:

F_g = Total load on the glass as determined by Equations 24-2, 24-3 and 24-4.

F_{ge} = Nonfactored load in accordance with ASTM E1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between the nonfactored load charts in ASTM E1300 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 Equation 24-12.

$$0.6F_{gw} < 0.5\ F_{ge} \quad \textbf{(Equation 24-12)}$$

where:

F_g = Wind load on the glass due to ultimate design wind speed, V_{ult}, computed in accordance with Section 1609.

F_{ge} = Nonfactored load in accordance with ASTM E1300. 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 in 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 2110.1.

2405.3 Screening. Where used in monolithic glazing systems, heat-strengthened 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 in 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 m^2) 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 $^3/_{16}$ 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 in 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 m^2) 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 and tubular daylighting devices. Unit skylights and tubular daylighting devices 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. Where 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. Where 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 Skylights rated for the same performance grade for both positive and negative design pressure. The design of skylights shall be based on Equation 24-13.

$$F_g \le PG \qquad \textbf{(Equation 24-13)}$$

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 Skylights rated for separate performance grades for positive and negative design pressure. The design of skylights rated for performance grade for both positive and negative design pressures shall be based on Equations 24-14 and 24-15.

$$F_{gi} \le PG_{Po} \qquad \textbf{(Equation 24-14)}$$

$$F_{go} \le PG_{Ne} \qquad \textbf{(Equation 24-15)}$$

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 $0.6W_o \ge D$,

where:

W_o = Outward wind force, psf (kN/m^2) due to ultimate design wind speed, V_{ult}, as calculated in Section 1609.

D = The dead weight of the glazing, psf (kN/m^2) as determined in Section 2404.2 for glass, or by the weight of the plastic, psf (kN/m^2) 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 $0.6\ W_o < D$,

where:

W_o = The outward wind force, psf (kN/m^2) due to ultimate design wind speed, V_{ult}. as calculated in Section 1609.

D = The dead weight of the glazing, psf (kN/m^2) 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

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.

or of a type that once applied, cannot be removed without being destroyed. A label meeting the requirements of this section shall be permitted in lieu of the manufacturer's designation.

Exceptions:

1. 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.
2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation.

2406.3.1 Multipane assemblies. Multipane 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:

1. Glazed openings of a size through which a 3-inch-diameter (76 mm) sphere is unable to pass.
2. Decorative glazing.
3. Glazing materials used as curved glazed panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.

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.
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 $1^1/_2$ 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) (0.79 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 stairways 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 1015 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 stairway landing. Glazing adjacent to the landing at the bottom of a stairway where the glazing is less than 60 inches (1524 mm) above the landing and within a 60-inch (1524 mm) horizontal arc that is less than 180 degrees (3.14 rad) from the bottom tread nosing shall be considered a hazardous location.

Exception: Glazing that is protected by a guard complying with Sections 1015 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 in a handrail, guardrail or a *guard* section shall be laminated glass constructed of fully tempered or heat-strengthened glass and shall comply with Category II or CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1. 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 $^1/_4$ inch (6.4 mm).

Exception: Single fully tempered glass complying with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1 shall be permitted to be used in handrails and guardrails where there is no walking surface beneath them or the walking surface is permanently protected from the risk of falling glass.

2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in Section 1607.8. A design factor of four shall be used for safety.

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 Balusters 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 be not greater than $1^1/_2$ 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 $^1/_2$ 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 athletic 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 WALKWAYS, ELEVATOR HOISTWAYS AND ELEVATOR CARS

2409.1 Glass walkways. Glass installed as a part of a floor/ceiling assembly as a walking surface and constructed with laminated glass shall comply with ASTM E2751 or with the load requirements specified in Chapter 16. Such assemblies shall comply with the fire-resistance rating requirements of this code where applicable.

2409.2 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.

2409.2.1 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.

2409.2.2 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.

2409.3 Visions panels in elevator hoistway doors. Glass in vision panels in elevator hoistway doors shall be permitted to be any transparent glazing material not less than $^1/_4$ inch (6.4 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 be not 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).

2409.4 Glass in elevator cars. Glass in elevator cars shall be in accordance with this section.

2409.4.1 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.

2409.4.2 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 C1249. The insulated glass unit design shall be in accordance with ASTM C1249, 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 C1401.*
4. *Design methodology shall address seismic movement in accordance with ASTM C1401, 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 C1392. The point load tests shall be done after the initial installation. >

j. Where the SSG is field assembled, hand pull tab tests in accordance with ASTM C1401, 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 C1401, C1392 and C1394. Inspection frequencies recommended in ASTM C1392 Section 5.1 shall be followed.* >

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 and thickness 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, GYPSUM PANEL PRODUCTS 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	BSC-CG	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																					
2501.1.1								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								
2514.1 Exception								X													

The state agency does not adopt sections identified with 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 25

GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER

SECTION 2501
GENERAL

2501.1 Scope. Provisions of this chapter shall govern the materials, design, construction and quality of gypsum board, gypsum panel products, lath, gypsum plaster, cement plaster and reinforced gypsum concrete.

2501.1.1 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 this code shall be detailed in the approved construction documents.*

2501.2 Performance. Lathing, plastering, gypsum board and gypsum panel product 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.

2501.3 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.

SECTION 2502
DEFINITIONS

2502.1 Definitions. The following terms are defined in Chapter 2:

CEMENT PLASTER.

EXTERIOR SURFACES.

GYPSUM BOARD.

GYPSUM PANEL PRODUCTS.

GYPSUM PLASTER.

GYPSUM VENEER PLASTER.

INTERIOR SURFACES.

WEATHER-EXPOSED SURFACES.

WIRE BACKING.

SECTION 2503
INSPECTION

2503.1 Inspection. Lath, gypsum board and gypsum panel products shall be inspected in accordance with Section 110.3.5.

2503.2 Additional requirements for inspection and testing. [DSA-SS, DSA-SS/CC and OSHPD 1 & 4]

1. *Lath, gypsum board and gypsum panel products shall be inspected in accordance with Chapter 17A and the California Administrative Code.*
2. *No lath, gypsum board and gypsum panel products 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 this code.*

4. The testing of gypsum board and gypsum panel 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, gypsum panel products or lath and plaster in vertical and horizontal assemblies.

2504.1.1 Wood framing. Wood supports for lath, gypsum board or gypsum panel products, as well as wood stripping or furring, shall be not 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 be not 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 $^3/_8$-inch (9.5 mm) and $^3/_4$-inch (19.1 mm) rib metal lath, $^1/_2$-inch-thick (12.7 mm) gypsum lath, gypsum board or gypsum panel product 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, gypsum board or gypsum panel products shall be designed to resist the loads specified in this code.*

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 $1^3/_4$ 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-frame shear walls sheathed with gypsum board, gypsum panel products or 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-frame shear walls sheathed with gypsum board or gypsum panel products 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 AND GYPSUM PANEL PRODUCT MATERIALS

2506.1 General. Gypsum board, gypsum panel products 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 and gypsum panel products 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.

TABLE 2506.2
GYPSUM BOARD MATERIALS AND ACCESSORIES

MATERIAL	STANDARD
Cold-formed steel studs and track, structural	AISI S200 and ASTM C955, Section 8
Cold-formed steel studs and track, nonstructural	AISI S220 and ASTM C645, Section 10
Elastomeric joint sealants	ASTM C920
Fiber-reinforced gypsum panels	ASTM C1278
Glass mat gypsum backing panel	ASTM C1178
Glass mat gypsum panel	ASTM C1658
Glass mat gypsum substrate	ASTM C1177
Joint reinforcing tape and compound	ASTM C474; C475
Nails FOR gypsum boards	ASTM C514, F547, F1667
Steel screws	ASTM C954; C1002
Steel studs, load-bearing	ASTM C955
Steel studs, nonload-bearing	ASTM C645
Standard specification for gypsum board	ASTM C1396
Testing gypsum and gypsum products	ASTM C22; C472; C473

2506.2.1 Other materials. Metal suspension systems for acoustical and lay-in panel ceilings shall comply with ASTM C635 listed in Chapter 35 and Section 13.5.6 of ASCE 7 for installation in high seismic areas.

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 refer-

enced 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
Cold-formed steel studs and track, structural	AISI S200 and ASTM C955, Section 8
Cold-formed steel studs and track, nonstructural	AISI S220 and ASTM C645, Section 10
Hydraulic cement	ASTM C1157; C1600
Gypsum casting and molding plaster	ASTM C59
Gypsum Keene's cement	ASTM C61
Gypsum plaster	ASTM C28
Gypsum veneer plaster	ASTM C587
Interior bonding compounds, gypsum	ASTM C631
Lime plasters	ASTM C5; C206
Masonry cement	ASTM C91
Metal lath	ASTM C847
Plaster aggregates Sand Perlite Vermiculite	 ASTM C35; C897 ASTM C35 ASTM C35
Plastic cement	ASTM C1328
Portland cement	ASTM C150
Steel screws	ASTM C1002; C954
Steel studs and track	ASTM C645; C955
Welded wire lath	ASTM C933
Woven wire plaster base	ASTM C1032

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 $^1/_2$-inch-wide (12.7 mm), 1 $^1/_2$-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 $^3/_8$-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, gypsum panel products 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 and gypsum panel products	GA-216; ASTM C840
Gypsum sheathing and gypsum panel products	ASTM C1280
Gypsum veneer base	ASTM C844
Interior lathing and furring	ASTM C841
Steel framing for gypsum board and gypsum panel products	ASTM C754; C1007

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 C1280.

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 and gypsum panel products shall occur on the framing members, except those edges and ends that are perpendicular to the framing members. Edges and ends of gypsum board and gypsum panel products shall be in moderate contact except in concealed spaces where fire-resistance-rated construction, shear resistance or diaphragm action is not required.

2508.4 Joint treatment. Gypsum board and gypsum panel product 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 or the gypsum panel product 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 panel products, gypsum backing board or gypsum sheathing.

4. On multilayer systems where the joints of adjacent layers are offset.
5. Assemblies tested without joint treatment.

2508.5 Horizontal gypsum board or gypsum panel product diaphragm ceilings. Gypsum board or gypsum panel products 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 $1^1/_2$:1 between shear resisting elements. Rotation or cantilever conditions shall not be permitted.

2508.5.2 Installation. Gypsum board or gypsum panel products 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.

2508.5.3 Blocking of perimeter edges. Perimeter edges shall be blocked using a wood member not less than 2-inch by 6-inch (51 mm by 152 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 or gypsum panel product.

2508.5.4 Fasteners. Fasteners used for the attachment of gypsum board or gypsum panel products 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 at all supports, including perimeter blocking, and not more than $^3/_8$ inch (9.5 mm) from the edges and ends of the gypsum board or gypsum panel product.

2508.5.5 Lateral force restrictions. Gypsum board or gypsum panel products 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
SHOWERS AND WATER CLOSETS

2509.1 Wet areas. Showers and public toilet walls shall conform to Section 1210.2.

2509.2 Base for tile. Materials used as a base for wall tile in tub and shower areas and wall and ceiling panels in shower areas shall be of materials listed in Table 2509.2 and installed in accordance with the manufacturer's recommendations. 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 C840 and the manufacturer's 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 C840.

TABLE 2509.2
BACKERBOARD MATERIALS

MATERIAL	STANDARD
Glass mat gypsum backing panel	ASTM C1178
Nonasbestos fiber-cement backer board	ASTM C1288 or ISO 8336, Category C
Nonasbestos fiber-mat reinforced cementitious backer unit	ASTM C1325

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.

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 them from the weather.

2510.3 Installation. Installation of these materials shall be in compliance with ASTM C926 and ASTM C1063.

TABLE 2508.5
SHEAR CAPACITY FOR HORIZONTAL WOOD-FRAME GYPSUM BOARD DIAPHRAGM CEILING ASSEMBLIES

MATERIAL	THICKNESS OF MATERIAL (MINIMUM) (inches)	SPACING OF FRAMING MEMBERS (inches)	SHEAR VALUE[a, b] (PLF OF CEILING)	MIMIMUM FASTENER SIZE
Gypsum board or gypsum panel product	$^1/_2$	16 o.c.	90	5d cooler or wallboard nail; $1^5/_8$-inch long; 0.086-inch shank; $^{15}/_{64}$-inch head[c]
Gypsum board or gypsum panel product	$^1/_2$	24 o.c.	70	5d cooler or wallboard nail; $1^5/_8$-inch long; 0.086-inch shank; $^{15}/_{64}$-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 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. $1^1/_4$-inch, No. 6 Type S or W screws are permitted to be substituted for the listed nails.

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. Gypsum backing for cement plaster shall be in accordance with Section 2510.5.2.1 or 2510.5.2.2.

2510.5.2.1 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 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 water-resistive barrier complying with ASTM E2556, Type I. 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 a water-resistive barrier complying with ASTM E2556, Type II 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 be not 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 to Table 2511.1.1 and Section 2507.

TABLE 2511.1.1
INSTALLATION OF PLASTER CONSTRUCTION

MATERIAL	STANDARD
Cement plaster	ASTM C926
Gypsum plaster	ASTM C842
Gypsum veneer plaster	ASTM C843
Interior lathing and furring (gypsum plaster)	ASTM C841
Lathing and furring (cement plaster)	ASTM C1063
Steel framing	ASTM C754; C1007

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 C842 and ASTM C926. 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 C842 or ASTM C926. Should ceiling surfaces require more than the maximum thickness permitted in ASTM C842 or ASTM C926, 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 C926.

2512.1.1 On-grade floor slab. On wood frame 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 C1063.

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 $3^1/_2$ inches (89 mm) shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C926. 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 C926.

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 $^1/_4$ 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 C926 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 be not 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 C926 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 C926. 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 $^7/_8$ inch (22 mm), including lath. Over concrete or masonry surfaces, the overall thickness shall be a minimum of $^1/_2$ 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 C926. 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.

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SECTION 2514
REINFORCED GYPSUM CONCRETE

2514.1 General. Reinforced gypsum concrete shall comply with the requirements of ASTM C317 and ASTM C956.

Exception: [DSA-SS and OSHPD 1 & 4] *Reinforced gypsum concrete shall be considered as an alternative system.*

2514.2 Minimum thickness. The minimum thickness of reinforced gypsum concrete shall be 2 inches (51 mm) except the minimum required thickness shall be reduced to $1^1/_2$ 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).

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	BSC-CG	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)								X	X												
Adopt only those sections that are listed below																					
Chapter / Section																					
2603.11.1								X	X												
2603.12.3								X	X												

The state agency does not adopt sections identified with 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 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, light-transmitting plastics and plastic composites, including plastic lumber. 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 COMPOSITE.

PLASTIC GLAZING.

PLASTIC LUMBER.

THERMOPLASTIC MATERIAL.

THERMOSETTING MATERIAL.

WOOD/PLASTIC COMPOSITE.

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 E84 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 plastic 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 NFPA 276 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 2603.9 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 2603.9, foam plastic shall be separated from the interior of a building by an approved thermal barrier of $^1/_2$-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 not less than 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. A thermal barrier is not required for foam plastic insulation that is a part of a Class A, B or C roof-covering assembly that is installed in accordance with the code and the manufacturer's instructions and is either constructed as described in Item 1 or tested as described in Item 2.

1. The roof assembly is 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, other approved type of edge support or an equivalent material.

2. The assembly with the foam plastic insulation satisfactorily passes NFPA 276 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 $1^1/_2$-inch-thick (38 mm) mineral fiber insulation; $^1/_4$-inch-thick (6.4 mm) wood structural panel, particleboard or hardboard; $^3/_8$-inch (9.5 mm) gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch (0.4 mm); $1^1/_2$-inch-thick (38 mm) self-supported spray-applied cellulose insulation in attic spaces only 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 aluminum, steel, fiberglass, 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/m^2) as determined by NFPA 259 shall be permitted as a siding backer board with a maximum thickness of $^1/_2$ 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, joist header and rim joist in Type V construction is subject to all of the following:

1. The maximum thickness of the foam plastic shall be $3^1/_4$ 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/m^3).
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 E84 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 $^1/_2$-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 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 E119 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 2603.9.

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 E84 or UL 723.

Exception: Prefabricated or factory-manufactured panels having minimum 0.020-inch (0.51 mm) aluminum facings and a total thickness of $^1/_4$ 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.

Exceptions:

1. One-story buildings complying with Section 2603.4.1.4.
2. Wall assemblies where the foam plastic insulation is covered on each face by not less than 1-inch (25 mm) thickness of masonry or concrete and meeting one of the following:
   2.1. There is no airspace between the insulation and the concrete or masonry.
   2.2. The insulation has a flame spread index of not more than 25 as determined in accordance with ASTM E84 or UL 723 and the maximum airspace between the insulation and the concrete or masonry is not more than 1 inch (25 mm).

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 $^3/_8$ 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 $^7/_8$-inch (22.2 mm) thickness of stucco complying with Section 2510.
6. A minimum $^1/_4$-inch (6.4 mm) thickness of fiber-cement lap, panel or shingle siding complying with Sections 1405.16 and 1405.16.1 or 1405.16.2.

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 E108 or UL 790.

2603.7 Foam plastic insulation used as interior finish or interior trim in plenums. Foam plastic insulation used as interior wall or ceiling finish or as interior trim in plenums 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 E84 or UL 723 and shall comply with one or more of Sections 2603.7.1, 2603.7.2 and 2607.3.

2603.7.1 Separation required. 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 E84 or UL 723 at the thickness and density intended for use.

2603.7.2 Approval. 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 E84 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. The foam plastic insulation shall be approved based on tests conducted in accordance with Section 2603.9.

2603.7.3 Covering. 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 E84 or UL 723 at the thickness and density intended for use.

2603.8 Protection against termites. In areas where the probability of termite infestation is very heavy in accordance with Figure 2603.8, 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 not less than 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.

2603.9 Special approval. Foam plastic shall not be required to comply with the requirements of Section 2603.4 or those of Section 2603.6 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.

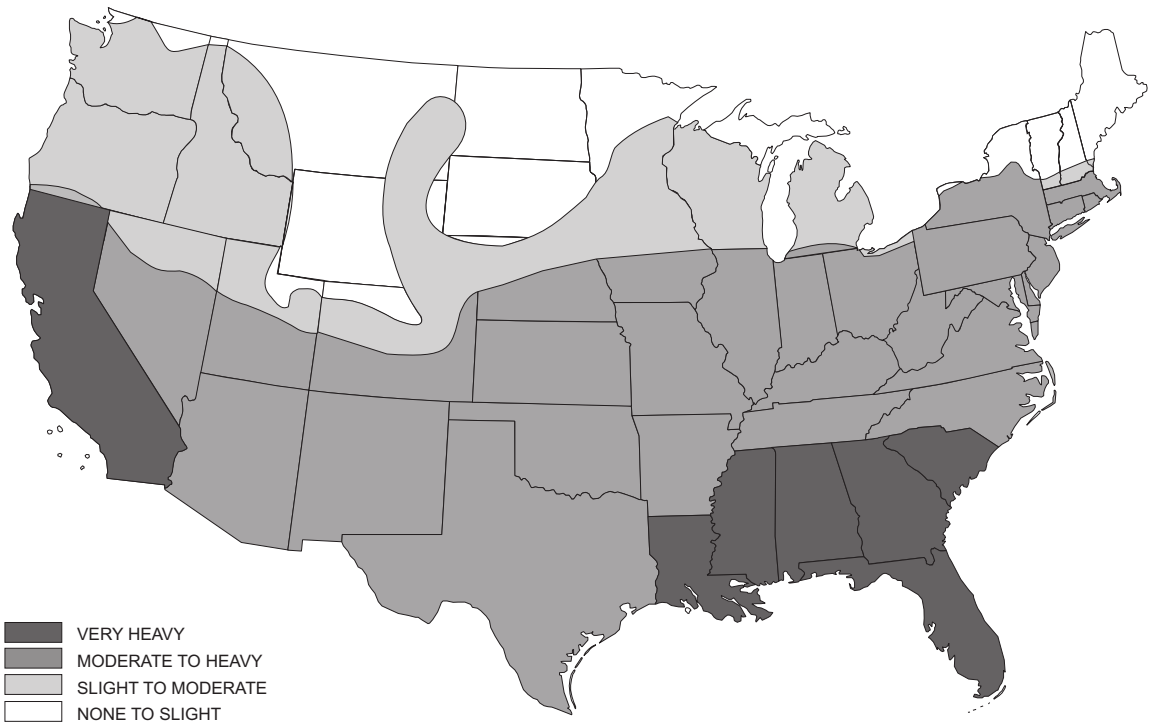


FIGURE 2603.9
TERMITE INFESTATION PROBABILITY MAP

2603.10 Wind resistance. Foam plastic insulation complying with ASTM C578 and ASTM C1289 and used as exterior wall sheathing on framed wall assemblies shall comply with ANSI/FS 100 for wind pressure resistance.

2603.11 Cladding attachment over foam sheathing to masonry or concrete wall construction. Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's installation instructions or an approved design. Foam sheathing shall be attached to masonry or concrete construction in accordance with the insulation manufacturer's installation instructions or an approved design. Furring and furring attachments through foam sheathing shall be designed to resist design loads determined in accordance with Chapter 16, including support of cladding weight as applicable. Fasteners used to attach cladding or furring through foam sheathing to masonry or concrete substrates shall be approved for application into masonry or concrete material and shall be installed in accordance with the fastener manufacturer's installation instructions.

Exceptions:

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing and connection to a masonry or concrete substrate, those requirements shall apply.
2. For exterior insulation and finish systems, refer to Section 1408.
3. For anchored masonry or stone veneer installed over foam sheathing, refer to Section 1405.

2603.11.1 Additional requirements. [DSA-SS, DSA-SS/CC] *In addition to the requirements of Section 2603.11, cladding and foam sheathing supports and attachments shall be designed and submitted to the enforcement agency for approval.*

2603.12 Cladding attachment over foam sheathing to cold-formed steel framing. Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's approved installation instructions, including any limitations for use over foam plastic sheathing, or an approved design. Where used, furring and furring attachments shall be designed to resist design loads determined in accordance with Chapter 16. In addition, the cladding or furring attachments through foam sheathing to framing shall meet or exceed the minimum fastening requirements of Sections 2603.12.1 and 2603.12.2, or an approved design for support of cladding weight.

Exceptions:

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.
2. For exterior insulation and finish systems, refer to Section 1408.
3. For anchored masonry or stone veneer installed over foam sheathing, refer to Section 1405.

2603.12.1 Direct attachment. Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.12.1.

TABLE 2603.12.1
CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)					
			16" o.c. fastener horizontal spacing			24" o.c. fastener horizontal spacing		
			Cladding weight			Cladding weight		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Steel framing (minimum penetration of steel thickness plus 3 threads)	#8 screw into 33 mil steel or thicker	6	3	3	1.5	3	2	DR
		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR
	#10 screw into 33 mil steel	6	4	3	2	4	3	0.5
		8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
	#10 screw into 43 mil steel or thicker	6	4	4	3	4	4	2
		8	4	4	2	4	3	1.5
		12	4	3	1.5	4	3	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.
DR = design required; o.c. = on center.
a. Steel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
b. Screws shall comply with the requirements of AISI S200.
c. Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578 or ASTM C1289.

2603.12.2 Furred cladding attachment. Where steel or wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.12.2. Where placed horizontally, wood furring shall be preservative-treated wood in accordance with Section 2303.1.9 or naturally durable wood and fasteners shall be corrosion resistant in accordance Section 2304.10.5. Steel furring shall have a minimum G60 galvanized coating.

2603.12.3 Additional requirements. [DSA-SS, DSA-SS/CC] *In addition to the requirements of Section 2603.12, 2603.12.1, and 2603.12.2, cladding and foam sheathing supports and attachments shall be designed and submitted to the enforcement agency for approval.*

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 2603.9. Foam plastics that are used as interior finish shall also meet the flame spread and smoke-developed 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.

[F] 2604.2.1 Density. The minimum density of the interior trim shall be 20 pcf (320 kg/m^3).

[F] 2604.2.2 Thickness. The maximum thickness of the interior trim shall be $^1/_2$ 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 E84 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 E84 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 m^2) in area and shall be separated by not less than 4 feet (1219 mm) vertically.

Exception: The area and separation requirements and the smoke-density limitation are not applicable to plastic

TABLE 2603.12.2
FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE[b]	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[d] (inches)					
					16" o.c. furring[e]			24" o.c. furring[e]		
					Cladding weight			Cladding weight		
					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 33 mil steel furring or minimum 1x wood furring[c]	33 mil steel stud	#8 screw	Steel thickness plus 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness plus 3 threads	12	4	2	DR	4	1	DR
				16	4	1.5	DR	3	DR	DR
				24	3	DR	DR	2	DR	DR
	43 mil or thicker steel stud	#8 Screw	Steel thickness plus 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness plus 3 threads	12	4	3	1.5	4	3	DR
				16	4	3	0.5	4	2	DR
				24	4	2	DR	4	0.5	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.

DR = design required: o.c. = on center.

a. Wood furring shall be Spruce-Pine fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33 mil and 43 mil thickness and 50 ksi steel for 54 mil steel or thicker.

b. Screws shall comply with the requirements of AISI S200.

c. Where the required cladding fastener penetration into wood material exceeds $^3/_4$ inch and is not more than $1^1/_2$ inches, a minimum 2-inch nominal wood furring shall be used or an approved design.

d. Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578 or ASTM C1289.

e. Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

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 D1929; a smoke-developed index not greater than 450 where tested in the manner intended for use in accordance with ASTM E84 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 D2843 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 D635.

Class CC2: Plastic materials that have a burning rate of $2^1/_2$ 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 D635.

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 not less than 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 not less than 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 is 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

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 m^2.

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.

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 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-l, 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 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.

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 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 m^2) 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 not more than 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 m^2.

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 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 not less than 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 E108 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 not less than 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 E108 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 sprin-

kler 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 $33^1/_3$ 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 402.6.4. 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 m^2).

2611.4 Encasement. Edges and backs of the sign shall be fully encased in metal.

SECTION 2612
PLASTIC COMPOSITES

2612.1 General. Plastic composites shall consist of either wood/plastic composites or plastic lumber. Plastic composites shall comply with the provisions of this code and with the additional requirements of Section 2612.

2612.2 Labeling and identification. Packages and containers of plastic composites used in exterior applications shall bear a label showing the manufacturer's name, product identification and information sufficient to determine that the end use will comply with code requirements.

2612.2.1 Performance levels. The label for plastic composites used in exterior applications as deck boards, stair treads, handrails and guards shall indicate the required performance levels and demonstrate compliance with the provisions of ASTM D7032.

2612.2.2 Loading. The label for plastic composites used in exterior applications as deck boards, stair treads, handrails and guards shall indicate the type and magnitude of the load determined in accordance with ASTM D7032.

2612.3 Flame spread index. Plastic composites shall exhibit a flame spread index not exceeding 200 when tested in accordance with ASTM E84 or UL 723 with the test specimen remaining in place during the test.

Exception: Materials determined to be noncombustible in accordance with Section 703.5.

2612.4 Termite and decay resistance. Plastic composites containing wood, cellulosic or any other biodegradable materials shall be termite and decay resistant as determined in accordance with ASTM D7032.

2612.5 Construction requirements. Plastic composites shall be permitted to be used as exterior deck boards, stair treads, handrails and guards in buildings of Type VB construction.

2612.5.1 Span rating. Plastic composites used as exterior deck boards shall have a span rating determined in accordance with ASTM D7032.

2612.6 Plastic composite decking, handrails and guards. Plastic composite decking, handrails and guards shall be installed in accordance with this code and the manufacturer's instructions.

SECTION 2613
FIBER-REINFORCED POLYMER

2613.1 General. The provisions of this section shall govern the requirements and uses of fiber-reinforced polymer in and on buildings and structures.

2613.2 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.

2613.3 Interior finishes. Fiber-reinforced polymer used as interior finishes, decorative materials or trim shall comply with Chapter 8.

2613.3.1 Foam plastic cores. Fiber-reinforced polymer used as interior finish and which contains foam plastic cores shall comply with Chapter 8 and this chapter.

2613.4 Light-transmitting materials. Fiber-reinforced polymer used as light-transmitting materials shall comply with Sections 2606 through 2611 as required for the specific application.

2613.5 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 2614
REFLECTIVE PLASTIC CORE INSULATION

2614.1 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 2614 and of one of the following: Section 2614.3 or 2614.4.

2614.2 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.

2614.3 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 E84 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 E2599.

2614.4 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	BSC-CG	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																		
Adopt only those sections that are listed below							X														
Chapter / Section																					
2702.2.5							X														
2702.2.6							X														
2702.2.15			X																		
2702.2.21			X																		

The state agency does not adopt sections identified with 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 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 the *California Electrical Code.*

SECTION 2702
EMERGENCY AND STANDBY POWER SYSTEMS

[F] 2702.1 Installation. Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

[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] 2702.1.2 Electrical. Emergency power systems and standby power systems required by this code or the *California Fire Code* shall be installed in accordance with the *California Fire Code*, NFPA 70, NFPA 110 and NFPA 111.

[F] 2702.1.3 Load transfer. Emergency power systems shall automatically provide secondary power within 10 seconds after primary power is lost, unless specified otherwise in this code. Standby power systems shall automatically provide secondary power within 60 seconds after primary power is lost, unless specified otherwise in this code.

[F] 2702.1.4 Load duration. Emergency power systems and standby power systems shall be designed to provide the required power for a minimum duration of 2 hours without being refueled or recharged, unless specified otherwise in this code.

[F] 2702.1.5 Uninterruptable power source. An uninterrupted source of power shall be provided for equipment when required by the manufacturer's instructions, the listing, this code or applicable referenced standards.

[F] 2702.1.6 Interchangeability. Emergency power systems shall be an acceptable alternative for installations that require standby power systems.

[F] 2702.1.7 Group I-2 occupancies. In Group I-2 occupancies, in new construction or where the building is substantially damaged, where an essential electrical system is located in flood hazard areas established in Section 1612.3, the system shall be located and installed in accordance with ASCE 24.

[F] 2702.2 Where required. Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

[F] 2702.2.1 Emergency alarm systems. Emergency power shall be provided for emergency alarm systems as required by Section 415.5.

[F] 2702.2.2 Elevators and platform lifts. Standby power shall be provided for elevators and platform lifts as required in Sections 1009.4, 1009.5, 3003.1, 3007.8 and 3008.8.

[F] 2702.2.3 Emergency responder radio coverage systems. Standby power shall be provided for emergency responder radio coverage systems required in Section 915 and the *California Fire Code*. The standby power supply shall be capable of operating the emergency responder radio coverage system for a duration of not less than 24 hours.

[F] 2702.2.4 Emergency voice/alarm communication systems. Emergency power shall be provided for emergency voice/alarm communication systems as required in Section 907.5.2.2.5. The system shall be capable of powering the required load for a duration of not less than 24 hours, as required in NFPA 72.

[F] 2702.2.5 Exit signs. Emergency power shall be provided for exit signs as required in Section 1013.6.3. The system shall be capable of powering the required load for a duration of not less than 90 minutes.

[F] 2702.2.6 Group I-2 occupancies. Essential electrical systems for Group I-2 occupancies shall be in accordance with Section 407.10.

[F] 2702.2.7 Group I-3 occupancies. Emergency power shall be provided for power-operated doors and locks in Group I-3 occupancies as required in Section 408.4.2.

[F] 2702.2.8 Hazardous materials. Emergency or standby power shall be provided in occupancies with hazardous materials where required by the *California Fire Code*.

[F] 2702.2.9 High-rise buildings. Emergency and standby power shall be provided in high-rise buildings as required in Sections 403.4.8.

[F] 2702.2.10 Horizontal sliding doors. Standby power shall be provided for horizontal sliding doors as required in Section 1010.1.4.3. The standby power supply shall have a capacity to operate not fewer than 50 closing cycles of the door.

[F] 2702.2.11 Means of egress illumination. Emergency power shall be provided for means of egress illumination as required in Section 1008.3. The system shall be capable of powering the required load for a duration of not less than 90 minutes.

[F] 2702.2.12 Membrane structures. Standby power shall be provided for auxiliary inflation systems in permanent membrane structures as required in Section 3102.8.2. Standby power shall be provided for a duration of not less than 4 hours. Auxiliary inflation systems in temporary air-supported and air-inflated membrane structures shall be provided in accordance with Section 3103.10.4 of 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 Semiconductor fabrication facilities. Emergency power shall be provided for semiconductor fabrication facilities as required in Section 415.11.10.

[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] 2702.2.15 Smoke control systems. Standby power shall be provided for smoke control systems as required in Sections 404.7, 909.11, 909.20.6.2 and 909.21.5.

[F] 2702.2.16 Underground buildings. Emergency and standby power shall be provided in underground buildings as required in Section 405.

2702.2.17 Group L-Occupancy. *Emergency power shall be provided in Group L occupancies in accordance with this chapter and Section 453.4.6.1.*

[F] 2702.3 Critical circuits. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

[F] 2702.4 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	BSC-CG	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																		
Adopt only those sections that are listed below																					
Chapter / Section																					
2802			X																		

The state agency does not adopt sections identified with 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 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 Arrestor. [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 arrestor shall be not less than four times the net free area of the outlet of the chimney.*
2. *The spark arrestor 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 $^{1}/_{2}$ inch (12.7 mm) nor block the passage of spheres having a diameter of less than $^{3}/_{8}$ 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 in the minimum number as shown in Table 2902.1 based on the actual use of the building or space. Uses not shown in Table 2902.1 shall be considered individually by the code official. The number of occupants shall be determined by this code.

[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 2902.1.1 and 2902.2)

No.	CLASSIFICATION	OCCUPANCY	DESCRIPTION	WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE *INTERNATIONAL PLUMBING CODE*)		LAVATORIES		BATHTUBS/ SHOWERS	DRINKING FOUNTAINS (SEE SECTION 410 OF THE *INTERNATIONAL 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
			Restaurants, banquet halls and food courts	1 per 75	1 per 75	1 per 200		—	1 per 500	1 service sink
		A-3[d]	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)

[P] TABLE 2902.1—(continued)
MINIMUM NUMBER OF REQUIRED PLUMBING FIXTURES[a]
(See Sections 2902.1.1 and 2902.2)

No.	CLASSIFICATION	OCCUPANCY	DESCRIPTION	WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE *INTERNATIONAL PLUMBING CODE*)		LAVATORIES		BATHTUBS/ SHOWERS	DRINKING FOUNTAINS (SEE SECTION 410 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[e]
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 *International 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 service sink
		I-2	Hospitals, ambulatory nursing home care recipient[b]	1 per room[c]		1 per room[c]		1 per 15	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 service sink
		I-3	Reformatories, detention centers and correctional centers[b]	1 per 15		1 per 15		1 per 15	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 service sink

(continued)

[P] TABLE 2902.1—continued
MINIMUM NUMBER OF REQUIRED PLUMBING FIXTURES[a]
(See Sections 2902.1.1 and 2902.2)

No.	CLASSIFICATION	OCCUPANCY	DESCRIPTION	WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE *INTERNATIONAL PLUMBING CODE*)		LAVATORIES		BATHTUBS OR SHOWERS	DRINKING FOUNTAINS (SEE SECTION 410 OF THE *INTERNATIONAL 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[e]
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 and lodging houses with five or fewer guest rooms	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 *International 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, provided that each patient sleeping unit has direct access to the toilet room and provisions for privacy for the toilet room user are provided.
d. The occupant load for seasonal outdoor seating and entertainment areas shall be included when determining the minimum number of facilities required.
e. 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 fewer.
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 or 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 be either separate or combined employee and public toilet facilities.

Exception: Public toilet facilities shall not be required in:

1. Open or enclosed parking garages where there are no parking attendants.
2. Structures and tenant spaces intended for quick transactions, including takeout, pickup and drop-off, having a public access area less than or equal to 300 square feet (28 m^2).

[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. 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 distances of travel to required employee facilities in factory and industrial occupancies are permitted to exceed that required by this section, provided that the location and maximum distance of travel 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 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 distance of travel 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 distance of travel 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] 2902.3.6 Prohibited toilet room location. Toilet rooms shall not open directly into a room used for the preparation of food for service to the public.

[P] 2902.4 Signage. Required public facilities shall be provided with signs that designate the sex as required by Section 2902.2. Signs shall be readily visible and located near the entrance to each toilet facility. Signs for accessible toilet facilities shall comply with Section 1111.

[P] 2902.4.1 Directional signage. Directional signage indicating the route to the required public toilet facilities shall be posted in a lobby, corridor, aisle or similar space, such that the sign can be readily seen from the main entrance to the building or tenant space.

[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 distance of travel of 500 feet (152 m) 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 (91 440 mm). Drinking fountains shall be located on an accessible route.

[P] 2902.6 Small occupancies. Drinking fountains shall not be required for an occupant load of 15 or fewer.

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	BSC-CG	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	X															
3001.2			X																		
3001.3						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																		
3007.2			X																		
3007.7.1			X																		
3007.7.4			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 state agency does not adopt sections identified with 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 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.

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, ANSI MH29.1, 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 or to serve as part of an accessible means of egress shall comply with Section 1009 and either *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 not 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 1009.4.
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, not fewer than 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 be not 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, Section 2.11.1.2, and access panels as described in ASME A17.1, 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 enclo- ** sures shall comply with Section 2409.2.

3002.9 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.

3002.10 Photoelectric tube bypass switch.

3002.10.1 *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.*

3002.10.2 *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.*

3002.10.3 *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.*

3002.10.4 *The switch shall be clearly labeled TO BE USED IN CASE OF FIRE ONLY.*

3002.10.5 *Switches shall be kept in working order or be removed when existing installations are arranged to comply with Section 3002.10.5, 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 $^1/_2$ 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
CONVEYING SYSTEMS

3004.1 General. Escalators, moving walks, conveyors, personnel hoists and material hoists shall comply with the provisions of Sections 3004.2 through 3004.4.

3004.2 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 $^{1}/_{28}$-inch (0.9 mm) wood veneers on balustrades backed up with noncombustible materials.

3004.2.1 Enclosure. Escalator floor openings shall be enclosed with shaft enclosures complying with Section 713.

3004.2.2 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.

3004.3 Conveyors. Conveyors and conveying systems shall comply with ASME B20.1.

3004.3.1 Enclosure. Conveyors and related equipment connecting successive floors or levels shall be enclosed with shaft enclosures complying with Section 713.

3004.3.2 Conveyor safeties. Power-operated conveyors, belts and other material-moving devices shall be equipped with automatic limit switches that will shut off the power in an emergency and automatically stop all operation of the device.

3004.4 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 that 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 3005
MACHINE ROOMS

3005.1 Access. An approved means of access shall be provided to elevator machine rooms, control rooms, control spaces and machinery spaces.

3005.2 Venting. Elevator machine rooms, machinery spaces that contain the driving machine, and control rooms or spaces that contain the operation or motion controller 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.

3005.3 Pressurization. The elevator machine room, control rooms or control space with openings into a pressurized elevator hoistway shall be pressurized upon activation of a heat or smoke detector located in the elevator machine room, control room or control space.

3005.4 Machine rooms, control rooms, machinery spaces, and control spaces. Elevator machine rooms, control rooms, control spaces and machinery spaces outside of but attached to a hoistway that have openings into the hoistway 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:

1. For other than fire service access elevators and occupant evacuation elevators, where machine rooms, machinery spaces, control rooms and control 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.
2. For other than fire service access elevators and occupant evacuation elevators, in buildings four stories or less above grade plane where machine room, machinery spaces, control rooms and control spaces do not abut and have no openings to the hoistway enclosure they serve, the machine room, machinery spaces, control rooms and control spaces are not required to be fire-resistance rated.

3005.4.1 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:*

1. *Approved smoke detectors shall be installed in the elevator hoistway, elevator machine room, elevator machinery spaces, elevator control spaces, or eleva-*

tor control rooms and connected to the building fire alarm system in accordance with Section 907.

2. *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.*

3. *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.*

4. *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 having a fire protection rating not less than that required for the hoistway enclosure doors. The exceptions to Section 3005.4 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 $1^1/_2$-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]

3005.5 Shunt trip. Where elevator hoistways, elevator machine rooms, control rooms and control spaces containing elevator control equipment are protected with automatic sprinklers, a means installed in accordance with Section 21.4 of NFPA 72 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 automatic sprinklers outside the hoistway, machine room, machinery space, control room or control space shall not disconnect the main line power supply.

3005.6 Plumbing systems. Plumbing systems shall not be ** located in elevator equipment rooms.

SECTION 3006
ELEVATOR LOBBIES AND HOISTWAY OPENING PROTECTION

3006.1 General. Elevator hoistway openings and enclosed elevator lobbies shall be provided in accordance with the following:

1. Where hoistway opening protection is required by Section 3006.2, such protection shall be in accordance with Section 3006.3.
2. Where enclosed elevator lobbies are required for underground buildings, such lobbies shall comply with Section 405.4.3.
3. Where an area of refuge is required and an enclosed elevator lobby is provided to serve as an area of refuge, the enclosed elevator lobby shall comply with Section 1009.6.
4. Where fire service access elevators are provided, enclosed elevator lobbies shall comply with Section 3007.6.
5. Where occupant evacuation elevators are provided, enclosed elevator lobbies shall comply with Section 3008.6.

3006.2 Hoistway opening protection required. Elevator hoistway door openings shall be protected in accordance with Section 3006.3 where an elevator hoistway connects more than *two stories in Group A, E, H, I, L, R-1, R-2 and R-2.1 occupancies, high-rise buildings, and other applications listed in Section 1.11 regulated by the Office of the State Fire Marshal, and more than three stories for all other occupancies.* Hoistway opening protection is required to be enclosed within a shaft enclosure in accordance with Section 712.1.1 when any of the following conditions apply:

1. The building is not protected throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2.
2. *Group A occupancies;*
3. *Group E occupancies;*
4. *Group H occupancies;*
5. *Group I occupancies;*
6. *Group L occupancies;*
7. *Group R-1, R-2 and R-2.1 occupancies; and*
8. *High-rise buildings.*

See Section 403.6 for additional requirements for high-rise buildings.

Exceptions:

1. Protection of elevator hoistway door openings is not required where the elevator serves only open parking garages in accordance with Section 406.5.
2. Protection of elevator hoistway door openings is not required at the level(s) of exit discharge, provided the level(s) of exit discharge is equipped with an automatic sprinkler system in accordance with Section 903.3.1.1.

3. Enclosed elevator lobbies and protection of elevator hoistway door openings are not required on levels where the elevator hoistway opens to the exterior.

3006.3 Hoistway opening protection. Where Section 3006.2 requires protection of the elevator hoistway door opening, the protection shall be provided by one of the following:

1. An enclosed elevator lobby shall be provided at each floor to separate the elevator hoistway shaft enclosure doors from each floor by fire partitions in accordance with Section 708. In addition, doors protecting openings in the elevator lobby enclosure walls shall comply with Section 716.5.3 as required for corridor walls. Penetrations of the enclosed elevator lobby by ducts and air transfer openings shall be protected as required for corridors in accordance with Section 717.5.4.1.
2. An enclosed elevator lobby shall be provided at each floor to separate the elevator hoistway shaft enclosure doors from each floor by smoke partitions in accordance with Section 710 where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2. In addition, doors protecting openings in the smoke partitions shall comply with Sections 710.5.2.2, 710.5.2.3 and 716.5.9. Penetrations of the enclosed elevator lobby by ducts and air transfer openings shall be protected as required for corridors in accordance with Section 717.5.4.1.
3. Additional doors shall be provided at each elevator hoistway door opening in accordance with Section 3002.6. Such door shall comply with the smoke and draft control door assembly requirements in Section 716.5.3.1 when tested in accordance with UL 1784 without an artificial bottom seal.
4. *[SFM] When approved, in other than Group I-2 occupancies* elevator hoistway shall be pressurized in accordance with Section 909.21.
5. *[SFM] Enclosed elevator lobbies are not required where the hoistway door has a fire-protection rating as required by Section 708.7 and the hoistway door opening is also protected by a listed and labeled smoke containment system complying with ICC ES AC 77.*

3006.4 Means of egress. Elevator lobbies shall be provided with at least one means of egress complying with Chapter 10 and other provisions in this code. Egress through an elevator lobby shall be permitted in accordance with Item 1 of Section 1016.2.

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 3007.9. 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 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 permitted by Section 903.3.1.1.1 and as prohibited by Section 3007.2.1.

3007.2.1 Prohibited locations. Automatic sprinklers shall not be installed in machine rooms, elevator machinery spaces, control rooms, control spaces and elevator hoistways of fire service access elevators.

3007.2.2 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.

3007.3 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.

3007.4 Shunt trip. Means for elevator shutdown in accordance with Section 3005.5 shall not be installed on elevator systems used for fire service access elevators.

3007.5 Hoistway enclosures. The fire service access elevator hoistway shall be located in a shaft enclosure complying with Section 713.

3007.5.1 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.

3007.5.2 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.

3007.6 Fire service access elevator lobby. The fire service access elevator shall open into a fire service access elevator lobby in accordance with Sections 3007.6.1 through 3007.6.5. Egress is permitted through the elevator lobby in accordance with Item 1 of Section 1016.2.

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 3006.3.

3007.6.1 Access to *smokeproof enclosure.* 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 *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 Section 716.5.3.

3007.6.2 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 3007.6.3.

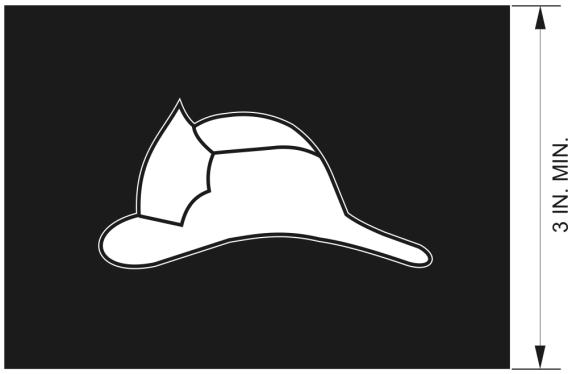
Exception: Enclosed fire service access elevator lobbies are not required at the levels of exit discharge.

3007.6.3 Lobby doorways. Other than doors to the hoistway, elevator control room or elevator control space, each doorway to a fire service access elevator lobby shall be provided with a $^3/_4$-hour fire door assembly complying with Section 716.5. The fire door assembly shall 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.

3007.6.4 Lobby size. Regardless of the 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 an area with a dimension of not less than 8 feet (2440 mm).

3007.6.5 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 3007.6.5 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 helmet shall contrast with the background, with either a light helmet on a dark background or a dark helmet on a light background.
3. The vertical center line of the fire service access elevator symbol shall be centered on the hoistway door frame. Each symbol shall be not less than 78 inches (1981 mm), and not more than 84 inches (2134 mm) above the finished floor at the threshold.



For SI: 1 inch = 25.4 mm.

FIGURE 3007.6.5
FIRE SERVICE ACCESS ELEVATOR SYMBOL

3007.7 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.

3007.8 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. Ventilation and cooling equipment for elevator machine rooms, control rooms, machine spaces and control spaces.
4. Elevator car lighting.

3007.8.1 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, shall be a circuit integrity cable having a fire-resistance rating of not less than 2 hours or shall be protected by a listed electrical protective system 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.

3007.9 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.

3007.9.1 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 3008.10. Where other elevators are used for occupant self-evacuation, those elevators shall 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.

3008.1.3 Operation. The occupant evacuation elevators shall be used for occupant self-evacuation in accordance with the occupant evacuation operation requirements in ASME A17.1/CSA B44 and the building's fire safety and evacuation plan.

3008.2 Automatic sprinkler system. The building shall be equipped throughout with an approved, electrically supervised automatic sprinkler system in accordance with Section 903.3.1.1, except as otherwise permitted by Section 903.3.1.1.1 and as prohibited by Section 3008.2.1.

3008.2.1 Prohibited locations. Automatic sprinklers shall not be installed in elevator machine rooms, machinery spaces, control rooms, control spaces and elevator hoistways of occupant evacuation elevators in accordance with this section and Section 3005.4.1.

3008.2.2 Sprinkler system monitoring. The automatic 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.

3008.3 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.

3008.4 Shunt trip. Means for elevator shutdown in accordance with Section 3005.5 shall not be installed on elevator systems used for occupant evacuation elevators.

3008.5 Hoistway enclosure protection. Occupant evacuation elevator hoistways shall be located in shaft enclosures complying with Section 713.

3008.5.1 Structural integrity of hoistway enclosures. Occupant evacuation elevator hoistway enclosures shall comply with Sections 403.2.3.1 through 403.2.3.4.

3008.6 Occupant evacuation elevator lobby. Occupant evacuation elevators shall open into an elevator lobby in accordance with Sections 3008.6.1 through 3008.6.6. Egress is permitted through the elevator lobby in accordance with Item 1 of Section 1016.2.

3008.6.1 Access to interior exit stairway or ramp. The occupant evacuation elevator lobby shall have direct access from the enclosed elevator lobby to an interior exit stairway or ramp.

Exception: Access to an interior exit stairway or ramp 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 Section 716.5.3.

3008.6.2 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 3008.6.3.

Exception: Enclosed occupant evacuation elevator lobbies are not required at the levels of exit discharge.

3008.6.3 Lobby doorways. Other than the doors to the hoistway, elevator machine rooms, machinery spaces, control rooms and control spaces within the lobby enclosure smoke barrier, each doorway to an occupant evacuation elevator lobby shall be provided with a $^{3}/_{4}$-hour fire door assembly complying with Section 716.5. The fire door assembly shall 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.

3008.6.3.1 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.

3008.6.3.2 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.

3008.6.4 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 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.

3008.6.5 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.

3008.6.6 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. The two-way communication system shall be designed and installed in accordance with Sections 1009.8.1 and 1009.8.2.

3008.7 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 machinery and electrical apparatus cooling equipment where provided, elevator machine room, control room and control space ventilation and cooling equipment.

5. Status of standby or emergency power system that provides backup power to the elevator equipment, elevator machinery and electrical cooling equipment where provided, elevator machine room, control room and control space ventilation and cooling equipment.

6. Activation of any fire alarm initiating device in any elevator lobby, elevator machine room, machine space containing a motor controller or electric driving machine, control space, control room or elevator hoistway.

3008.7.1 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.*

3008.8 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. Ventilation and cooling equipment for elevator machine rooms, control rooms, machinery spaces and control spaces.

3. Elevator car lighting.

3008.8.1 Protection of wiring or cables. Wires or cables that are located outside of the elevator hoistway, machine room, control room and control space 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, shall be circuit integrity cable having a fire-resistance rating of not less than 2 hours or shall be protected by a listed electrical circuit protective system 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 operation.

3008.9 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 907.5.2.2.

3008.9.1 Notification appliances. Not fewer than one audible and one visible notification appliance shall be installed within each occupant evacuation elevator lobby.

3008.10 Hazardous material areas. No building areas shall contain hazardous materials exceeding the maximum allowable quantities per control area as addressed in Section 414.2.

SECTION 3009
SPECIAL REQUIREMENTS FOR ELEVATORS IN HOSPITALS

3009.1 General. [OSHPD 1] *In hospital buildings, all elevators shall comply with the provisions of this section.*

3009.1.1 Seismic switch. *The seismic switch, as required by ASME A17.1, shall be connected to the essential electrical system.*

3009.1.2 Annunciator. *Either a visible or an audible annunciator shall be connected to the essential electrical system and be located in the elevator machine room. The annunciator will indicate if the seismic switch is inoperative due to a loss of power. If a visual annunciator is used, it shall be clearly visible in the room.*

3009.1.3 Travel speed. *After a seismic switch has been triggered, the elevator shall have the ability to operate at a "go slow" speed until the elevator can be inspected. "Go slow" speed is defined as a travel speed of not more than 150 feet per minute (45.72 meters per minute).*

3009.1.4 Cable-operated elevators. *For cable-operated elevators, an additional sensor switch shall be installed on the governor rope/sheave. The sensor shall prevent car movement when the governor tail sheave is dislodged from its normal position.*

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	BSC-CG	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	X																
Adopt only those sections that are listed below	X		X				X														
Chapter / Section																					
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 with 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, membrane-covered frame and tensile membrane 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.

3102.1.1 Tensile membrane structures. Tensile membrane structures, including permanent and temporary structures, shall be designed and constructed in accordance with ASCE 55. The provisions in Sections 3102.3 through 3102.6 shall apply.

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.

TENSILE MEMBRANE STRUCTURE.

3102.3 Type of construction. Noncombustible membrane structures shall be classified as Type IIB construction. Noncombustible 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 Test Method 1 or Test Method 2, as appropriate, 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 the provisions 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 Test Method 1 or Test Method 2, as appropriate, of NFPA 701.

3102.4 Allowable floor areas. The area of a membrane structure shall not exceed the limitations specified in Section 506.

3102.5 Maximum height. Membrane structures shall not exceed one story nor shall such structures exceed the height limitations in feet specified in Section 504.3.

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 the membrane 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 Test Method 1 or Test Method 2, as appropriate, of NFPA 701 shall be permitted to be used as the roof or as a skylight on buildings of Type IIB, III, IV and V construction, provided the membrane 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.

3102.7.1 Lateral restraint. For membrane-covered frame structures, the membrane shall not be considered to provide lateral restraint in the calculation of the capacities of the frame members.

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 Conformance. Temporary structures and uses shall conform to the structural strength, fire safety, means of egress, accessibility, light, ventilation and sanitary requirements of this code as necessary to ensure public health, safety and general welfare.

3103.1.2 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 that 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.

3104.1.1 Application. Pedestrian walkways shall be designed and constructed in accordance with Sections 3104.2 through 3104.9. Tunnels shall be designed and constructed in accordance with Sections 3104.2 and 3104.10.

3104.2 Separate structures. Buildings connected by pedestrian walkways or tunnels shall be considered to be separate structures.

Exceptions:

1. Buildings that are on the same lot and considered as portions of a single building in accordance with Section 503.1.2.
2. ***[DSA-AC and HCD 1-AC]*** *For purposes of accessibility in residential facilities 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 Connections of pedestrian walkways to buildings. The connection of a pedestrian walkway to a building shall comply with Section 3104.5.1, 3104.5.2, 3104.5.3 or 3104.5.4.

Exception: Buildings that are on the same lot and considered as portions of a single building in accordance with Section 503.1.2.

3104.5.1 Fire barriers. Pedestrian walkways shall be separated from the interior of the building by not less than 2-hour fire barriers constructed in accordance with Section 707 and Sections 3104.5.1.1 through 3104.5.1.3.

3104.5.1.1 Exterior walls. Exterior walls of buildings connected to pedestrian walkways shall be 2-hour fire-resistance rated. This protection shall extend not less than 10 feet (3048 mm) in every direction surrounding the perimeter of the pedestrian walkway.

3104.5.1.2 Openings in exterior walls of connected buildings. Openings in exterior walls required to be fire-resistance rated in accordance with Section 3104.5.1.1 shall be equipped with opening protectives providing a not less than $^3/_4$-hour fire protection rating in accordance with Section 716.

3104.5.1.3 Supporting construction. The fire barrier shall be supported by construction as required by Section 707.5.1.

3104.5.2 Alternative separation. The wall separating the pedestrian walkway and the building shall comply with Section 3104.5.2.1 or 3104.5.2.2 where:

1. The distance between the connected buildings is more than 10 feet (3048 mm).
2. The pedestrian walkway and connected buildings are equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, and the roof of the walkway is not more than 55 feet (16 764 mm) above grade connecting to the fifth, or lower, story above grade plane, of each building.

   Exception: Open parking garages need not be equipped with an automatic sprinkler system.

3104.5.2.1 Passage of smoke. The wall shall be capable of resisting the passage of smoke.

3104.5.2.2 Glass. The wall shall be constructed of a tempered, wired or laminated glass wall and doors or glass separating the interior of the building from the pedestrian walkway. The glass shall be protected by an automatic sprinkler system in accordance with Section 903.3.1.1 that, when actuated, shall completely wet the entire surface of interior sides of the wall or glass. Obstructions shall not be installed between the sprinkler heads and the wall or glass. 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.

3104.5.3 Open sides on walkway. Where the distance between the connected buildings is more than 10 feet (3048 mm), the walls at the intersection of the pedestrian walkway and each building need not be fire-resistance rated provided 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. The roof of the walkway shall be located not more than 40 feet (12 160 mm) above grade plane, and the walkway shall only be permitted to connect to the third or lower story of each building.

Exception: Where the pedestrian walkway is protected with a sprinkler system in accordance with Section 903.3.1.1, the roof of the walkway shall be located not more than 55 feet (16 764 mm) above grade plane and the walkway shall only be permitted to connect to the fifth or lower story of each building.

3104.5.4 Exterior walls greater than 2 hours. Where exterior walls of connected buildings are required by Section 705 to have a fire-resistance rating greater than 2 hours, the walls at the intersection of the pedestrian walkway and each building need not be fire-resistance rated provided:

1. The pedestrian walkway is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
2. The roof of the walkway is not located more than 55 feet (16 764 mm) above grade plane and the walkway connects to the fifth, or lower, story above grade plane of each building.

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 and 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 Awnings and canopy materials. Awnings and canopies shall be provided with an approved covering that meets the fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 or has a flame spread index not greater than 25 when tested in accordance

with ASTM E84 or UL 723. *All fabrics and all interior decorative fabrics or materials shall be flame resistant in accordance with the provisions 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: The fire propagation performance and flame spread index requirements shall not apply to awnings installed on detached one- and two-family dwellings.

SECTION 3106
MARQUEES

3106.1 General. Marquees shall comply with Sections 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

[BS] 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.

[BS] 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 term is 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 be completely enclosed by a barrier complying 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 F1346 need not comply with this section.

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 $1^3/_4$ inches (44 mm) in width. Where there are decorative cutouts within vertical members, spacing within the cutouts shall be not greater than $1^3/_4$ 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 $1^3/_4$ inches (44 mm) in width.

3109.4.1.5 Chain link dimensions. Mesh size for chain link fences shall be not greater than a $2^1/_4$-inch square (57 mm square) unless the fence is provided with slats fastened at the top or the bottom that reduce the openings to not more than $1^3/_4$ 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 $1^3/_4$ 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 1010.1.9 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 $^1/_2$ 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 produces an audible warning when the door 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 F1346.
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 Item 1 or 2 above.

3109.4.1.9 Pool structure as barrier. Where an above-ground 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 that 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 F1346-91.*

ENCLOSURE *means a fence, wall or other barrier that isolates a swimming pool from access to the home.*

EXIT ALARMS *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 F2286 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 F1346.*
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 F2208 "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 download. 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 ES13-89).*
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 F2200.

3110.4 Vehicular gate openers. Vehicular gate openers, where provided, shall be listed in accordance with UL 325.

SECTION 3111
PHOTOVOLTAIC PANELS AND MODULES

3111.1 General. Photovoltaic panels and modules shall comply with the requirements of this code and the *California Fire Code*.

3111.1.1 Rooftop-mounted photovoltaic panels and modules. Photovoltaic panels and modules installed on a roof or as an integral part of a roof assembly shall comply with the requirements of Chapter 15 and the *California Fire 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 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	BSC-CG	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																					
3101B (last paragraph only)							X														

The state agency does not adopt sections identified with 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 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 $^1/_4$ 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 $^1/_2$ 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/cm^2.*

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$^1/_2$-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 $4^1/_2$ 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 $4^1/_2$ 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. *Slip resistant 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 $4^1/_2$ 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 $4^1/_2$ 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 + $^1/_2$ 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$^1/_2$ 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 ($^1/_8$ inch per foot) but no more than 2 percent ($^1/_4$ 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 m^2) 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 $^1/_4$ inch (6.4 mm) 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 $1^3/_4$ 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 m^2) 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 m^2) 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 $^1/_4$ 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 $1^{1}/_{4}$ 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 shut-off 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 m^2) of filter area. The backwash rate shall not be less than 15 gallons per minute per square foot (611.2 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 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 $2^1/_2$ 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 $^1/_2$ 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 $^1/_2$ 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/m^2) 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 groundwater 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 $1^1/_4$ 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 mm^2) 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.*

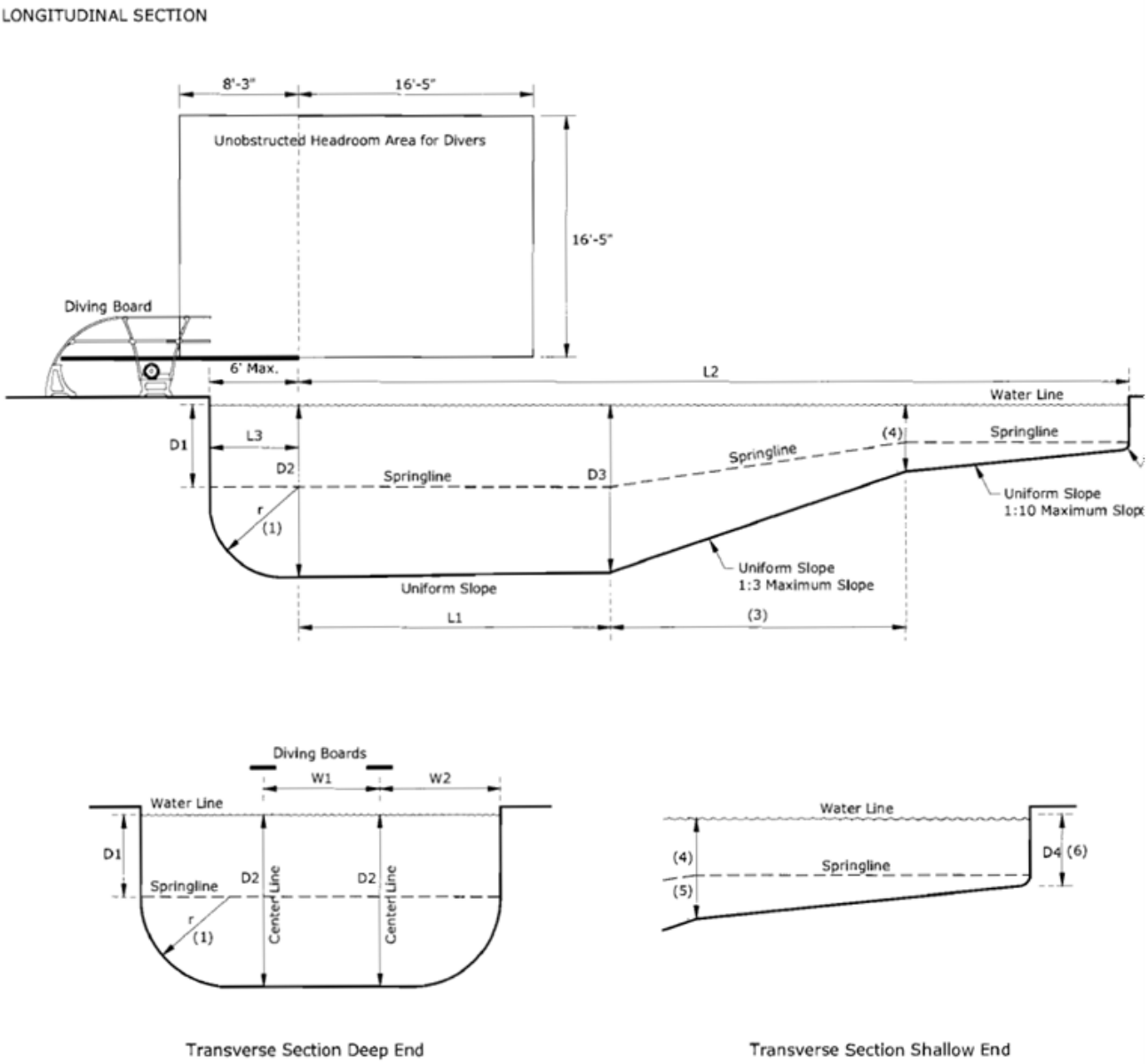


FIGURE 31B-1
DEPTHS AND CLEARANCES FOR POOLS WITH DIVING BOARDS GREATER THAN 30 INCHES (762 mm) ABOVE THE WATER LINE

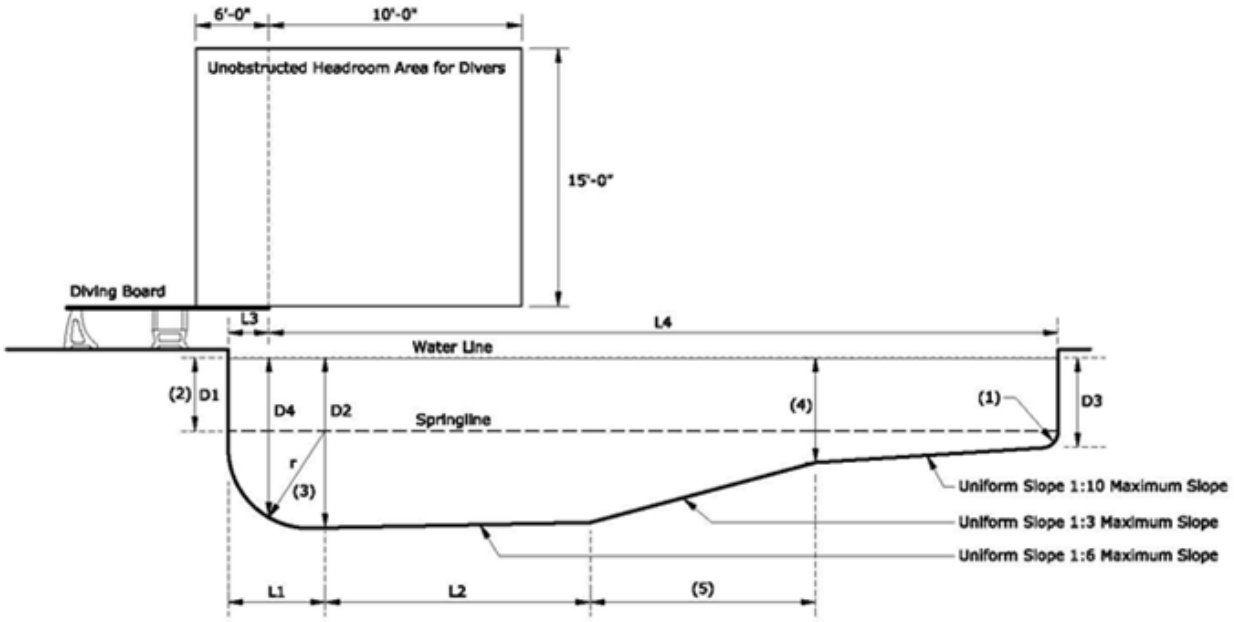
TABLE 31B-1

	DEPTH OF WATER					LENGTH OF SECTION				
BOARDS AND PLATFORMS	**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

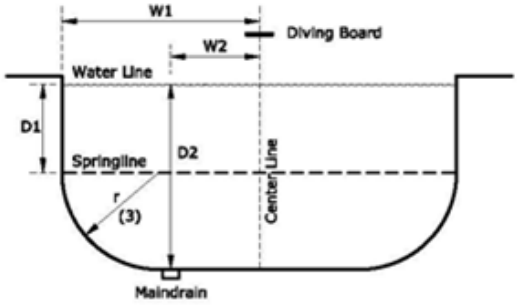


FIGURE 31B-2
DEPTHS AND CLEARANCES FOR POOLS WITH DIVING BOARDS 30 INCHES (762 MM) OR LESS ABOVE THE WATER LINE

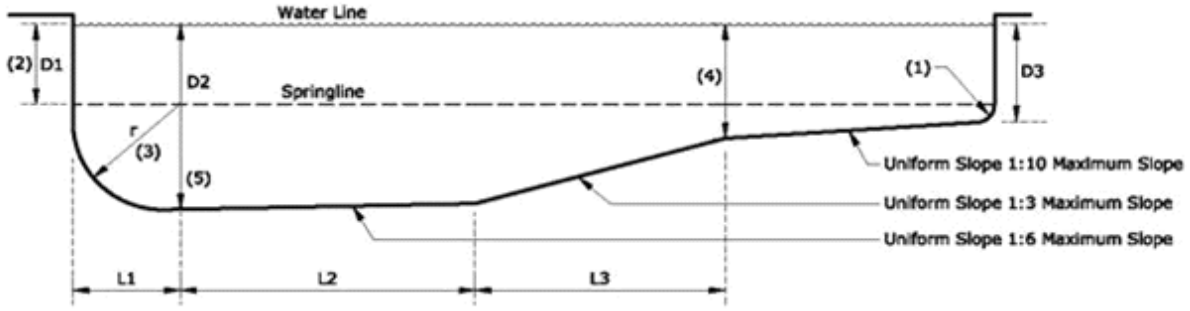
TABLE 31B-2

	DEPTH OF WATER				LENGTH OF SECTION					
DIMENSION	**D1**	**D2**	**D3**	**D4**	**L1**	**L2**	**L3**		**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

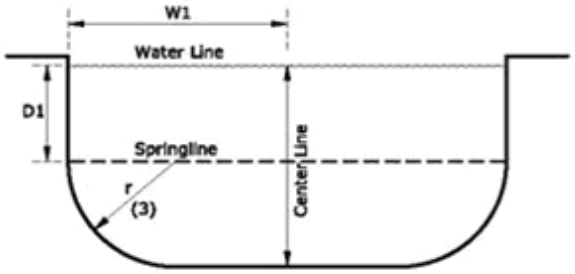


FIGURE 31B-3
DEPTHS AND CLEARANCES FOR POOLS WITHOUT DIVING BOARDS

TABLE 31B-3A
POOLS WITH MAXIMUM WATER DEPTH ≤ 6′0″

	DEPTH OF WATER			LENGTH OF SECTION			
DIMENSION	**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′0″

	DEPTH OF WATER			LENGTH OF SECTION		
DIMENSION	**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 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 m^2).*

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.*

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
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SECTION 3150B
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SECTION 3151B
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SECTION 3152B
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SECTION 3153B
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SECTION 3154B
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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 purposed 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 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 aboveground, 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:*

   a. File the form issued by the department pursuant to subdivision (g), as otherwise provided in subdivision (h).

   b. File a signed statement attesting that the required work has been completed.

   c. Provide a document containing the name and license number of the qualified individual who completed the required work.

   d. 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:

      (i) 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.

      (ii) 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. A statement of whether the pool operates with a single suction outlet or multiple suction outlets that comply with Subdivision (5).

   b. 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.

   c. 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.

   d. 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).

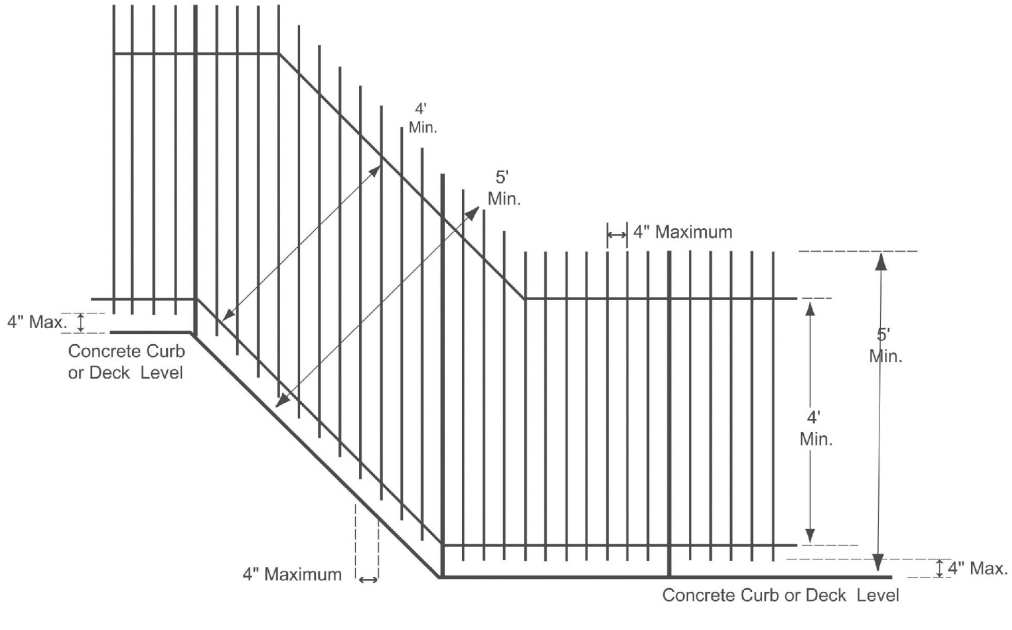


FIGURE 31B-4
PERPENDICULAR FENCING DIMENSIONS ON SLOPING GROUND

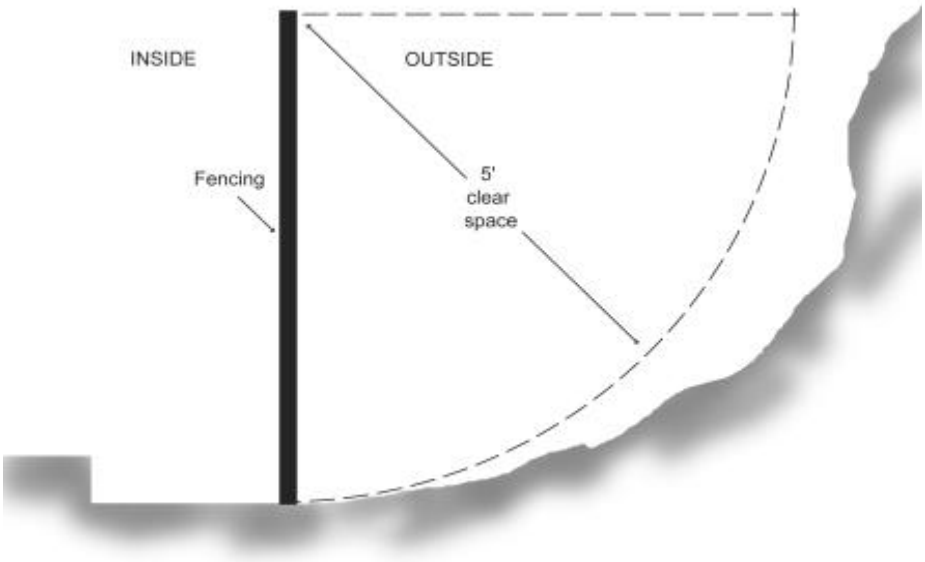
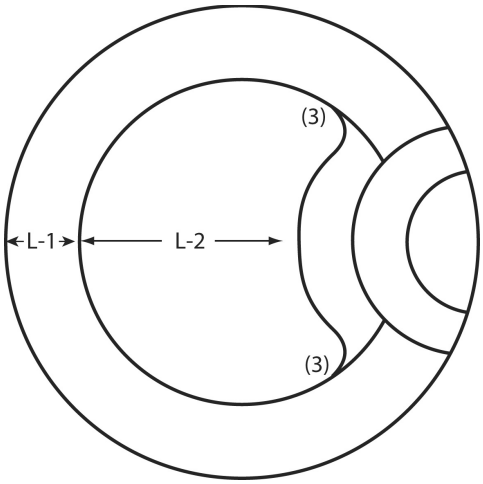


FIGURE 31B-5
EFFECTIVE FENCING HEIGHT

TOP VIEW



TRANSVERSE SECTION

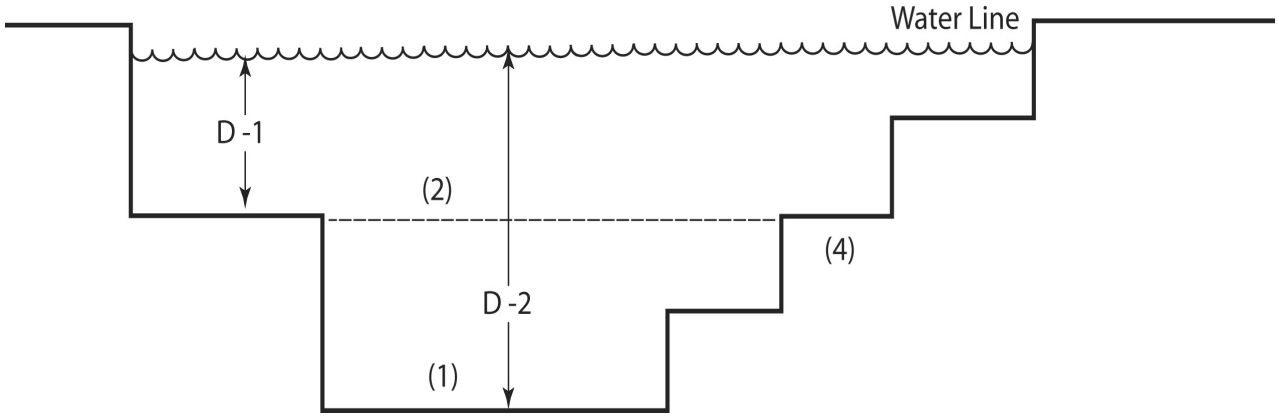


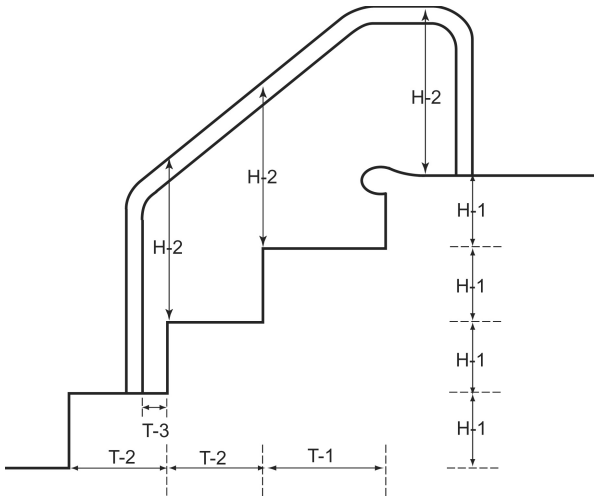
FIGURE 31B-6
DEPTHS AND DIMENSIONS FOR SPA POOLS

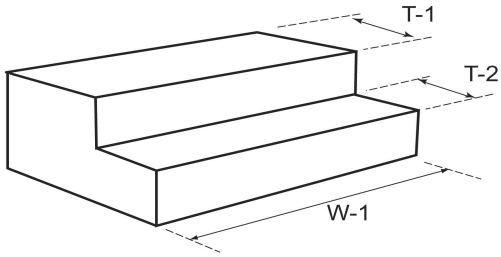
TABLE 31B-6

	DEPTH OF WATER		LENGTH OF SECTION	
DIMENSION	**D1**	**D2**	**L1**	**L2**
Minimum	—	*24"*	*12"*	*24"*
Maximum	*24"*	—	*24"*	—

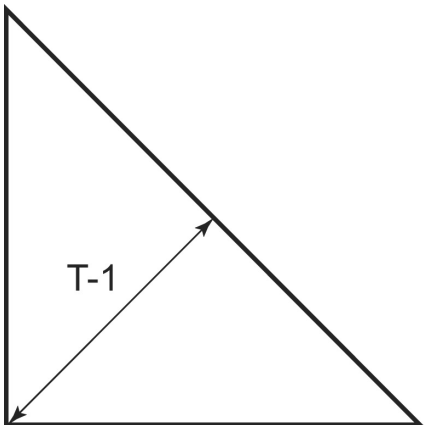
Notes for Figure 31B-6 and Table 31B-6:

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 3111B for step and handrail dimensions.*

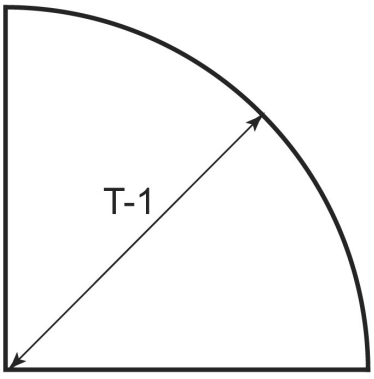




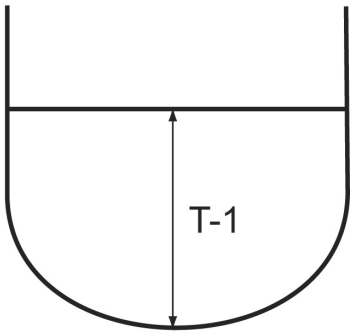
Standard Step



Triangular Step



Corner Step



Concave Step

FIGURE 31B-7
STAIR AND HANDRAIL DIMENSIONS

TABLE 31B-7

DIMENSION	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".

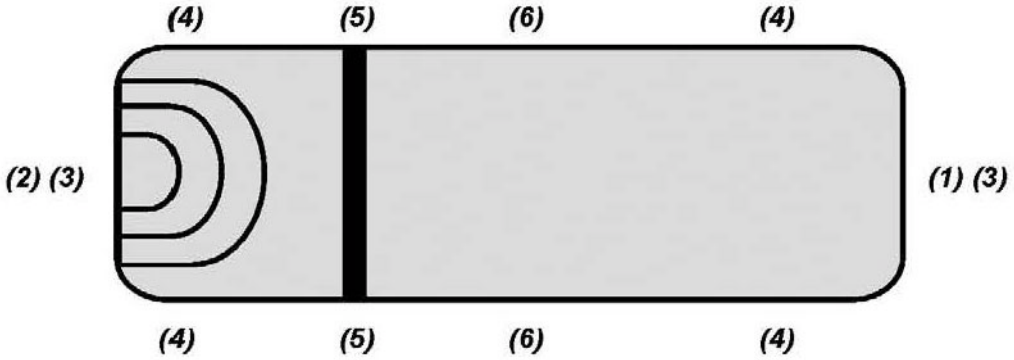


FIGURE 31B-8
DEPTH MARKER LOCATIONS

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	BSC-CG	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	BSC-CG	SFM	HCD			DSA			OSHPD				BSCC	DPH	AGR	DWR	CEC	CA	SL
				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	BSC-CG	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																					

The state agency does not adopt sections identified with 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 31F [SLC]
MARINE OIL TERMINALS

Division I

SECTION 3101F [SLC] INTRODUCTION

3101F.1 Authority. *The Lempert-Keene-Seastrand oil spill prevention and response act of 1990 (act), as amended, authorizes the California State Lands Commission (SLC) to regulate marine terminals, herein referred to as marine oil terminals (MOTs), in order to protect public health, safety and the environment. The authority for this regulation is contained in Sections 8750 through 8760 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 onshore and offshore MOTs as defined under this act, including marine terminals that transfer liquefied natural gas (LNG).*

The Marine Environmental Protection Division (Division) administers this code on behalf of the SLC.

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 specifically address terminal siting or 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 Division.

In circumstances where new technologies are proposed, equivalent prevention of oil spills and protection to the public health, safety and the environment must be demonstrated, subject to Division approval.

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.

Section 3112F provides requirements specific to marine terminals that transfer LNG.

Generally, English units are typically prescribed herein; however, System International (SI) units are utilized in Section 3112F and in many of the references.

3101F.5 Spill prevention. *Each MOT shall utilize up-to-date Risk and Hazards Analysis results developed per CCPS "Guidelines for Hazard Evaluation Procedures" [1.1] and [1.2], to identify the hazards associated with operations at the MOT, including operator error, the use of the facility by various types of vessels (e.g. multi-use transfer operations), equipment failure, and external events likely to cause an oil spill.*

If there are changes made to the built MOT or subsequently any new hazard is identified with significant impact, the updated Risk and Hazards Analysis shall be used.

Assessed magnitude of potential oil spill releases and consequences shall be mitigated by implementing appropriate designs using best achievable technologies, subject to Division approval. The residual risks are addressed by operational and administrative means via 2 CCR 2385 [1.3].

Risk and Hazards Analysis requirements specific to marine terminals that transfer LNG are discussed in Section 3112F.2.

3101F.6 Oil spill exposure classification. *Each MOT shall be categorized into one of three oil spill exposure classifications (high, medium or low) as shown in Table 31F-1-1, based on all of the following:*

1. *Exposed total volume of oil (V_T) during transfer.*
2. *Maximum number of oil transfer operations per berthing system (defined in Section 3102F.1.3) per year.*
3. *Maximum vessel size (DWT capacity) that may call at the MOT.*

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 total volume (V_T) of potential exposed oil is equal to the sum of the stored and flowing volumes ($V_s + V_F$) at the MOT, prior to the emergency shutdown (ESD) system(s) stopping the flow of oil. All potential spill scenarios shall be evaluated and the governing scenario clearly identified. The stored volume (V_s) is the non-flowing oil. The flowing volume (V_F) shall be calculated as follows:

$$V_F = Q_C \times \Delta t \times (1/3{,}600) \qquad (1\text{-}1)$$

where

V_F = *Flowing Volume [bbl]*

Q_C = *Maximum Cargo Transfer Rate [bbl/hr]*

Δt = *For MOTs that first transferred oil on or before January 1, 2017, Δt may be taken as (ESD time, 30 or 60 seconds). For MOTs that first transfer oil after January 1, 2017, Δt shall be taken as ((ESD closure time) + (time required to activate ESD)) [seconds].*

If spill reduction strategies, (e.g. pipeline segmentation devices, system flexibility and spill containment devices) are adopted, such that the maximum volume of exposed oil during transfer is less than 1,200 barrels, the spill classification of the facility may be lowered.

This classification does not apply to marine terminals that transfer LNG.

3101F.7 Management of Change. *Whenever physical changes are made to the built MOT that significantly impact operations, a Management of Change (MOC) process shall be followed per Section 6.6 of API Standard 2610 [1.4].*

TABLE 31F-1-1
MOT OIL SPILL EXPOSURE CLASSIFICATION

SPILL CLASSIFICATION	EXPOSED TOTAL VOLUME OF OIL (V_T) (bbls)	MAXIMUM NUMBER OF TRANSFERS PER BERTHING SYSTEM PER YEAR	MAXIMUM VESSEL SIZE (DWT×1,000)
High	*≥ 1200*	*N.A.*	*N.A.*
Moderate	*< 1200*	*≥ 90*	*≥ 30*
Low	*< 1200*	*< 90*	*< 30*

3101F.8 Review requirements.

3101F.8.1 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, and shall include a concluding statement of compliance with this code.*

3101F.8.2 Peer review. *The Division may require peer review of advanced engineering analyses and designs, including, but not limited to, nonlinear dynamic structural analyses, alternative lateral force procedures, complex geotechnical evaluations, subsea pipeline analyses and designs, and fatigue analyses. Peer review shall be performed by an external independent source to maintain the integrity of the process.*

The peer reviewer(s) and their affiliated organization shall have no other involvement in the project, except in a review capacity. The peer reviewer(s) shall be a California registered engineer(s) familiar with regulations governing the work and have technical expertise in the subject matter to a degree of at least that needed for the original work. The peer reviewer(s)' credentials shall be presented to the Division for approval prior to commencement of the review.

Upon completion of the review process, the peer reviewer(s) shall submit a written report directly to the Division that covers all aspects of the review process, including, but not limited to:

1. *Scope, extent and limitations of the review.*
2. *Status of the documents reviewed at each stage (i.e. revision number and date).*
3. *Findings.*
4. *Recommended corrective actions and resolutions, if necessary.*
5. *Conclusions.*
6. *Certification by the peer reviewer(s), including whether or not the final reviewed work meets the requirements of this code.*
7. *Formal documentation of important peer review correspondence, including requests for information and written responses.*

The owner and operator shall cooperate in the review process, but shall not influence the peer review. If the original work requires modification after completion of the peer review, the final analyses and designs shall be submitted to the Division.

3101F.8.3 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.9 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.*

3101F.10 References.

[1.1]Center for Chemical Process Safety (CCPS), 2008, "Guidelines for Hazard Evaluation Procedures", 3rd ed., New York.

[1.2]California Code of Regulations (CCR), Title 14, Division 1, Chapter 3, Oil Spill Contingency Plans (14 CCR 815.01 through 818.03), Section 817.02(c)(1) – Risk and Hazard Analysis.

[1.3]California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5 – Marine Terminals Inspection and Monitoring (2 CCR 2300 et seq.)

[1.4]American Petroleum Institute (API), 2005, API Standard 2610 (R2010), "Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities," 2nd ed., Washington, D.C.

Authority: *Sections 8750 through 8760, Public Resources Code.*

Reference: *Sections 8750, 8751, 8755 and 8757, Public Resources Code. Section 8670.28(a)(7), Government 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) are:

1. Annual compliance inspection
2. Audits
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), for a significant change in operations, or as a result of a significant, potentially damage-causing event. 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.

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 assessment. 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,

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.

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 compliance inspection. *The Division may carry out annual inspections to determine the compliance status of the MOT with this code, based on the terminal's audit and inspection findings and action plan implementation (see Section 3102F.3.9).*

These inspections may include a visual and tactile assessment of structural, mechanical and electrical systems of the topside and underside areas of the dock, including the splash zone. Subject to operating procedures, a boat shall be provided to facilitate the inspection of the dock undersides and piles down to the splash zone.

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 multidisciplinary 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 of each terminal shall be completed concurrently with the inspections (see Section 3102F.3.5). The audit team leader shall recommend either: (1) a default subsequent audit interval of 4 years, or (2) an alternate interval, based on assessments of the structural, mechanical and electrical systems, and consideration of:*

1. *The extent of the latest deterioration and/or disrepair,*
2. *The rate of future anticipated deterioration and/or disrepair,*
3. *The underwater inspection guidance provided in Table 31F-2-1, and*
4. *Other specified factors.*

Based on independent assessment of these factors, the Division may accept the audit team leader's recommendation or require a different subsequent audit interval.

If there are no changes in the defined purpose (see Section 3102F.3.6.1) of the berthing system(s), relevant prior analyses may be referenced. However, if there is a significant change in the operations or condition of berthing system(s), 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 curricu-

lum, 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 3108F.2.2.*

3102F.3.4.7 Corrosion specialist. *The corrosion specialist shall be a chemical engineer, corrosion engineer, chemist or other professional with expertise in the types and causes of corrosion, and available means to prevent, monitor and mitigate associated damage. The specialist shall perform the corrosion assessment (Section 3102F.3.6.5) and may be directly involved in corrosion inspection (Section 3102F.3.5.4).*

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.3.4.9 Division representation. *The Division representative(s) may participate in any audit or inspection as observer(s). The Division shall be notified in advance of audit-related inspections.*

3102F.3.5 Scope of inspections.

3102F.3.5.1 Structural inspections.

3102F.3.5.1.1 Above water structural inspection. *The above water inspection shall include all accessible 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)*

3102F.3.5.1.2 Underwater structural inspection. *The underwater inspection shall include all components below deck 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) [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 shall be cleaned at designated locations, generally near the low waterline, at the mudline, 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 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

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
UNDERWATER INSPECTION LEVELS OF EFFORT [2.2]

LEVEL		SAMPLE SIZE AND METHODOLOGY[1]							
		Steel		Concrete		Timber		Composite	Slope Protection, Channel Bottom or Mudline-Scour
		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	As necessary
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%	Sonar imaging as necessary

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

generally limited to key structural areas, areas which are suspect or areas which may be representative of the underwater structure.

3102F.3.5.2 Special inspection considerations.

3102F.3.5.2.1 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.3.5.2.2 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 significant 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.3.5.2.3 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.3.5.3 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.

Utility, auxiliary and fire protection piping shall have external visual inspections, similar to that defined in Section 10.1 of API RP 574 [2.3] (N/E).

3102F.3.5.4 Corrosion inspection.

During each audit, a comprehensive corrosion inspection shall be performed by a qualified engineer or technician. This inspection shall include all steel and metallic components, and any installed cathodic protection system (CPS). CPS inspection during the audit is not intended to substitute for required testing and maintenance performed on a more frequent schedule per Section 3111F.10. All inspection results shall be documented, and shall be used in the corrosion assessment (Section 3102F.3.6.5).

Submerged wharf structures and associated cathodic protection equipment (if installed) shall be inspected per [2.2]. Above water structures, ancillary equipment, supports, and hardware shall be visually

inspected. Corrosion inspection of utility, auxiliary and fire pipelines shall be done per Section 3102F.3.5.3.

For oil pipelines in an API 570 [2.4] inspection program, a corrosion inspection is not required as part of the audit; however, the latest inspection results, calculations, and conclusions shall be reviewed, and any significant results shall be included in the corrosion assessment.

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.3.6.5 Corrosion assessment (N/E). *A comprehensive assessment shall be performed by the corrosion specialist (Section 3102F.3.4.7), to determine the existing and potential corrosion using "as-built" drawings and specifications. This assessment shall comprise all steel and metallic components, including the structure, pipelines, supports and other MOT ancillary equipment. This assessment shall also include prestressed and reinforced concrete structures.*

If cathodic protection is installed to protect wharf structures and/or pipelines, the following records shall be evaluated for each system:

1. *CPS equipment condition and maintenance*
2. *Impressed current readings (as applicable)*
3. *Potential survey results*

3102F.3.7 Follow-up actions. *Follow-up actions per Table 31F-2-6 shall be prescribed by the audit team. 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. <

For action plan implementation between audits, see Section 3102F.3.9.

TABLE 31F-2-4
ASSESSMENT RATINGS

RATING		DESCRIPTION OF STRUCTURE(S) AND/OR SYSTEMS[4]	
		OSAR[1] and SSAR[2]	ICAR[3]
6	Good	The capacity of the structure or system meets the requirements of this standard. The structure or system should be considered fit-for-purpose. No repairs or upgrades are required.	No problems or only minor problems noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs or upgrades are required.
5	Satisfactory	The capacity of the structure or system meets the requirements of this standard. The structure or system should be considered fit-for-purpose. No repairs or upgrades are required.	Limited minor to moderate defects or deterioration observed, but no overstressing observed. No repairs or upgrades are required.
4	Fair	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. 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.	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. 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.
3	Poor	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. 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.	Advanced deterioration or overstressing observed on widespread portions of the structure, but does not significantly reduce the load bearing capacity of the structure. 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.
2	Serious	The capacity of the structure or system is more than 25 percent below the requirements of this standard, as determined from an engineering evaluation. 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.	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. 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.
1	Critical	The capacity of the structure or system is critically deficient relative to the requirements of this standard. The structure or system is not fit-for-purpose. The facility shall cease operations until deficiencies are corrected and accepted by the Division.	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. The facility shall cease operations until deficiencies are corrected and accepted by the Division.

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

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. Emergency Actions may consist of barricading or closing all or portions of the berthing system, evacuating product lines and ceasing transfer operations. The berthing system is not fit-for-purpose. 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. The berthing system is not fit-for-purpose. 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 do not require emergency or urgent actions. The MOT may have limitations placed on its operational status.
P4	Specified whenever damage or defects requiring repair are observed. The berthing system is fit-for-purpose. Repair can be performed during normal maintenance cycles, but not to exceed one year.
R	Recommended action is a good engineering/maintenance practice, but not required by these standards. The berthing system is fit-for-purpose.

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.

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 between audits. *The operator is responsible for correction of deficiencies between audits. Prior to implementation, projects shall be submitted for Division review in accordance with Section 3101F.8.3. During project implementation, the Divi-*

sion shall be informed of any significant changes. After project completion, "as-built" documentation, including drawings, calculations and analyses, shall be submitted to the Division.

Executive Summary Tables shall be updated by the operator and submitted to the Division at least annually.

3102F.4 Post-event inspection. *A post-event inspection is a focused inspection following a significant, potentially damage-causing event such as an earthquake, storm, vessel impact, fire, explosion or tsunami. The primary purpose is to assess the integrity of structural, mechanical and electrical systems. This assessment will determine the operational status and/or any remedial measures required.*

3102F.4.1 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.

3102F.4.2 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.*

3102F.4.3 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, 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 (2 CCR 2300 et seq.)

[2.2] Childs, K.M., editor, 2001, "Underwater Investigations - Standard Practice Manual," American Society of Civil Engineers, Reston, VA.

[2.3] American Petroleum Institute (API), 2009, API Recommended Practice 574 (API RP 574), "Inspection Practices for Piping System Components," 3rd ed., Washington, D.C.

[2.4] American Petroleum Institute (API), 2009, API 570, "Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems," 3rd ed., Washington, D.C.

Authority: *Sections 8750 through 8760, 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]	Fit-for-purpose (Y/N)	Description or comments[7]
North Wharf	Berth 1	Wharfhead	O	5	08/2008	08/2011	02/2008	N/A	Y	None
North Wharf	Berth 1	Mooring Dolphin	M	3	08/2008	08/2011	05/2008	12/2008	N	Hook capacity inadequate
North Wharf	Berth 1	Breasting Dolphin	B	2	08/2008	08/2011	06/2008	02/2010	N	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)	Description or comments[7]
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 liquefation
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, Trestles, 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
Berthing system	Berth(s)[1]	Structure(s)[1]	Type of inspection[3]	ICAR rating[4,9]	Last inspection date (MM/YYYY)[10]	Inspection interval (YRS.)	Next inspection due date (MM/YYYY)[10]	Description or comments[7]
North Wharf	Berth 1	Wharfhead	AW	5	02/2008	3	02/2011	General satisfactory condition. See RAPs in Table ES-2 for details.
North Wharf	Berth 1	Wharfhead	UW	4	02/2008	5	02/2013	Pile damage; 10 serve, 15 minor See RAPs in Table ES-2 for details.
North Wharf	Berth 1	Breasting Dolphin BD-1	AW	6	02/2008	3	02/2011	See RAPs in Table ES-2
North Wharf	Berth 1	Breasting Dolphin BD-1	UW	5	02/2008	5	02/2013	See RAPs in Table ES-2
North Wharf	Berth 1	Dolphins, Trestle, Catwalks, Bulkhead walls, etc.						
South Wharf	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-2-8

EXAMPLE	EXECUTIVE SUMMARY TABLE (ES-2) COMPONENT DEFICIENCY REMEDIAL ACTION PRIORITIES (RAP)[1]											REV. # MM/YYYY
Berthing system	Berth(s)	Structure(s) or location(s)	Deficiency item label[2]	Component: deficiency description	Remedial action priority (RAP)[3]	CBC section reference	Audit checklist reference (optional)	Description of planned remedial action	P.E. review required? (Y/N)[4]	Repair/ replacement due date (MM/YYYY)	Completion date (MM/YYYY)	Description of completed actions
North Wharf	Berth 1	Wharfhead	02.0001.001	**Piles:** 10 piles have severe damage; 15 piles have minor damage.	P2	3102F.3.5.2		Replace 10 severe piles. Monitor 15 minor piles.	Y	05/2008	04/2008	10 piles replaced
North Wharf	Berth 1	Mooring Dolphin MD-1	02.0001.002	**Curb:** Spalling of concrete curb w/o exposed reinforcement.	R	3102F.3.5.2		Repair concrete curbs.	N	02/2009		
North Wharf	Berth 1	Wharfhead	08.0001.002	**International Shore Fire Connection:** Connections available, but not connected.	P3	3108F.6.3.4	8.6.22	Install International Shore Fire Connections.	N	10/2008		
North Wharf	Berth 1	Wharfhead	11.0001.001	**Conduit Seals near Manifold:** Conduit seals inadequate for Class 1, Division 1 location.	P1	3111F.2		Replace conduit seals with seals adequate for Class 1. Division 1 location within 30 days.	Y	04/2008	04/2008	Seals replaced
North Wharf	Berth 1	Wharfhead	11.0001.001	**Pressurized Instrumentation Panel near Shelter:** Pressure gauge reads "low" and will not hold pressure in Class 1, Division 2 location.	P2	3111F.2	3111F.4.5	Repair pressurized instrument ation panel in Class 1, Division 2 location within 60 days.	Y	05/2008	05/2008	Pressurized instrumentation panel could not be repaired and was replaced.

These notes apply to Table 31F-2-8:

1. *After a deficiency is corrected/completed, the row of text corresponding to that deficiency may be grayed out in subsequent ES-2 tables, and removed entirely in the subsequent audit.*
2. *The "Deficiency Item Labels" shall be assigned in the format shown above with the first series of numbers representing the Code Division/Section number ("XX"), a period (".") for separation, the second series of numbers representing the deficiency item number ("XXXX"), a period (".") for separation, and the third series of numbers representing the ES-2 table revision number ("XXX") in which the deficiency was first reported. Note that the deficiency item numbering will start from "0001" for the first deficiency in each section of the audit, and will increase consecutively in all future ES-2 tables.*
3. *RAPs shall be assigned in accordance with Table 31F-2-5.*
4. *Professional engineering review required in accordance with Section 3102F.3.8 under "Follow-up Actions."*

EXAMPLE

STATEMENT OF TERMINAL OPERATING LIMITS

Terminal Name & Location

50 to 65 KDWT Vessel Starboard Side

GENERAL INFORMATION

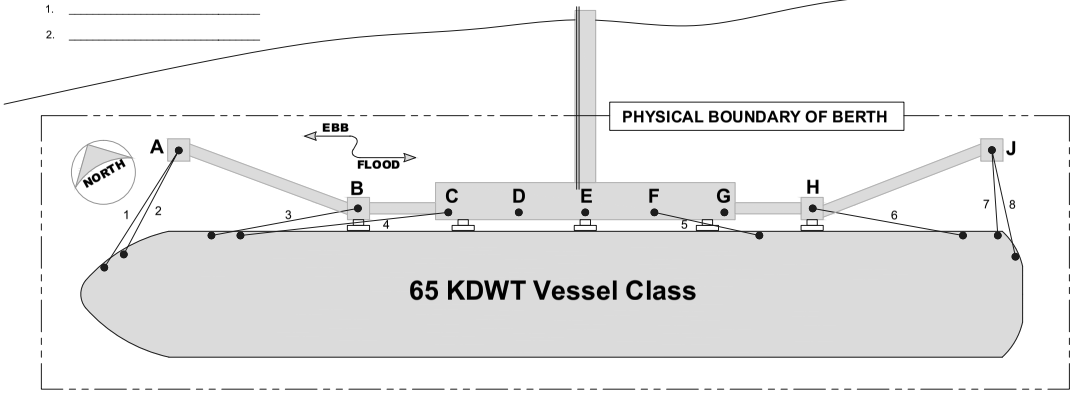
REFERENCE CALCULATION(S):

NAME OF REPORT(S) / PREPARER(S) / DATE(S)

ALTERNATIVE(S) APPROVED:

1. _____

2. _____



MOORING DEVICE INFORMATION

MOORING POINT	DEVICE TYPE	CAPACITY (KIPS)
A	DOUBLE HOOK	300 (150 PER HOOK)
B	DOUBLE HOOK	300 (150 PER HOOK)
C	BOLLARD	200
D	BOLLARD	OUT OF SERVICE
E	BOLLARD	200
F	BOLLARD	200
G	BOLLARD	OUT OF SERVICE
H	DOUBLE HOOK	300 (150 PER HOOK)
J	TRIPLE HOOK	450 (150 PER HOOK)

VESSEL DESCRIPTION:

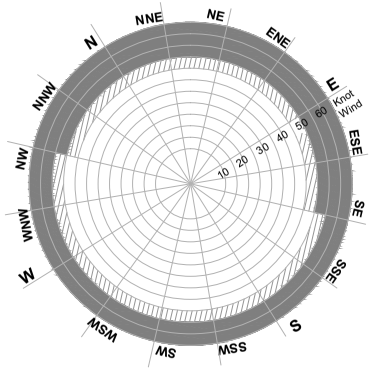
DWT	65,570 LT
MAXIMUM ARRIVAL DISPLACEMENT	45,500 LT
MAXIMUM DRAFT	60.0 FT
MAXIMUM ARRIVAL DRAFT	38.0 FT
MAXIMUM LOA	750.0 FT
MAXIMUM BEAM	105.0 FT

BERTH DESCRIPTION:

MINIMUM WATER DEPTH	40.0 FT @ MLLW
MINIMUM UNDERKEEL CLEARANCE	2.0 FT

BERTHING NOTES:

1. MAXIMUM IMPACT VELOCITY = 0.33 FPS.
2. BERTHING IS NOT ALLOWED AT AN APPROACH ANGLE GREATER THAN 6 DEGREES.
3. NO BERTHING OPERATION WILL TAKE PLACE WITH WIND VELOCITIES GREATER THAN 38 KNOTS (43.7 MPH).



WIND RESTRICTION DIAGRAM

LEGEND:

OPERATIONAL CONDITION LIMIT:
TERMINATE PRODUCT TRANSFER

SURVIVAL CONDITION LIMIT:
DISCONNECT PRODUCT LINES & DEPART BERTH

ENVIRONMENTAL CONDITION LIMITS

1. WIND RESTRICTION DIAGRAM IS APPLICABLE FOR:
   - MAXIMUM EBB CURRENT: 3.9 KNOTS TOWARDS, 290 DEG TO 310 DEG FROM NORTH
   - MAXIMUM FLOOD CURRENT: 2.6 KNOTS TOWARDS, 110 DEG TO 130 DEG FROM NORTH
   - WAVE PERIOD: T < 4.0 SEC
2. TERMINATE PRODUCT TRANSFER AND DISCONNECT IF CURRENT EXCEEDS MAGNITUDE OR DIRECTION STATED IN NOTE 1.

MOORING NOTES:

1. PASSING VESSEL EFFECTS ARE CONSIDERED IN THE MOORING ANALYSIS.
2. MAXIMUM ALLOWED:
   SURGE : +/- 10 FT.
   SWAY : +/- 2.0 FT.
3. STOP OPERATIONS IF A PASSING VESSEL WITH LOA > 250 FT IS WITHIN 300 FT.
4. DO NOT EXCEED ONE LINE PER HOOK.

MOORING LINE DESCRIPTION :

MINIMUM NO. OF LINES	8
NO. OF HEAD LINES	0
NO. OF AFT LINES	0
NO. OF BREAST LINES	2 FORWARD, 2 AFT
NO. OF SPRING LINES	2 FORWARD, 2 AFT

MINIMUM BREAKING LOAD, MBL: 165 KIPS

ACTUAL LINE LOADS NOT TO EXCEED __% OF MBL

REV. NO. & DATE

FIGURE 31F-2-1

TABLE 31F-2-9
POST-EVENT RATINGS AND REMEDIAL ACTIONS [2.2]

RATING	SUMMARY OF DAMAGE	REMEDIAL ACTIONS
A	*No significant event-induced damage observed.*	*No further action required. The berthing system may continue operations.*
B	*Minor to moderate event-induced damage observed but all primary structural elements and electrical/mechanical systems are sound.*	*Repairs or mitigation may be required to remain operational. The berthing system may continue operations.*
C	*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.*	*Repairs or mitigation may be necessary to resume or remain operational. The berthing system may be allowed to resume limited operations.*
D	*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.*	*The berthing system may not resume operations until the deficiencies are corrected.*

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 ma/or 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-4-1 and 31F-4-2) are dependent on the spill classification obtained from Table 31F-1-1.*

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).*

For Site Classes A through E (Section 3103F.4.2.1), peak ground and design spectral accelerations may be obtained from:

1. *U.S. Geological Survey (USGS) published data as discussed in Section 3103F.4.2.2, or*
2. *A site-specific probabilistic seismic hazard analysis (PSHA) as discussed in Section 3103F.4.2.3.*

Site-specific PSHA is required for Site Class F.

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-4-1. 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.4) 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:*

A, B, C, D, E and F

For Site Class 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 directly from the US Seismic Design Maps tool available at the USGS website (http://earthquake.usgs.gov/designmaps/us/application.php) for the site condition(s) appropriate for the MOT site and the selected probability of exceedance. For this purpose, select the "2013 ASCE 41" as the design code reference document (based on 2008 USGS hazard data available), "Custom" under the Earthquake Hazard Level option, required Probability of Exceedance (in 50 years), and*

appropriate Site Soil Classification(s) for the MOT site. The USGS tool directly provides the peak ground and spectral accelerations for the selected hazard level and site condition(s).

The alternative method of obtaining earthquake ground motion parameters, from the most current USGS data for selected hazard level and site condition(s), is permitted. If needed, the data for appropriate probability of exceedance may be obtained using the procedure described in Chapter 1 of FEMA 356 [3.1], and corrected for the MOT site as discussed in Section 3103F.4.2.4 or Section 3103F.4.2.5.

3103F.4.2.3 Earthquake motions from site-specific probabilistic seismic hazard analyses. *Site-specific Probabilistic Seismic Hazard Analysis (PSHA) shall use appropriate seismic sources and their characterization, attenuation relationships, probability of exceedance, and site soil conditions. Site-specific PSHA shall be conducted by a qualified California registered civil engineer with a California authorization as a geotechnical engineer per Section 3102F.3.4.8.*

If site-specific PSHA is used for Site Classes A, B, C, D or E, results from the site-specific PSHA shall be compared with those from the USGS published data as described in Section 3103F.4.2.2. If the two sets of values differ significantly, a justification for using the characterization chosen shall be provided. If DPGA and DSA from site-specific PSHA are less than 80 percent of the values from USGS data, a peer review may be required.

3103F.4.2.4 Simplified evaluation of site amplification effects. *When the MOT site class is different from the Site Classes B to 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 from Chapter 1 of FEMA 356 [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 Site Classes B and C boundary.

1. *Calculate the spectral acceleration values at 0.20 and 1.0 second period:*

$$S_{XS} = F_a S_S \quad (3\text{-}1)$$

$$S_{X1} = F_v S_1 \quad (3\text{-}2)$$

where:

F_a = *site coefficient obtained from Table 31F-3-3*

F_v = *site coefficient obtained from Table 31F-3-4*

S_S = *short period (usually at 0.20 seconds) spectral acceleration value (for the boundary of Site Classes B and 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 Site Classes B and C) at 1.0 second period*

S_{XS}= *spectral acceleration value obtained using the short period S_s and factored by Table 31F-3-3 for the site class under consideration.*

S_{X1}= *spectral acceleration value obtained using the 1.0 second period S_1 and factored by Table 31F-3-4 for the site class under consideration.*

2. *Set* $PGA_X = 0.4S_{XS}$ *(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_{X1} 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 $0 < T < 0.2T_0$

$$S_a = (S_{XS})(0.4 + 3T/T_0) \quad (3\text{-}4)$$

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 $0.2T_0 < T < T_0$

$$S_a = S_{XS} \quad (3\text{-}5)$$

for $T > T_0$

$$S_a = S_{X1}/T \quad (3\text{-}6)$$

where:

$$T_0 = S_{X1}/S_{XS} \quad (3\text{-}7)$$

The resulting PGA_X is the DPGA. However, the S_a shall be modified for near-fault directivity effects, per Section 3103F.4.2.6 to obtain the final DSAs.

TABLE 31F-3-3
VALUES OF F_a

SITE CLASS	S_s				
	< 0.25	0.5	0.75	1.0	> 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: Linear interpolation can he used to estimate values of F_a for intermediate values of S_S.

* Site-specific dynamic site response analysis shall be performed.

TABLE 31F-3-4
VALUES OF F_v

SITE CLASS	S_1				
	< 0.1	0.2	0.3	0.4	> 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: Linear interpolation can he 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 Site Class 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 [3.2] 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.

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.*

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 well established procedures such as that described in Somerville, et al. [3.3]. 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 2/3 (see Section 1.6 of FEMA 356 [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.4) 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 Chapter 1 of FEMA 356 [3.1], and is denoted as DSA_d. The following procedure does not include near-fault directivity effects.*

For $0 < T < 0.2\ T_0$

$$DSA_d = S_{XS}[(5/B_S - 2)\ T/T_0 + 0.4] \quad (3\text{-}8)$$

For $0.2\ T_0 < T < T_0$

$$DSA_d = DSA/B_S \quad (3\text{-}9)$$

For $T > T_0$

$$DSA_d = S_1/(B_1\ T) \quad (3\text{-}10)$$

where:

T = *period*

$T_0 = S_{X1}/S_{XS}$

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-3-5.

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-3-5
VALUES OF B_S AND B_1 [3.1]

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) [3.4].

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) [3.4].

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 29 of ASCE/SEI 7 [3.5]). 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:

$$V_w = V_h\left(\frac{33}{h}\right)^{1/7} \qquad (3\text{-}11)$$

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:

$$V_{t=30\,sec} = \frac{V_t}{c_t} \qquad (3\text{-}12)$$

where:

$V_{t=30\,sec}$ = *wind speed for a 30-second duration*

V_t = *wind speed over a given duration*

c_t = *conversion factor from Figure 31F-3-1*

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 [3.6]:

$$V_w = 1.10\,V_L \qquad (3\text{-}13)$$

where:

V_w = *over water wind speed*

V_L = *over land wind speed*

3103F.5.2.3 Static wind loads on vessels. *The OCIMF MEG3 [3.7] 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. [3.8].

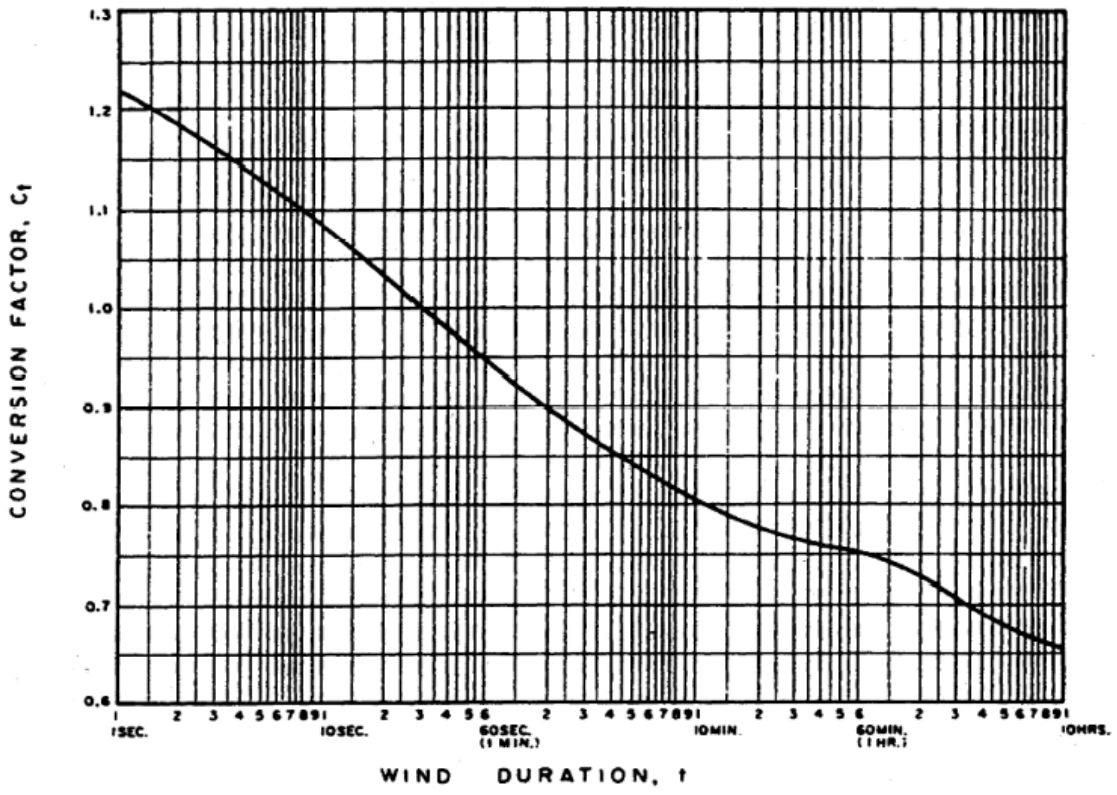


FIGURE 31F-3-1 WIND SPEED CONVERSION FACTOR [3.6]

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 [3.9] 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:*

$$V_c^2 = (1/T)\int_o^t (v_c)^2\, ds \qquad (3\text{-}14)$$

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 shall be adjusted by the factors provided in Figure 31F-3-2 to obtain the equivalent average velocity over the draft of the vessel.

3103F.5.3.3 Static current loads. *The OCIMF MEG3 [3.7] or the UFC 4-159-03 [3.10] 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.*

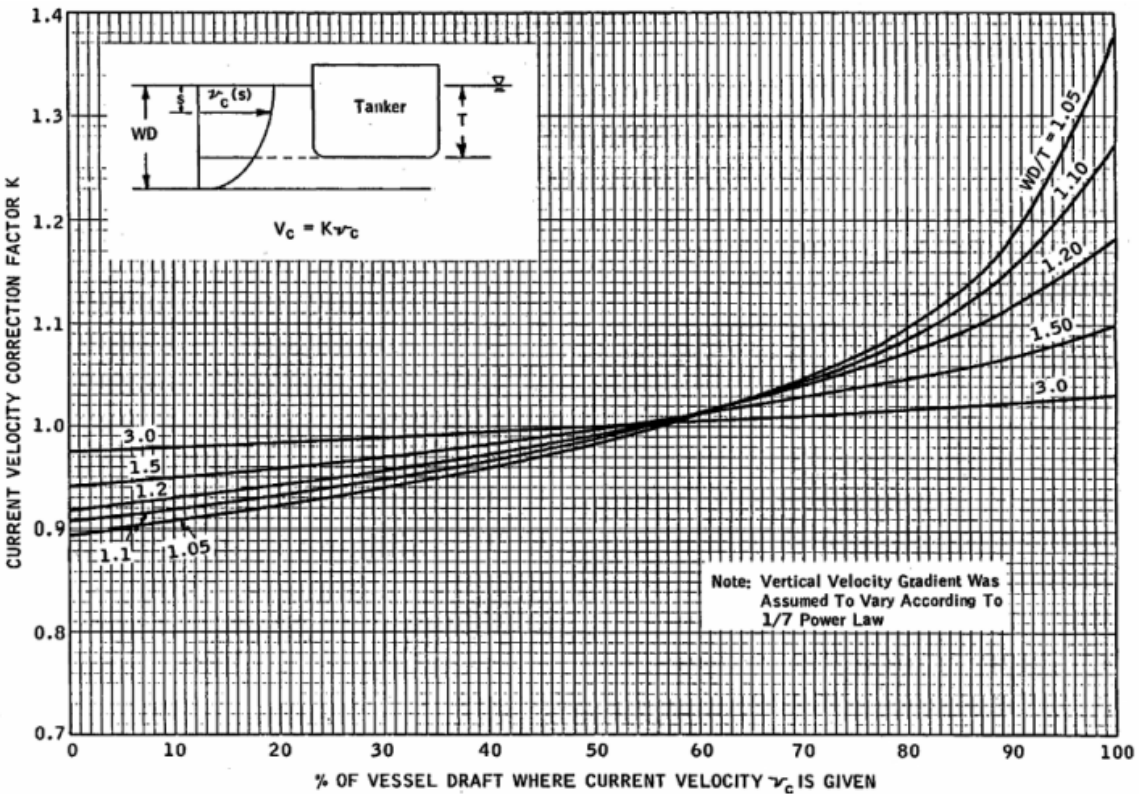


FIGURE 31F-3-2 CURRENT VELOCITY CORRECTION FACTOR (p. 23 [3.7])

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 [3.11] 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.

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 [3.12] or Wang [3.13] may be used to determine forces on a moored vessel. Kriebel's recent wave tank study improves on an earlier work of Seelig [3.14].

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 allowing the vessels to 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 these recent studies focused on near field tsunamis with predicted return periods of 5,000 to 10,000 years [3.15]. 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. [3.16].

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 [3.17]. Table 31F-3-6 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 [3.17].

Loads from tsunami-induced waves can be calculated for various structural configurations [3.18]. Tsunami wave heights in shallow water and particle kinematics can also be obtained. Other structural considerations include uplift and debris impact.

TABLE 31F-3-6
TSUNAMI RUN-UP VALUES (ft) AND CURRENT SPEEDS (ft/sec) IN THE SAN FRANCISCO BAY AREA (AFTER [3.17])

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 [3.19] and PIANC [3.20].*

Kinetic energy shall be calculated from the following equation:

$$E_{vessel} = \frac{1}{2} \cdot \frac{W}{g} \cdot V_n^2 \qquad (3\text{-}15)$$

where:

E_{vessel} = *Berthing energy of vessel [ft-lbs]*

W = *Total weight of vessel and cargo in pounds [long tons H 2240]*

g = *Acceleration due to gravity [32.2 ft/sec^2]*

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:

$$E_{fender} = F_A \cdot C_b \cdot C_m \cdot E_{vessel} \qquad (3\text{-}16)$$

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 Section 5-1.5.3 of UFC 4-152-01 [3.19] or PIANC Section 4.2.8 [3.20].*

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:

$$C_b = C_e \cdot C_g \cdot C_d \cdot C_c \qquad (3\text{-}17)$$

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 [3.21]:

$$DT = 1.25\ DWT(d_{actual}/d_{max}) \qquad (3\text{-}18)$$

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.

For fender system selection, Section 3105F.4.5 shall be followed.

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:*

$$C_e = \frac{k^2}{a^2 + k^2} \qquad (3\text{-}19)$$

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, Cg, 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 [3.19].*

3103F.6.4 Deformation coefficient (C_d). *This accounts for the energy reduction effects due to local deformation of the ships 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 berth 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 [3.19].

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:

$$C_m = 1 + 2 \cdot \frac{d_{actual}}{B} \qquad (3\text{-}20)$$

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 [3.19].

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-3-7. Site condition is determined from Table 31F-3-8.

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.

TABLE 31F-3-7
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-3-8
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

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-3-9.

TABLE 31F-3-9
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.*

3103F.7.2 Wind loads. *Chapter 29 of ASCE/SEI 7[3.5] shall be used to establish minimum wind loads on the structure. Additional information about wind loads may be obtained from Simiu and Scanlan [3.22].*

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-3-10 or Table 31F-3-11, depending on component type. For additional load combinations, see UFC 4-152-01 [3.19].*

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). *Typically, the live load on MOTs is small and may be neglected for combinations including earthquake loads. However, in some cases, a higher value of live load may be warranted depending on MOT use, and an appropriate value of live load shall be considered 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 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.*

TABLE 31F-3-10
LRFD LOAD FACTORS FOR LOAD COMBINATIONS [3.19]

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-3-11
SERVICE OR ASD LOAD FACTORS FOR LOAD COMBINATIONS [3.19]

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	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[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/SEI 7 [3.5]

3103F.9 Safety factors for mooring lines. *Safety factors for different material types of mooring lines are given in Table 31F-3-12. 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 hardware shall be clearly marked with their safe working loads (or allowable working loads) [3.7]. The certificate issued by the manufacturer normally defines the safe working loads of this hardware.*

TABLE 31F-3-12
SAFETY FACTORS FOR ROPES [3.7]

Steel Wire Rope	1.82
Polyamide	2.22
Other Synthetic	2.00
Polyamide Tail for Wire Mooring Lines	2.50
Other Synthetic Tail for Wire Mooring Lines	2.28
Polyamide Tail for Synthetic Mooring Lines	2.75
Other Synthetic Tail for Synthetic Mooring Lines	2.50
Joining Shackles	2.00

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:

$$F_d = 1.2 \times MBL \times [1 + 0.75\,(n-1)] \qquad (3\text{-}21)$$

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-3-13 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-3-13
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 of UFC 4-159-03 [3.10]

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]*

A = *Site Class A as defined in Table 31F-6-1*

B = *Beam of vessel*

B = *Site Class B as defined in Table 31F-6-1*

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 visous damping.*

C = *Site Class C as defined in Table 31F-6-1*

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*

D = *Site Class D as defined in Table 31F-6-1*

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 = *Site Class E as defined in Table 31F-6-1*

E_{fender} = *Energy to be absorbed by the fender system*

E_{vessel} = *Berthing energy of vessel [ft-lbs]*

F = *Site Class F as defined in Table 31F-6-1*

F_a, F_v = *Site coefficients from Tables 31F-3-3 and 31F-3-4, respectively*

F_A = *Accidental factor accounting for abnormal conditions*

g = *Acceleration due to gravity [32.2 ft/sec^2]*

h = *Elevation above water surface [feet]*

k = *Radius of longitudinal gyration of the vessel [ft]*

K = *Current velocity correction factor (Fig 31F-3-2)*

PGA_X = *Peak ground acceleration corresponding to the site class under consideration.*

s = *Water depth measured from the surface*

S_a = *Spectral acceleration*

S_1 = *Spectral acceleration value (for the boundary of Site Classes B and C) at 1.0 second*

S_S = *Spectral acceleration value (for the boundary of Site Classes B and C) at 0.2 seconds*

S_{X1} = *Spectral acceleration value at 1.0 second corresponding to the period of S_1 and the site class under consideration*

S_{XS} = *Spectral acceleration value at 0.2 seconds corresponding to the period of S_S and the site class under consideration*

T = *Draft of vessel (see Figure 31F-3-2)*

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 33-foot (10 m) elevation [knots]*

W = *Total weight of vessel and cargo inpounds [displacement tonnage × 2240]*

WD = *Water Depth (Figure 31F-3-2)*

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Authority: Sections 8750 through 8760, 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 Configuration classification. *Each MOT shall be designated as regular or irregular based on torsional irregularity criteria presented in ASCE/SEI 7 [4.1]. An MOT is defined to be irregular when maximum displacement at one end of the MOT transverse to an axis is more than 1.2 times the average of the displacement at the two ends of the MOT as described in Figure 31F-4-1. For MOTs with multiple segments separated by expansion joints, each segment shall be designated as regular or irregular using criteria in this section. 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 a MOT is divided into seismically isolated sections, an evaluation of the relative movement of pipelines and supports shall be considered, including phase differences (Section 3109F.3).

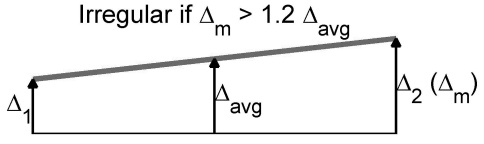

FIGURE 31F-4-1
DEFINITION OF IRREGULAR MOT

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 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-4-1. For this purpose, the displacement capacity of each element of the structure shall be checked against its displacement demand including the orthogonal effects of Section 3104F.4.2. The required analytical procedures are summarized in Table 31F-4-2.*

The displacement capacity of the structure shall be calculated using the nonlinear static (pushover) procedure. For the nonlinear static (pushover) procedure, the pushover load shall be applied at the target node defined as the center of mass (CM) of the MOT structure. It is also acceptable to use a nonlinear dynamic procedure for capacity evaluation, subject to peer review in accordance with Section 3101F.8.2.

Methods used to calculate the displacement demand are linear modal, nonlinear static and nonlinear dynamic.

Mass to be included in the displacement demand calculation shall include mass from self-weight of the structure, weight of the permanent equipment, and portion of the live load that may contribute to inertial mass during earthquake loading, such as a minimum of 25% of the floor live load in areas used for storage.

Any rational method, subject to the Division's approval, can be used in lieu of the required analytical procedures shown in Table 31F-4-2.

3104F.2.3.1 Nonlinear static capacity procedure (pushover). *To assess displacement capacity, 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 used in the pushover analysis.*

TABLE 31F-4-1
SEISMIC PERFORMANCE CRITERIA[1, 2]

SPILL CLASSIFICATION[3]	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

1. For new MOTs, see Section 3104F.3.
2. For marine terminals transferring LNG, return periods of 72 and 475 years shall be used for Levels 1 and 2, respectively.
3. See Section 3101F.6 for spill classification.

TABLE 31F-4-2
MINIMUM REQUIRED ANALYTICAL PROCEDURES

SPILL CLASSIFICATION[1]	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[2]	Nonlinear Static
Low	Regular/Irregular	Concrete/Steel	Nonlinear Static	Nonlinear Static
High/Medium/Low	Regular/Irregular	Timber	Nonlinear Static	Nonlinear Static

1. See Section 3101F.6 for spill classification.
2. Linear modal demand procedure may be required for cases where more than one mode is expected to contribute to the displacement demand.

Alternatively, displacement capacity of a pile in the MOT structure may be estimated from pushover analysis of an individual pile with appropriate axial load and pile-to-deck connection.

The displacement capacity of a pile from the pushover analysis shall be defined as the displacement that can occur at the top of the pile without exceeding plastic rotation (or material strain) limits, either at the pile-deck hinge or in-ground hinge, as defined in Section 3107F. If pile displacement has components along two axes, as may be the case for irregular MOTs, the pile displacement capacity shall be defined as the resultant of its displacement components along the two axes.

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. The effects of connection flexibility shall be considered in pile-to-deck connection modeling. For prestressed concrete piles, Figure 31F-4-2 may be used. 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.

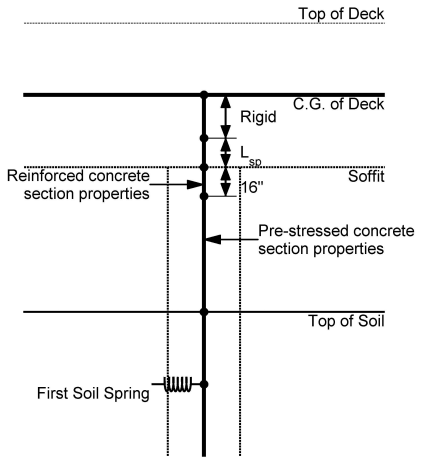

FIGURE 31F-4-2
PILE-DECK CONNECTION MODELING FOR PRESTRESSED CONCRETE PILE (ADAPTED FROM [4.2])

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-4-3. 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.

A series of single pile analyses may be sufficient to establish the nonlinear springs required for the pushover analysis.

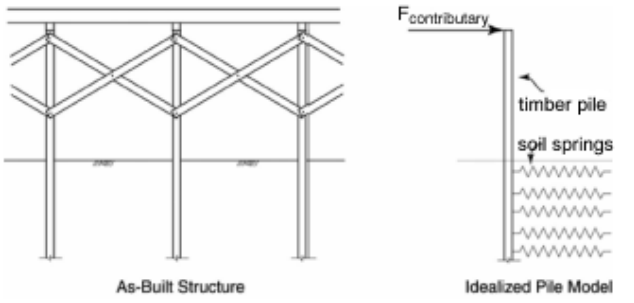

FIGURE 31F-4-3
SIMPLIFIED SINGLE PILE MODEL OF A TIMBER PILE SUPPORTED STRUCTURE

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 spill classifications. A linear modal procedure is required for irregular structures with high or moderate spill classifications, and may be used for all other classifications in lieu of the nonlinear static procedure.*

In the nonlinear static demand procedure, deformation demand in each element shall be computed at the target node displacement demand. The analysis shall be conducted in each of the two orthogonal directions and results combined as described in Section 3104F.4.2.

The target displacement demand of the structure, Δ_d, shall be calculated by multiplying the spectral response acceleration, S_A, corresponding to the effective elastic structural period, T_e (see Equation (4-2) or Equation (4-8)), by $T_e^2/4\pi^2$. $\Delta_d = S_A(T_e^2/4\pi^2)$. If $T_e < T_0$, where T_0 is the period corresponding to the peak of the acceleration response spectrum, a refined analysis (see Section 3104F.2.3.2.1 or 3104F.2.3.2.2) shall be used to calculate the displacement demand. In the refined analysis, the target node displacement demand may be computed from the Coefficient Method of ASCE/SEI 41 [4.3] that is based on the procedure presented in FEMA 440 [4.6], or the Substitute Structure Method presented in Priestley et al. [4.4]. Both of these methods utilize the pushover curve developed in Section 3104F.2.3.1.

3104F.2.3.2.1 Coefficient Method. *The Coefficient Method is based on the ASCE/SEI 41 [4.3] procedure.*

The first step in the Coefficient Method requires idealization of the pushover curve to calculate the effective elastic lateral stiffness, k_e, and effective yield strength, F_y, of the structure as shown in Figure 31F-4-4.

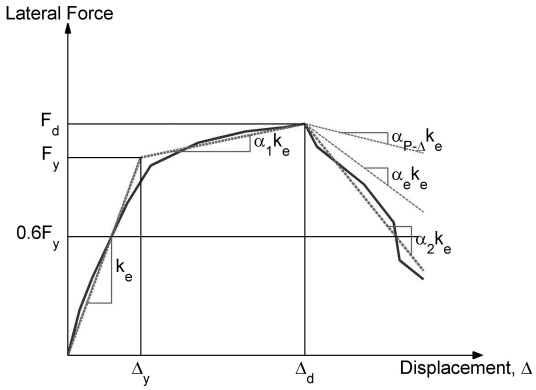

FIGURE 31F-4-4
IDEALIZATION OF PUSHOVER CURVE (ADAPTED FROM [4.3])

The first line segment of the idealized pushover curve shall begin at the origin and have a slope equal to the effective elastic lateral stiffness, k_e. The effective elastic lateral stiffness, k_e, shall be taken as the secant stiffness calculated at the lateral force equal to 60 percent of the effective yield strength, F_y, of the structure. The effective yield strength, F_y, shall not be taken as greater than the maximum lateral force at any point along the pushover curve.

The second line segment shall represent the positive post-yield slope ($\alpha_1 k_e$) determined by a point (F_d,Δ_d) and a point at the intersection with the first line segment such that the area above and below the actual curve area approximately balanced. (F_d,Δ_d) shall be a point on the actual pushover curve at the calculated target displacement, or at the displacement corresponding to the maximum lateral force, whichever is smaller.

The third line segment shall represent the negative post-yield slope ($\alpha_2 k_e$), determined by the point at the end of the positive post-yield slope (F_d,Δ_d) and the point at which the lateral force degrades to 60 percent of the effective yield strength.

The target displacement shall be calculated from:

$$\Delta_d = C_1 C_2 S_A \frac{T_e^2}{4\pi^2} \qquad (4\text{-}1)$$

where:

S_A = *spectral acceleration of the linear-elastic system at vibration period, which is computed from:*

$$T_e = 2\pi\sqrt{\frac{m}{k_e}} \qquad (4\text{-}2)$$

where:

m = *seismic mass as defined in Section 3104F.2.3*

k_e = *effective elastic lateral stiffness from idealized pushover*

C_1 = *modification factor to relate maximum inelastic displacement to displacement calculated for linear elastic response. For period less than 0.2 s, C_1 need not be taken greater than the value at T_e = 0.2 s. For period greater than 1.0 s, C_1 = 1.0. For all other periods:*

$$C_1 = 1 + \frac{\mu_{strength} - 1}{\alpha T_e^2} \qquad (4\text{-}3)$$

where:

α = *Site class factor*

= *130 for Site Class A or B,*

= *90 for Site Class C, and*

= *60 for Site Class D, E, or F.*

$\mu_{strength}$ = *ratio of elastic strength demand to yield strength coefficient calculated in accordance with Equation (4-5). The Coefficient Method is not applicable where $\mu_{strength}$ exceeds μ_{max} computed from Equation (4-6).*

C_2 = *modification factor to represent the effects of pinched hysteresis shape, cyclic stiffness degradation, and strength deterioration on the maximum displacement response. For periods greater than 0.7s, C_2 = 1.0. For all other periods:*

$$C_2 = 1 + \frac{1}{800}\left(\frac{\mu_{strength} - 1}{T_e}\right)^2 \qquad (4\text{-}4)$$

The strength ratio $\mu_{strength}$ shall be computed from:

$$\mu_{strength} = \frac{mS_A}{F_y} \qquad (4\text{-}5)$$

where:

F_y = *yield strength of the structure in the direction under consideration from the idealized pushover curve.*

For structures with negative post-yield stiffness, the maximum strength ratio μ_{max} shall be computed from:

$$\mu_{max} = \frac{\Delta_d}{\Delta_y} + \frac{|\alpha_e|^{-h}}{4} \qquad (4\text{-}6)$$

where:

Δ_d = *larger of target displacement or displacement corresponding to the maximum pushover force,*

Δ_y = *displacement at effective yield strength*

h = *1 + 0.15lnT_e, and*

α_e = *effective negative post-yield slope ratio which shall be computed from:*

$$\alpha_e = \alpha_{P\text{-}\Delta} + \lambda(\alpha_2 - \alpha_{P\text{-}\Delta}) \qquad (4\text{-}7)$$

where:

$\alpha_{P\text{-}\Delta}$, and the maximum negative post-elastic stiffness ratio, α_2, are estimated from the idealized force-deformation curve, and λ is a near-field effect factor equal to 0.8 for sites with 1 second spectral value, S_1 greater than or equal to 0.6g and equal to 0.2 for sites with 1 second spectral value, S_1 less than 0.6g.

3104F.2.3.2.2 Substitute Structure Method. *The Substitute Structure Method is based on the procedure presented in Priestley et al. [4.4] and is briefly summarized below.*

1. *Idealize the pushover curve from nonlinear pushover analysis, as described in Section 3104F.2.3.2.1, and estimate the yield force, F_y, and yield displacement, Δ_y.*
2. *Compute the effective elastic lateral stiffness, k_e, as the yield force, F_y, divided by the yield displacement, Δ_y.*
3. *Compute the structural period in the direction under consideration from:*

$$T_e = 2\pi\sqrt{\frac{m}{k_e}} \qquad (4\text{-}8)$$

where:

m = *seismic mass as defined in Section 3104F.2.3*

k_e = *effective elastic lateral stiffness in direction under consideration*

4. *Determine target displacement Δ_d, from:*

$$\Delta_d = S_A\frac{T_e^2}{4\pi^2} \qquad (4\text{-}9)$$

S_A = *spectral displacement corresponding to structural period, T_e*

5. *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-4-5 or Equation (4-10) may be used for concrete and steel piles connected to the deck through dowels embedded in the concrete.*

$$\xi_{eff} = 0.05 + \frac{1}{\pi}\left(1 - \frac{1-r}{\sqrt{\mu_\Delta}} - r\sqrt{\mu_\Delta}\right) \qquad (4\text{-}10)$$

where:

r = *ratio of second slope over elastic slope (see Figure 31F-4-7)*

Equation (4-10) for effective damping was developed by Kowalsky et al. [4.5] for the Takeda hysteresis model of system's force-displacement relationship.

6. *From the acceleration response spectra, create elastic displacement spectra, S_D, using Equation (4-11) for various levels of damping.*

$$S_D = \frac{T^2}{4\pi^2} S_A \qquad (4\text{-}11)$$

7. *Using the curve applicable to the effective structural damping, ξ_{eff}, find the effective period, T_d (see Figure 31F-4-6).*
8. *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.*
9. *The effective secant stiffness, k_{eff}, can then be found from:*

$$k_{eff} = \frac{4\pi^2}{T_d^2} m \qquad (4\text{-}12)$$

where:

m = *seismic mass as defined in Section 3104F.2.3*

T_d = *effective structural period*

10. *The required strength, F_u, can now be estimated by:*

$$F_u = k_{eff}\Delta_d \qquad (4\text{-}13)$$

11. *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_Δ.*
12. *Repeat the process until a satisfactory solution is obtained (see Figure 31F-4-7).*
13. *From pushover data, calculate the displacement components of an element along the two axis of the system.*

3104F.2.3.3 Linear modal demand procedure. *For irregular concrete/steel structures with moderate or high spill classifications, a linear modal 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, to compute*

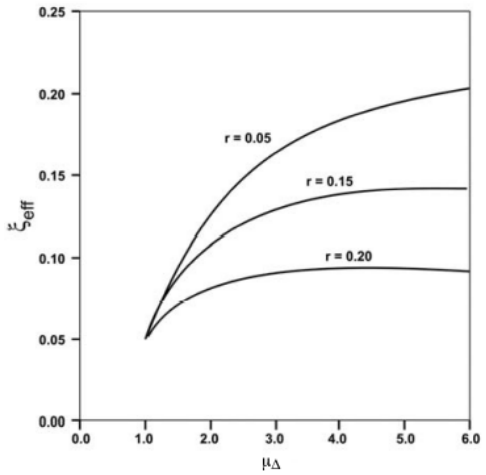

FIGURE 31F-4-5
RELATION BETWEEN DUCTILITY, μ_Δ, AND EFFECTIVE DAMPING, ξ_{eff} [4.5]

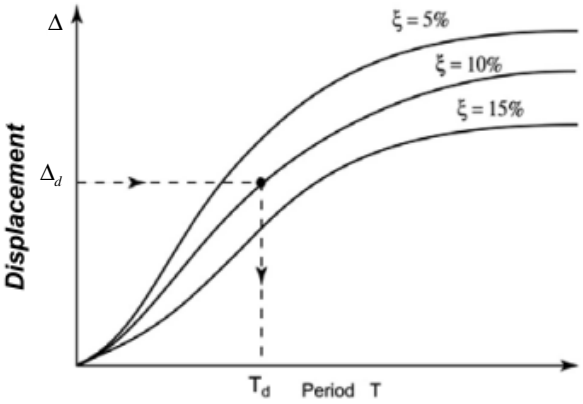

FIGURE 31F-4-6
DESIGN DISPLACEMENT RESPONSE SPECTRA

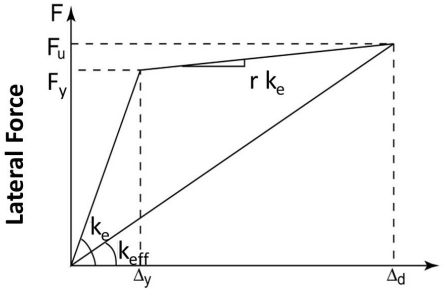

FIGURE 31F-4-7
EFFECTIVE LATERAL STIFFNESS (ADAPTED FROM [4.4])

displacement components of an element along each axis of the system.

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-4-8 (also see Section 3106F.9). 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 is $T < T_0$, where T_0 is the period corresponding to the peak of the acceleration response spectrum, the displacement demand from the linear modal analysis shall be amplified to account for nonlinear system behavior by an amplification factor. The amplification factor shall be equal to either $C_1 \times C_2$ per Section 3104F.2.3.2.1, or the ratio of the final target displacement and the initial elastic displacement of Equation (4-9) per Section 3104F.2.3.2.2.

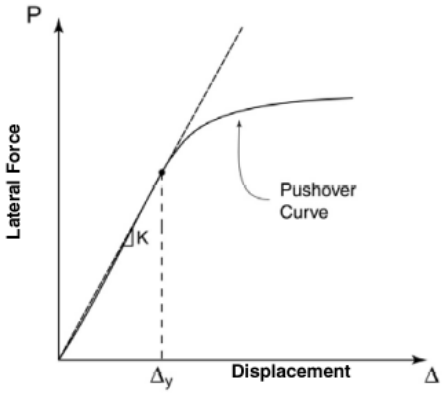

FIGURE 31F-4-8
STIFFNESS FOR LINEAR MODAL ANALYSIS

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.8.2). 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.8.2, peer review is required.*

3104F.3 New MOTs. *The analysis and design requirements described in Section 3104F.2 shall also apply to new MOTs. However, new MOTs shall comply with the seismic performance criteria for high spill classification, as defined in Table 31F-4-1. 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 seismic effects. *The design displacement demand at an element, δ_d, shall be calculated by combining the longitudinal, δ_x, and transverse, δ_y, displacements in the horizontal plane (Figure 31F-4-9):*

$$\delta_d = \sqrt{\delta_x^2 + \delta_y^2} \qquad (4\text{-}14)$$

where:

$$\delta_x = \delta_{xy} + 0.3\delta_{xx} \qquad (4\text{-}15)$$

and

$$\delta_y = 0.3\delta_{yx} + \delta_{yy} \qquad (4\text{-}16)$$

OR

$$\delta_y = \delta_{yx} + 0.3\delta_{yy} \qquad (4\text{-}17)$$

and

$$\delta_x = 0.3\delta_{xy} + \delta_{xx} \qquad (4\text{-}18)$$

whichever results in the greater design displacement demand.

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-4-10):*

$$\frac{V}{W} \geq 4\frac{\Delta_d}{H} \qquad (4\text{-}19)$$

where:

V = *base shear strength of the structure obtained from a plastic analysis*

W = *dead load of the frame*

Δ_d = *displacement demand*

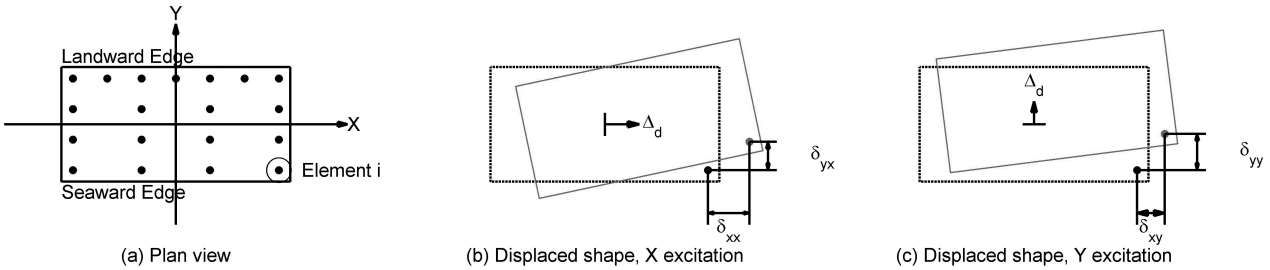

FIGURE 31F-4-9
PLAN VIEW OF WHARF SEGMENT UNDER X AND Y SEISMIC EXCITATIONS

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.

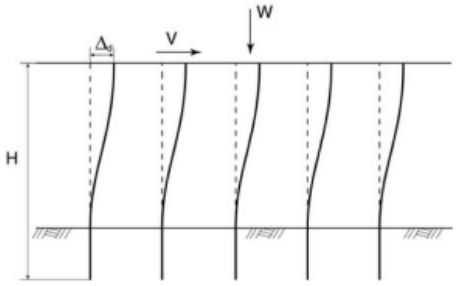

FIGURE 31F-4-10
P-Δ EFFECT

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 [4.7]) shall be calculated as follows:*

$$V_{sk} = 1.5(e/L_l)V_{\Delta T} \qquad (4\text{-}20)$$

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 Ferritto et al. [4.7]).*

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 [4.7].

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 assessment. *In general, for nonstructural components, the evaluation procedures of Section 3110F.8 apply.*

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.

3104F.6 Nonstructural critical systems assessment. *A seismic assessment of the survivability and continued operation during a Level 2 earthquake (see Table 31F-4-1) 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 CalARP [4.8].*

3104F.7 Symbols.

α = *Site class factor*

C_1 = *Modification factor to relate expected maximum inelastic displacement to displacement calculated for linear elastic response*

C_2 = *Modification factor to represent the effects of pinched hysteresis shape, cyclic stiffness degradation and strength deterioration on the maximum displacement response*

e = *Eccentricity between center of mass and center of rigidity*

F_u = *Required strength at maximum response*

F_y = *Effective yield strength*

H = *Distance from maximum in-ground moment to center of gravity of the deck*

k_e = *Effective elastic lateral stiffness*

k_{eff} = *Effective secant lateral stiffness*

L_1 = *Longitudinal length between wharf expansion joints*

m = *Seismic mass*

r = *Ratio of second slope over elastic slope*

S_A = *Spectral response acceleration at T*

S_D = *Displacement response spectrum at T*

S_1 = *1-second spectral response acceleration*

T = *Fundamental period of structure*

T_d = *Effective structural period*

T_e = *Effective elastic structural period*

V = *Base shear strength of the structure obtained from a plastic analysis*

V_{sk} = *Shear force across shear keys*

$V_{\Delta T}$ = *Total segment lateral force*

W = *Dead load of the frame*

α_1 = *Positive post-yield slope ratio equal to positive post-yield stiffness divided by the effective stiffness*

α_2 = *Negative post-yield slope ratio equal to negative post-yield stiffness divided by the effective stiffness*

α_e = *Effective negative post-yield slope ratio equal to effective post-yield negative stiffness divided by the effective stiffness*

$\alpha_{P\text{-}\Delta}$ = *Negative slope ratio caused by P-Δ effects*

Δ_{avg} = *Average of displacements, Δ_1 and Δ_2, at ends of the MOT transverse to an axis*

Δ_d = *Target displacement*

Δ_m = *Maximum of displacements, Δ_1 and Δ_2, at ends of the MOT transverse to an axis*

Δ_y = *Displacement at yield strength*

Δ_1, Δ_2 = *Displacement at ends of the MOT transverse to an axis*

δ_d = *Design displacement demand at an element*

δ_x = *Displacement of an element in X direction*

δ_y = *Displacement of an element in Y direction*

δ_{xx} = *X displacement under X direction excitation*

δ_{xy} = *X displacement under Y direction excitation*

δ_{yx} = *Y displacement under X direction excitation*

δ_{yy} = *Y displacement under Y direction excitation*

λ = *Near-field effect factor*

μ_{max} = *Maximum strength ratio*

$\mu_{strength}$ = *Ratio of elastic strength demand to yield strength*

μ_Δ = *Ductility level*

ξ_{eff} *or* ξ = *Effective structural damping*

3104F.8 References.

[4.1] American Society of Civil Engineers (ASCE), 2010, ASCE/SEI 7-10 (ASCE/SEI 7), "Minimum Design Loads for Buildings and Other Structures," Reston, VA.

[4.2] American Society of Civil Engineers (ASCE), 2014, ASCE/COPRI 61-14 (ASCE/COPRI 61), "Seismic Design of Piers and Wharves," Reston, VA.

[4.3] American Society of Civil Engineers (ASCE), 2014, ASCE/SEI 41-13 (ASCE/SEI 41), "Seismic Evaluation and Retrofit of Existing Buildings," Reston, VA.

[4.4] Priestley, M.J.N., Seible, F., Calvi, G.M., 1996, "Seismic Design and Retrofit of Bridges," John Wiley & Sons, Inc., New York.

[4.5] Kowalsky, M.J., Priestley, M.J.N, MacRae, G.A., 1994, "Displacement-Based Design – A Methodology for Seismic Design Applied to Single Degree of Freedom Reinforced Concrete Structures," Report No. SSRP – 94/16, University of California, San Diego.

[4.6] Federal Emergency Management Agency (FEMA), June 2005, FEMA 440, "Improvement of Nonlinear Static Seismic Analysis Procedures," Redwood City, CA.

[4.7] 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.

[4.8] CalARP Program Seismic Guidance Committee, December 2013, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.

Authority: Sections 8750 through 8760, 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.*

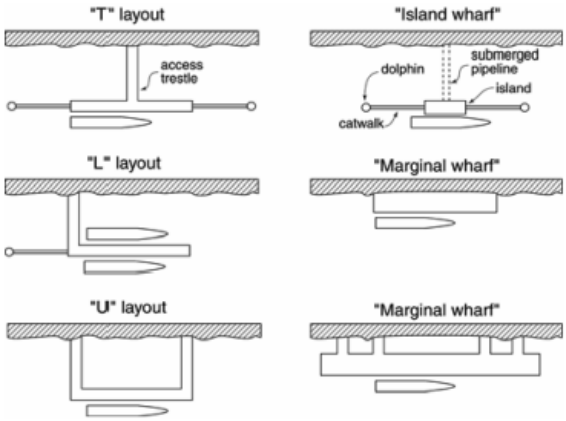

FIGURE 31F-5-1
TYPICAL PIER AND WHARF CONFIGURATIONS

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 325 [5.2] and ANSI/AWC 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 (MEG 3) [5.4] or UFC 4-159-03 [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)*
5. *The maximum allowable extension limits of the loading arms and/or hoses.*
6. *The maximum allowable compression/deflection of the fender system.*

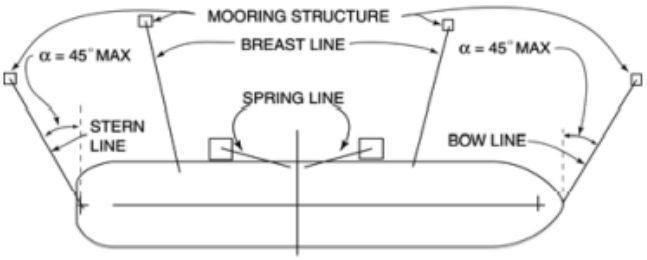

FIGURE 31F-5-2
HORIZONTAL LINE ANGLES [5.4]

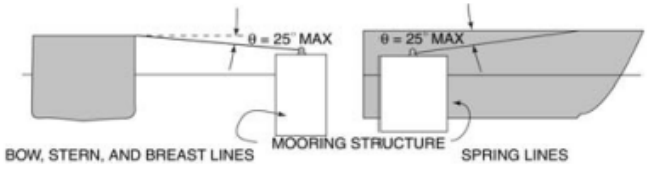

FIGURE 31F-5-3
VERTICAL LINE ANGLES [5.4]

3105F.2.1 Manual procedure. *Simplified calculations may be used to determine the mooring forces for barges with Favorable Site Conditions (see Table 31F-3-8) 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).*

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*
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 analysis (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:

$$V_{crit} = 1.5 + \frac{L - 2B}{500 - 2B}\ 4.5(knots) \qquad (5\text{-}1)$$

Exception: *If $L \le 2B$, 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.

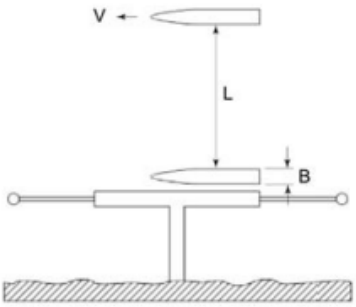

FIGURE 31F-5-4
PASSING VESSEL

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.5.5 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. Section 3103F.5.7 and Table 31F-3-6 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 325 [5.2], and ANSI/AWC 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 fenders 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.

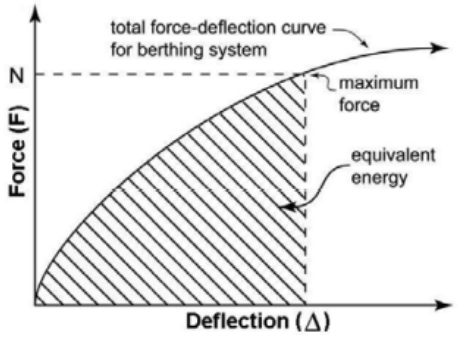

FIGURE 31F-5-5
BERTHING ENERGY CAPACITY

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 calculated using rational analysis considering curvature of the bow and 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:

$$F = \mu N \qquad (5\text{-}3)$$

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 UFC 4-152-01 [5.8] and PIANC [5.9]. Velocity and temperature factors, contact angle effects and manufacturing tolerances shall be considered (see Appendices A and B of PIANC [5.9]). Also, see Section 3103F.6.*

3105F.5 Layout of new MOTs. *Guidelines for layout of new MOTs are provided in OCIMF MEG3 [5.4]. 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.*

3105F.6 Offshore moorings. *Offshore MOT moorings shall be designed and analyzed considering the site water depth, metocean environment and class of vessels calling per OCIMF MEG3 [5.4] or UFC 4-152-01 [5.8].*

3105F.6.1 Mooring analyses. *Analysis procedures shall conform to the OCIMF MEG3 [5.4] or UFC 4-159-03 [5.5], and the following:*

1. *A mooring analysis shall be performed for the range of tanker classes and barges calling at each offshore berth.*
2. *Forces acting on moored vessels shall be determined according to Section 3103F.5 and analysis shall consider all possible vessel movements, contribution of buoys, sinkers, catenaries affecting mooring line stiffness and anchorages.*
3. *Correlation of winds, waves and currents shall be considered. The correlation may be estimated by probabilistic analysis of metocean data.*
4. *The actual expected displacement of the vessels shall be used in the analysis.*
5. *Underwater inspections and bathymetry shall be considered.*
6. *Both fully laden and ballast conditions shall be considered.*
7. *Dynamic analysis shall be used to evaluate moorings performance.*

3105F.6.2 Design of mooring components. *Design of mooring components shall be based on loading combinations and safety factors defined in Sections 3103F.8 through 3103F.10 and follow the guidelines provided in either the OCIMF MEG3 [5.4] or UFC 4-159-03 [5.5].*

3105F.7 Symbols.

α = *Horizontal mooring line angles*

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*

N = *Maximum horizontal berthing force*

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*

3105F.8 References.

[5.1] American Concrete Institute (ACI), 2014, ACI 318-14 (ACI 318), "Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)," Farmington Hills, MI.

[5.2] American Institute of Steel Construction, Inc. (AISC), 2011, AISC 325-11 (AISC 325), "Steel Construction Manual," 14th ed., Chicago, IL.

[5.3] American Wood Council (AWC), 2014, ANSI/AWC NDS-2015 (ANSI/AWC NDS), "National Design Specification (NDS) for Wood Construction," 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 (Revised 1 September 2012), Unified Facilities Criteria (UFC) 4-159-03, "Design: Moorings," Washington D.C.

[5.6] Department of Defense, 12 December 2001 (Revised 19 October 2010), Unified Facilities Criteria (UFC) 4-150-06, "Military Harbors and Coastal Facilities," Washington D.C

[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.

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Authority: Sections 8750 through 8760, 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 under static and seismic conditions.*

3106F.1.2 Applicability. *The requirements provided herein apply to all new and existing MOTs.*

3106F.1.3 Loading. *The loading for geotechnical hazard assessment and foundation analyses under static and seismic conditions is provided in Sections 3103F and 3104F.*

3106F.2 Site characterization. *Site characterization shall be based on site-specific geotechnical information. If existing information is used, the geotechnical engineer of record shall provide adequate justification.*

3106F.2.1 Site classes. *Each MOT shall be assigned at least one site class. Site Classes A, B, C, D, and E are defined in Table 31F-6-1, and Site Class F is defined by any of the following:*

1. *Soils vulnerable to significant potential loss of stiffness, strength, and/or volume under seismic loading due to liquefiable soils, quick and highly sensitive clays, and/or 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 the thickness of clay exceeds 25 feet.*
4. *Very thick soft/medium stiff clays with undrained shear strength less than 1,000 psf, where the thickness of clay exceeds 120 feet.*

3106F.2.2 Site-specific information.

1. *Site-specific investigations shall include adequate borings and/or cone penetration tests (CPTs) and other appropriate field methods, to enable the determination of geotechnical parameters.*
2. *Adequate coverage of subsurface data, both horizontally and vertically, shall be obtained to develop geotechnical parameters.*
3. *Exploration shall be deep enough to characterize subsurface materials that are affected by embankment behavior and shall extend to depth of at least 20 feet below the deepest foundation depth.*
4. *During field exploration, particular attention shall be given to the presence of continuous low-strength layers or thin soil layers that could liquefy or weaken during the design earthquake shaking.*
5. *CPTs provide continuous subsurface profile and shall be used to complement exploratory borings. When CPTs are performed, at least one boring shall be performed next to one of the CPT soundings to check that the CPT-soil behavior type interpretations are reasonable for the site. Any difference between CPT interpretation and subsurface condition obtained from borings shall be reconciled.*
6. *Quantitative site soil stratigraphy is required to a depth of 100 feet for assigning a site class (see Table 31F-6-1).*
7. *Laboratory tests may be necessary to supplement the borings and insitu field tests.*

3106F.3 Seismic loads for geotechnical evaluations. *Section 3103F.4 defines the earthquake loads to be used for structural and geotechnical evaluations in terms of design Peak Ground Accelerations (PGA), spectral accelerations and design earthquake magnitude. Values used for analyses are based on Probabilistic Seismic Hazard Analyses (PSHA) using two levels of seismic performance criteria (Section 3104F.2.1 and Table 31F-4-1).*

3106F.4 Liquefaction potential. *The liquefaction potential of the soils in the immediate vicinity of or beneath each MOT, and associated slopes, embankments or rock dikes shall be evaluated for the PGAs associated with seismic performance Levels 1 and 2. Liquefaction potential evaluation should fol-*

TABLE 31F-6-1
SITE CLASSES

SITE CLASS	SOIL PROFILE	AVERAGE VALUES FOR TOP 100 FEET OF SOIL PROFILE[3]		
		Shear Wave Velocity, V_S [ft/sec]	Standard Penetration Test, SPT [blows/ft]	Undrained Shear Strength, S_U [psf]
A	Hard Rock	> 5,000		
B	Rock	2,500 to 5,000		
C	Very Stiff/Very Dense Soil and Soft Rock	1,200 to 2,500	> 50	> 2,000
D	Soft/Dense Soil Profile	600 to 1,200	15 to 50	1,000 to 2,000
E[1, 2]	Soft/Loose Soil Profile	< 600	< 15	< 1,000
F	Defined in Section 3106F.2.1			

1. *Site Class 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).*
2. *The plasticity index, P1, and the moisture content shall be determined in accordance with ASTM D4318 [6.1] and ASTM D2216 [6.2], respectively.*
3. *Conversion of CPT data to estimate equivalent V_s, SPT blow count, or S_u is allowed.*

low the procedures outlined in NCEER report [6.3], SCEC [6.4] and CGS Special Publication 117A [6.5].

If liquefaction is shown to be initiated in the above evaluations, the particular liquefiable strata and their thicknesses shall be clearly shown on site profiles. Resulting hazards associated with liquefaction shall be addressed including translational or rotational deformations of slopes or embankment systems and post liquefaction settlement of slopes or embankment systems and underlying foundation soils, as noted below. If such analyses indicate the potential for partial or gross (flow) failure of a slope or embankment, adequate evaluations shall be performed to confirm such a condition exists, together with analyses to evaluate potential slope displacements (lateral spreads). In these situations and for projects where more detailed numerical analyses are performed, a peer review (see Section 3101F.8.2) may be required.

3106F.5 Slope or embankment stability and seismically induced lateral spreading. *Slope or embankment stability related to the MOT facility, shall be evaluated for static and seismic loading conditions.*

3106F.5.1 Static slope stability. *Static stability analysis using conventional limit equilibrium methods shall be performed for site related slope or embankment systems. Live load surcharge shall be considered in analyses based on project-specific information. The long-term static factor of safety of the slope or embankment shall not be less than 1.5.*

3106F.5.2 Pseudo-static seismic slope stability. *Pseudo-static seismic slope or embankment stability analyses shall be performed to estimate the horizontal yield acceleration for the slope for the Level 1 and Level 2 earthquakes. During the seismic event, appropriate live load surcharge shall be considered.*

If liquefaction and/or strength loss of the site soils is likely, the following shall be used in the analyses, as appropriate:

1. *Residual strength of liquefied soils*
2. *Strengths compatible with the pore-pressure generation of potentially liquefiable soils*
3. *Potential strength reduction of clays*

The residual strength of liquefied soils shall be estimated using guidelines outlined in SCEC [6.4] or other appropriate documents as noted in CGS Special Publication 117A [6.5].

Pseudo-static analysis shall be performed without considering the presence of the foundation system. Using a horizontal seismic coefficient of one-half of the PGA, if the estimated factor of safety is greater than or equal to 1.1, then no further evaluation of lateral spreading or kinematic loading from lateral spreading is required.

3106F.5.3 Post-earthquake static slope stability. *The static factor of safety immediately following a design earthquake event shall not be less than 1.1 when any of the following are used in static stability analysis:*

1. *Post-earthquake residual strength of liquefied soils*
2. *Strengths compatible with the pore-pressure generation of potentially liquefiable soils*
3. *Potential strength reduction of clays*

3106F.5.4 Lateral spreading – Free field. *The earthquake–induced lateral deformations of the slope or embankment and associated foundations soils shall be determined for the Level 1 and Level 2 earthquakes using the associated PGA at the ground surface (not modified for liquefaction). If liquefaction and/or strength loss of the site soils is likely, the following shall be used in the analyses, as appropriate:*

1. *Residual strength of liquefied soils*
2. *Strengths compatible with the pore-pressure generation of potentially liquefiable soils*
3. *Potential strength reduction of clays*

The presence of the foundation system shall not be included in the "free field" evaluations.

Initial lateral spread estimates shall be made using the Newmark displacement approach documented in NCHRP Report 611 [6.6] or other appropriate but similar procedures.

3106F.6 Seismically induced settlement. *Seismically induced settlement shall be evaluated. Based on guidelines outlined in SCEC [6.4] or other appropriate documents such as CGS Special Publication 117A [6.5]. If seismically induced settlement is anticipated, the resulting design impacts shall be considered, including the potential development of downdrag loads on piles.*

3106F.7 Earth pressures. *Both static and seismic earth pressures acting on MOT structures shall be evaluated.*

3106F.7.1 Earth pressures under static loading. *The effect of static active earth pressures on structures resulting from static loading of backfill soils shall be considered where appropriate. Backfill sloping configuration, if applicable, and backland loading conditions shall be considered in the evaluations. The loading considerations shall be based on project-specific information. The earth pressures under static loading should be based on guidelines outlined in NAVFAC DM7-02 [6.7] or other appropriate documents.*

3106F.7.2 Earth pressures under seismic loading. *The effect of earth pressures on structures resulting from seismic loading of backfill soils, including the effect of porewater pressure build-up in the backfill, shall be considered. The seismic coefficients used for this analysis shall be based on the Level 1 and Level 2 earthquake PGA values.*

Evaluation of earth pressures under seismic loading, should be based on NCHRP Report 611 [6.6] or other appropriate methods.

3106F.8 Pile axial behavior.

3106F.8.1 Axial pile capacity. *Axial geotechnical capacity of piles under static loading shall be evaluated using guidelines for estimating axial pile capacities provided in POLB WDC [6.8] or other appropriate documents. A min-*

imum factor of safety of 2.0 shall be achieved on the ultimate capacity of the pile using appropriate MOT loading.

If liquefaction or seismically-induced settlement is anticipated, the ultimate axial geotechnical capacity of piles under seismic conditions shall be evaluated for the effects of liquefaction and/or downdrag forces on the pile. The ultimate geotechnical capacity of the pile during liquefaction shall be determined on the basis of the residual strength of the soil for those layers where the factor of safety for liquefaction is determined to be less than 1.0.

When seismically-induced settlements are predicted to occur during design earthquakes, the downdrag loads shall be computed, and the combination of downdrag load and static load determined. Only the tip resistance of the pile and the side friction resistance below the lowest layer contributing to the downdrag shall be used in the capacity evaluation. The ultimate axial geotechnical capacity of the pile shall not be less than the combination of the seismically induced downdrag force and the maximum static load.

3106F.8.2 Axial springs for piles. *The geotechnical analyst (see Section 3102F.3.4.8) shall coordinate with the structural analyst (see Section 3102F.3.4.4) and develop axial springs (T-z) for piles. The T-z springs may be developed either at the top or at the tip of the pile (see Figure 31F-6-1). If the springs are developed at the pile tip, the tip shall include both the friction resistance along the pile (i.e., side springs [t-z]) and tip resistance at the pile tip (i.e. tip springs [q-w]), as illustrated in Figure 31F-6-1. If T-z springs are developed at the pile top, the appropriate elastic shortening of the pile shall be included in the springs. Linear or nonlinear springs may be developed if requested by the structural analyst.*

Due to the uncertainties associated with the development of axial springs, such as the axial soil capacities, load distributions along the piles and simplified spring stiffnesses, both upper-bound and lower-bound limits shall be estimated and utilized in the analyses.

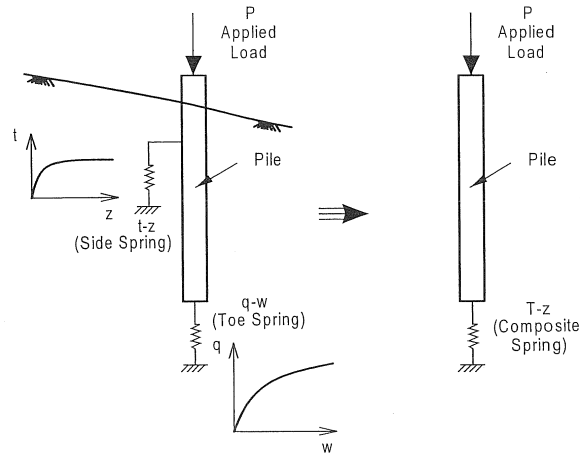

FIGURE 31F-6-1
AXIAL SOIL SPRINGS [6.8]

3106F.9 Soil springs for lateral pile loading. *For design of piles under loading associated with the inertial response of the superstructure, level-ground inelastic lateral springs (p-y) shall be developed. The lateral springs within the shallow portion of the piles (generally within 10 pile diameters below the ground surface) tend to dominate the inertial behavior. Geotechnical parameters for developing lateral soil springs shall follow guidelines provided in API RP 2A-WSD [6.9] or other appropriate documents.*

Due to uncertainties associated with the development of p-y curves for dike structures, upper-bound and lower-bound p-y springs shall be developed for use in superstructure inertial response analyses.

3106F.10 Soil-pile interaction. *Two separate loading conditions for the piles shall be considered:*

1. *Inertial loading under seismic conditions*
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 shall be designed such that the structural performance is acceptable when subjected to both inertial and kinematic loadings.

3106F.10.1 Inertial loading under seismic conditions. *The lateral soil springs shall be used in inertial loading response analyses. The evaluation of inertial loading can be performed by ignoring potential slope/embankment/dike system deformations (i.e., one end of the lateral soil spring at a given depth is attached to the corresponding pile node and the other end is assumed fixed).*

3106F.10.2 Kinematic loading from lateral spreading. *Kinematic pile loading from permanent lateral spread ground deformation in deep seated levels of slope/embankment/dike foundation soils shall be evaluated. The lateral deformations shall be restricted such that the structural performance of foundation piles is not compromised.*

The lateral deformation of the embankment or dike and associated piles and foundation soils shall be determined using analytical methods as follows:

1. *Initial estimates of free field lateral spread deformations (in the absence of piles) may be determined using the simplified Newmark sliding block method as described in Section 3106F.5.4. The geotechnical analyst shall provide the structural analyst with level-ground p-y curves for the weak soil layer controlling the lateral spread and soil layers above and below the weak layer. Appropriate overburden pressures shall be used in simplified pushover analyses, to estimate the pile displacement capacities and corresponding pile shear within the weak soil zone.*
2. *For the pushover analysis, the estimated displacements may be uniformly distributed within the thickness of the weak soil layer (i.e., zero at and below*

the bottom of the layer to the maximum value at and above the top of the weak layer), or as appropriate.

3. *For a simplified analysis (see Figure 31F-6-2), the pile shall be fixed against rotation and translation relative to the soil displacement at some distance above and below the weak soil layer. Between these two points, lateral soil springs are provided, which allow deformation of the pile relative to the deformed soil profile.*

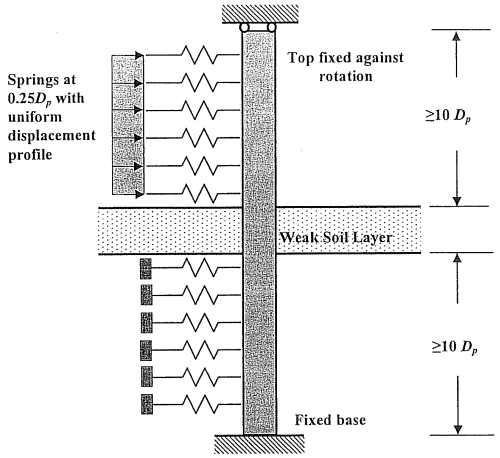

FIGURE 31F-6-2
SLIDING LAYER MODEL [6.8]

3106F.11 Soil-structure interaction – Shallow foundations and underground structures.

3106F.11.1 Shallow foundations. *Shallow foundations shall be assumed to move with the ground. Springs and dashpots may be evaluated as per Gazetas [6.10].*

3106F.11.2 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.12 Underwater seafloor pipelines. *Geotechnical evaluations of underwater pipelines shall include static stability of the seafloor ground supporting the pipeline and settlement and lateral deformation of the ground under earthquakes. If the pipeline is buried, the potential for uplift of the pipeline under earthquakes shall also be evaluated.*

3106F.13 Symbols.

A = *Site Class A as defined in Table 31F-6-1*

B = *Site Class B as defined in Table 31F-6-1*

C = *Site Class C as defined in Table 31F-6-1*

CPT = *Cone Penetration Test*

D = *Site Class D as defined in Table 31F-6-1*

D_p = *Pile diameter*

E = *Site Class E as defined in Table 31F-6-1*

F = *Site Class F as defined in Table 31F-6-1*

P = *Applied load*

PI = *Plasticity index*

p-y = *Lateral soil spring*

S_U = *Undrained shear strength*

SPT = *Standard Penetration Test*

t-z = *Axial soil spring along the side of pile*

T-z = *Composite axial soil spring at pile tip*

q-w = *Axial soil spring at pile tip*

V_S = *Shear wave velocity*

3106F.14 References.

[6.1] American Society for Testing and Materials (ASTM), 2014, ASTM D4318-10 (ASTM D4318), "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), 2014, ASTM D2216-10 (ASTM D2216), "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," West Conshohocken, PA.

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[6.4] 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.

[6.5] California Department of Conservation, California Geological Survey (CGS), 11 September 2008, "Guidelines for Evaluating and Mitigating Seismic Hazards in California," Special Publication 117A, Revised Release.

[6.6] National Cooperative Highway Research Program (NCHRP), 2008, "NCHRP Report 611: Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments," Washington, D.C.

[6.7] Naval Facilities Engineering Command (NAVFAC), 1986, NAVFAC DM7-02, "Foundation and Earth Structures," Alexandria, VA.

[6.8] Port of Long Beach (POLB), 2012 February 29, "Wharf Design Criteria (WDC)," Version 3.0, Long Beach, CA.

[6.9] American Petroleum Institute (API), November 2014, API Recommended Practice 2A-WSD (API RP 2A-WSD), "Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design," 22nd ed., Washington, D.C.

[6.10] Gazetas, G., September 1991, "Formulas and Charts for Impedances of Surface and Embedded Foundations," Journal of Geotechnical Engineering, ASCE, Vol. 117, No. 9.

Authority: Sections 8750 through 8760, 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 non-ductile components (shear controlled), all mechanical, electrical and mooring equipment (attachments to the deck) and for all non seismic load combinations:

$$f'_c = 1.0 f'_c \quad (7\text{-}1a)$$
$$f_y = 1.0 f_y \quad (7\text{-}1b)$$
$$f_p = 1.0 f_p \quad (7\text{-}1c)$$

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:

$$f'_c = 1.3 f'_c \quad (7\text{-}2a)$$
$$f_y = 1.1 f_y \quad (7\text{-}2b)$$
$$f_p = 1.0 f_p \quad (7\text{-}2c)$$

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:

$$f'_c = 1.7 f'_c \quad (7\text{-}3a)$$
$$f_y = 1.3 f_y \quad (7\text{-}3b)$$
$$f_p = 1.1 f_p \quad (7\text{-}3c)$$

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.*

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]).

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] 33	INTERMEDIATE[1] 40	HARD[1] 50	60	70	75
			Minimum Yield[2] (psi)	33,000	40,000	50,000	60,000	70,000	75,000
			Minimum Tensile[2] (psi)	55,000	70,000	80,000	90,000	95,000	100,000
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		
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. *Untilabout 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."*

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.*

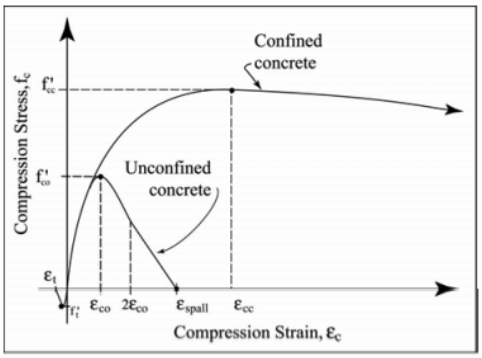

FIGURE 31F-7-1
STRESS-STRAIN CURVES FOR CONFINED

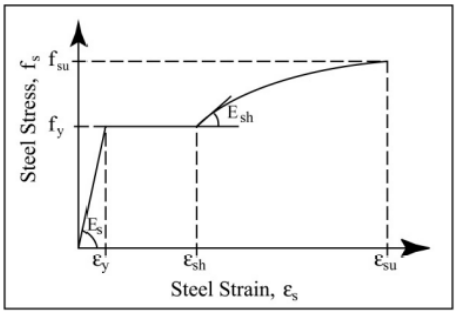

FIGURE 31F-7-2
STRESS-STRAIN CURVE FOR MILD REINFORCING STEEL OR STRUCTURAL STEEL [7.1]

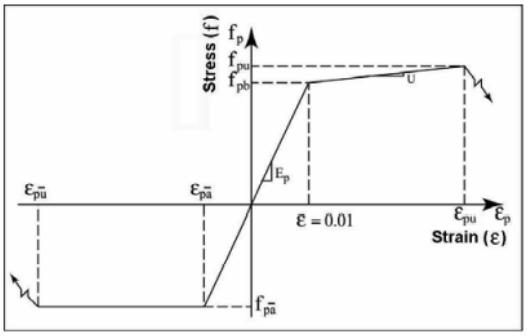

FIGURE 31F-7-3
STRESS-STRAIN CURVE FOR PRESTRESSED STEEL [7.4]

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:*

$$e/h \le 0.10 \qquad (7\text{-}4)$$

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) for reinforced concrete piles, when the plastic hinge forms against a supporting member is:

$$L_p = 0.08L + 0.15 f_{ye} d_b \ge 0.3 f_{ye} d_b \qquad (7\text{-}5)$$

where:

L = *distance from the critical section of the plastic hinge to the point of contraflexure*

d_b = *diameter of the longitudinal reinforcement or dowel, whichever is used to develop the connection*

f_{ye} = *design yield strength of longitudinal reinforcement or dowel, whichever is used to develop the connection (ksi)*

If a large reduction in moment capacity occurs due to spalling, then the plastic hinge length shall be:

$$L_p = 0.3 f_{ye} d_b \qquad (7\text{-}6)$$

The plastic hinge length, L_p (above ground), for prestressed concrete piles may also be computed from Table 31F-7-4 for permitted pile-to-deck connections as described in ASCE/COPRI 61 [7.5].

When the plastic hinge forms in-ground, the plastic hinge length may be determined using Equation (7-7) [7.5]:

$$L_p = 2D \qquad (7\text{-}7)$$

where:

D = *pile diameter or least cross-sectional dimension*

TABLE 31F-7-4
PLASTIC HINGE LENGTH FOR PRESTRESSED CONCRETE PILES [7.5]

CONNECTION TYPE	L_p AT DECK (in.)
Pile Buildup	$0.15 f_{ye} d_b \le L_p \le 0.30 f_{ye} d_b$
Extended Strand	$0.20 f_{pye} d_{st}$
Embedded Pile	$0.5D$
Dowelled	$0.25 f_{ye} d_b$
Hollow Dowelled	$0.20 f_{ye} d_b$
External Confinement	$0.30 f_{ye} d_b$
Isolated Interface	$0.25 f_{ye} d_b$

d_b = *diameter of the prestressing strand or dowel, whichever is used to develop the connection (in.)*
f_{ye} = *design yield strength of prestressing strand or dowel, as appropriate (ksi)*
D = *pile diameter or least cross-sectional dimension*
d_{st} = *diameter of the prestressing strand (in.)*
f_{pye} = *design yield strength of prestressing strand (ksi)*

3107F.2.5.4 Plastic rotation. *The plastic rotation is:*

$$\theta_p = L_p \phi_p = L_p (\phi_m - \phi_y) \qquad (7\text{-}8)$$

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:

$$\phi_m = \frac{\varepsilon_{cm}}{c_u} \qquad (7\text{-}9)$$

where:

ε_{cm} = *maximum limiting compression strain for the prescribed performance level (Table 31F-7-5)*

c_u = *neutral-axis depth, at ultimate strength of section*

TABLE 31F-7-5
LIMITS OF STRAIN

COMPONENT STRAIN	LEVEL 1	LEVEL 2
MCCS Pile/deck hinge	$\varepsilon_c \le 0.004$	$\varepsilon_c \le 0.025$
MCCS In-ground hinge	$\varepsilon_c \le 0.004$	$\varepsilon_c \le 0.008$
MRSTS Pile/deck hinge	$\varepsilon_s \le 0.01$	$\varepsilon_s \le 0.05$
MRSTS In-ground hinge	$\varepsilon_s \le 0.01$	$\varepsilon_s \le 0.025$
MPSTS In-ground hinge	$\varepsilon_p \le 0.005$ *(incremental)*	$\varepsilon_p \le 0.025$ *(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

Either Method A or B may be used for idealization of the moment-curvature curve.

3107F.2.5.4.1 Method A. *For Method A, the yield curvature, ϕ_y is the curvature at the intersection of the secant stiffness, EI_e, through first yield and the nominal strength, ($\varepsilon_c = 0.004$).*

$$\phi_y = \frac{M_y}{EI_e} \qquad (7\text{-}10)$$

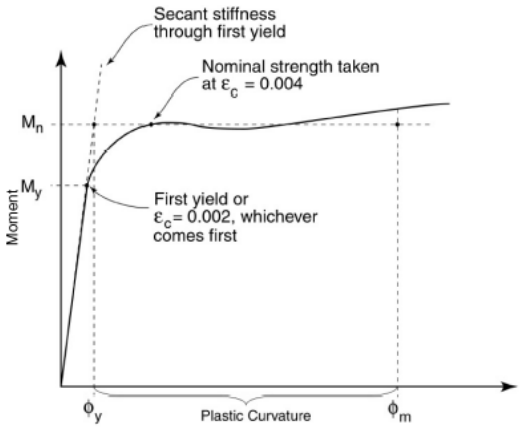

FIGURE 31F-7-4
METHOD A – MOMENT CURVATURE ANALYSIS

3107F.2.5.4.2 Method B. *For Method B, the elastic portion of the idealized moment-curvature curve is the same as in Method A (see Section 3107F.2.5.4.1). However, the idealized plastic moment capacity, M_p, and the yield curvature, ϕ_y, is obtained by balancing the areas between the actual and the idealized moment-curvature curves beyond the first yield point (see Figure 31F-7-5). Method B applies to moment-curvature curves that do not experience reduction in section moment capacity.*

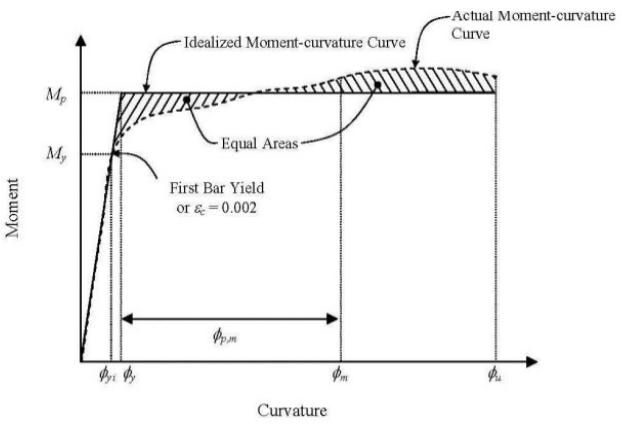

FIGURE 31F-7-5
METHOD B – MOMENT CURVATURE ANALYSIS [7.6]

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:

$$\varepsilon_{cu} = 0.005 \qquad (7\text{-}11)$$

3107F.2.5.5.2 Confined concrete piles:

Ultimate concrete compressive strain [7.1]:

$$\varepsilon_{cu} = 0.004 + (1.4\rho_s f_{yh}\varepsilon_{sm})/f'_{cc} \geq 0.005 \qquad (7\text{-}12)$$

$$\varepsilon_{cu} \leq 0.025$$

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).*

For all non-seismic loading combinations, concrete components shall be designed in accordance with the ACI 318 [7.7] requirements.

Note that for existing facilities, the pile/deck hinge may be controlled by the capacity of the dowel reinforcement in accordance with Section 3107F.2.7.

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 [7.8]):*

$$V_{design} = 1.4V_{max} \qquad (7\text{-}13)$$

If moment curvature analysis that takes into account strain-hardening, an uncertainty factor of 1.25 may be used:

$$V_{design} = 1.25V_{max} \qquad (7\text{-}14)$$

Shear capacity shall be based on nominal material strengths, and reduction factors according to ACI 318 [7.7].

As an alternative, the method of Kowalski and Priestley [7.9] 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):

$$V_n = V_c + V_s + V_p \quad (7\text{-}15)$$

A shear strength reduction factor of 0.85 shall be applied to the nominal strength, V_n, to determine the design shear strength. Therefore:

$$V_{design} \le 0.85V_n \quad (7\text{-}16)$$

The equations to determine V_c, V_s and V_p are:

$$V_c = k\sqrt{f'_c}A_e \quad (7\text{-}17)$$

where:

k = *factor dependent on the curvature ductility $\mu_\phi = \frac{\phi}{\phi_y}$, 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]:

$$V_s = \frac{\frac{\pi}{2} A_{sp} f_{yh} (D_p - c - c_o)\cot(\theta)}{s} \quad (7\text{-}18)$$

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 (N.A.) at flexural strength (see Figure 31F-7-7)*

c_0 = *distance from concrete cover to center of hoop or spiral (see Figure 31F-7-7)*

θ = *angle of critical crack to the pile axis (see Figure 31F-7-7) taken as 30° for existing structures, and 35° for new design*

s = *spacing of hoops or spiral along the pile axis*

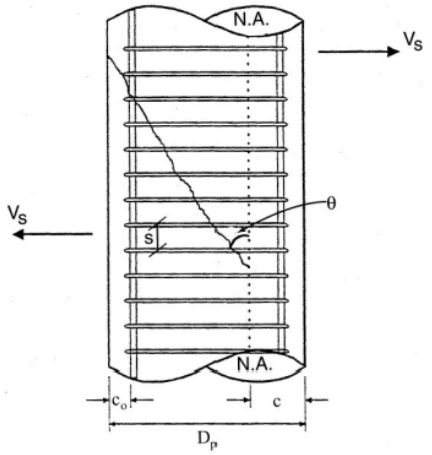

FIGURE 31F-7-7
TRANSVERSE SHEAR MECHANISM

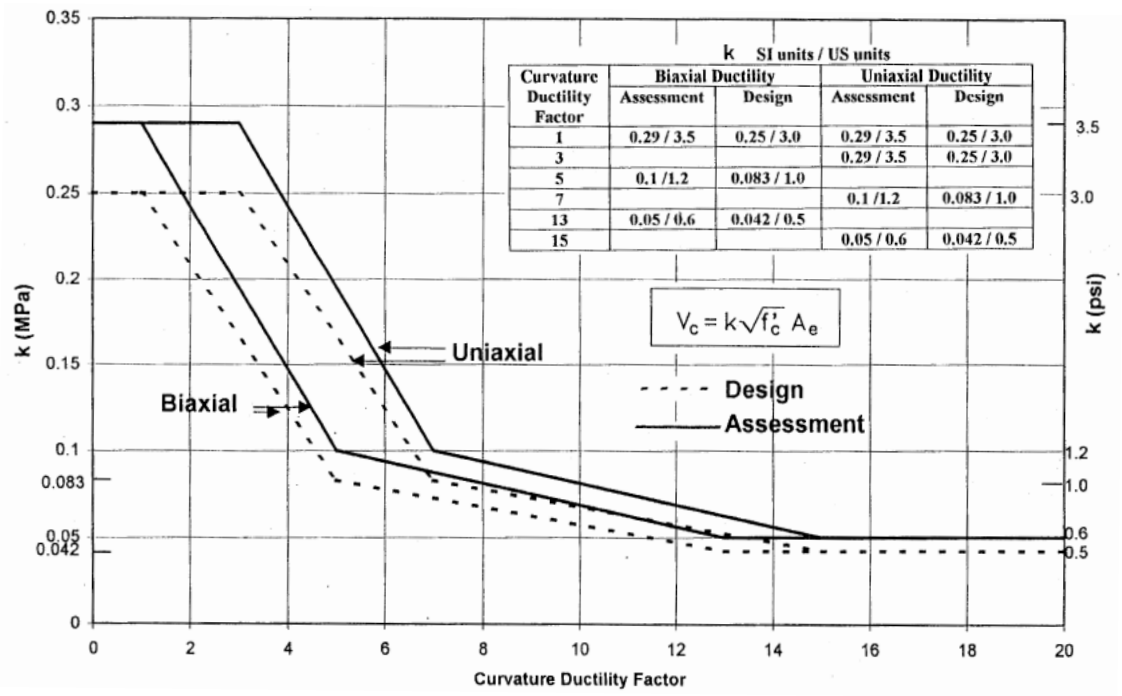

FIGURE 31F-7-6
CONCRETE SHEAR MECHANISM
(from Fig. 3-30 of [7.2])

Rectangular hoops or spirals [7.2]:

$$V_s = \frac{A_h f_{yh} (D_p - c - c_o) \cot(\theta)}{s} \quad (7\text{-}19)$$

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 Figure 31F-7-8):

$$V_p = \Phi (N_u + F_p) \tan \alpha \quad (7\text{-}20)$$

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*

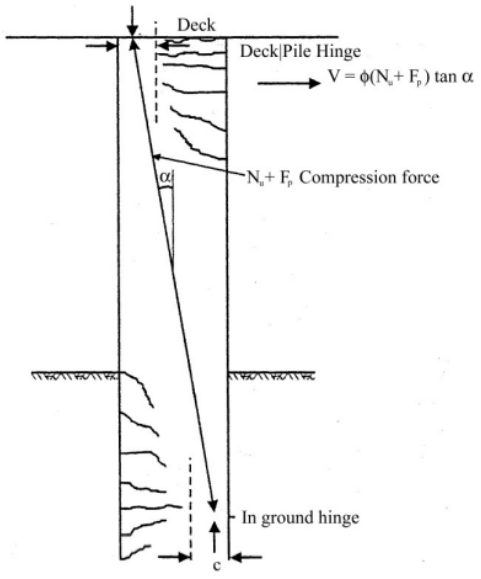

FIGURE 31F-7-8
AXIAL FORCE SHEAR MECHANISM

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, L_p (above ground), for steel piles may be computed from Table 31F-7-6 for pile-to-deck connections.*

When the plastic hinge forms in-ground, the plastic hinge length may be determined using Equation (7-21) [7.5]:

$$L_p = 2D \quad (7\text{-}21)$$

where:

D = *pile diameter*

TABLE 31F-7-6
PLASTIC HINGE LENGTH FOR STEEL PILES [7.5]

CONNECTION TYPE	L_p AT DECK (in.)
Embedded Pile	*0.5D*
Concrete Plug	$0.30 f_{ye} d_b$
Isolated Shell	$0.30 f_{ye} d_b + g$
Welded Embed	*0.5D*

d_b = *diameter of the dowel (in.)*
f_{ye} = *design yield strength of dowel (ksi)*
D = *pile diameter (in.)*
g = *gap distance from bottom of the deck to edge of pipe pile or external confinement (in.)*

3107F.2.6.4 Ultimate flexural strain capacity. *The following limiting value applies:*

Strain at extreme-fiber, $\varepsilon_u \leq 0.035$

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-7-7 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 325 [7.10].

TABLE 31F-7-7
STRUCTURAL STEEL STRAIN LIMITS, ε_u

COMPONENTS	LEVEL I	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 3104F.2.1)

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 325 [7.10]. For concrete filled pipe, Equation (7-15) may be used to determine shear capacity; however, V_{pile} must be substituted for V_s.

$$V_{pile} = (\pi/2)\, t f_{y,\,pile} (D_p - c - c_o) \cot \theta \quad (7\text{-}22)$$

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 [7.7]. 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.*

$$v_j = \frac{0.9M_p}{\sqrt{2}l_{dv}D_p^2} \qquad (7\text{-}23)$$

where:

v_j = *Nominal shear stress*

M_p = *Over strength 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*

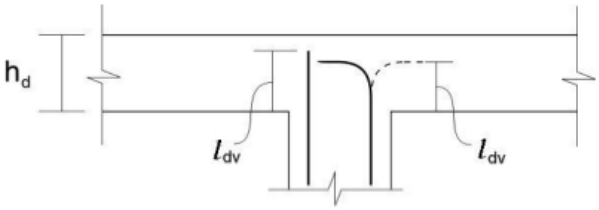

FIGURE 31F-7-9
DEVELOPMENT LENGTH

2. *Determine the nominal principal tension p_t, stress in the joint region:*

$$p_t = \frac{-f_a}{2} + \sqrt{\left(\frac{f_a}{2}\right)^2 + v_j^2} \qquad (7\text{-}24)$$

where:

$$f_a = \frac{N}{(D_p + h_d)^2} \qquad (7\text{-}25)$$

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 fa 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 (7-27) and (7-28).

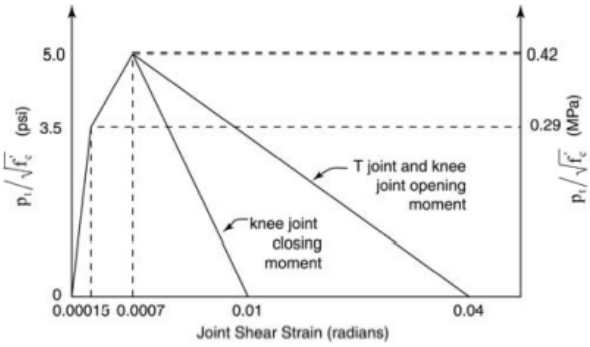

FIGURE 31F-7-10
DEGRADATION OF EFFECTIVE PRINCIPAL TENSION STRENGTH WITH JOINT SHEAR STRAIN (rotation) [7.1, pg. 564]

For $p_t = 5.0\sqrt{f'_c}$, determine the corresponding joint shear stress, v_j:

$$v_j = \sqrt{p_t(p_t - f_a)} \qquad (7\text{-}26)$$

3. *The moment capacity of the connection can be approximated as:*

$$M_c = \left(\frac{1}{.90}\right)\sqrt{2}v_j l_{dv} D_p^2 \le M_p \qquad (7\text{-}27)$$

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.

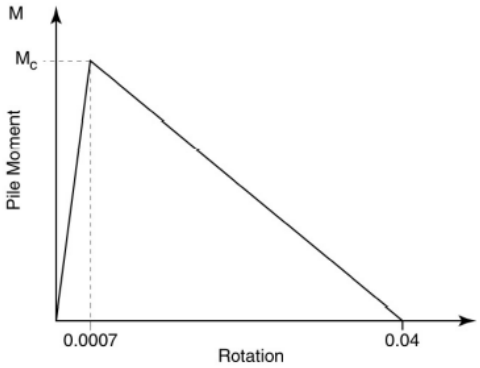

FIGURE 31F-7-11
REDUCED PILE MOMENT CAPACITY

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):

$$M_{c,r} = 2A_s f_y(h_d - d_c) + N\left(\frac{D_p}{2} - d_c\right) \quad (7\text{-}28)$$

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:

$$A_{s,\ deckbottom} \geq 0.5 \cdot A_s \quad (7\text{-}29)$$

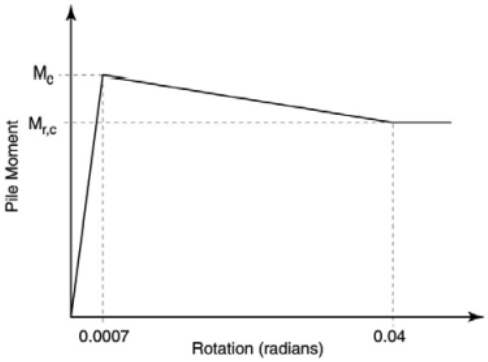

FIGURE 31F-7-11
JOINT ROTATION

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:

$$\phi'_y = \frac{\phi_y M_c}{M_n} \quad (7\text{-}30)$$

   M_n is defined in Figure 31F-7-4.

   The plastic curvature, ϕ_p, corresponding to a joint rotation of 0.04 can be calculated as:

$$\phi_p = \frac{0.04}{L_p} \quad (7\text{-}31)$$

   Where L_p, is given by Equation (7-5).

   The adjusted ultimate curvature, ϕ'_u, can now be calculated as:

$$\phi'_u = \phi_p + \frac{\phi_y M_{c,r}}{M_n} \quad (7\text{-}32)$$

   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.

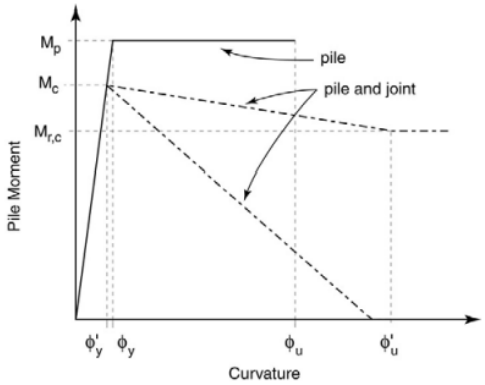

FIGURE 31F-7-13
EQUIVALENT PILE CURVATURE

3107F.2.7.2 Development length. *The minimum development length, l_{dc}, is:*

$$l_{dc} \geq \frac{0.025 \cdot d_b \cdot f_{ye}}{\sqrt{f'_c}} \quad (7\text{-}33)$$

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 (7-33), the moment capacity shall be calculated using a proportionately reduced yield strength, $f_{ye,r}$, for the vertical pile reinforcement:

$$f_{ye,\ r} = f_{ye} \cdot \frac{l_d}{l_{dc}} \quad (7\text{-}34)$$

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.

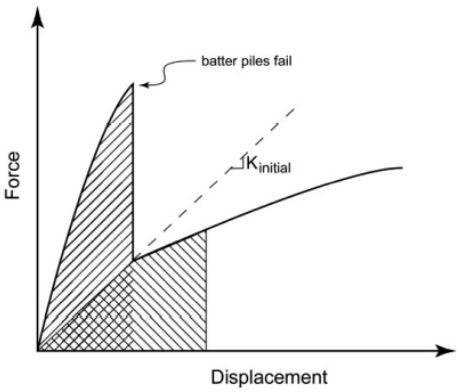

FIGURE 31F-7-14
PUSHOVER CURVE FOR ORDINARY BATTER PILES

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 limitations, 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 3108F.8.2).

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 [7.7].*

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 [7.7]; Level 2 seismic performance shall be limited to the following strains:*

Deck/pile cap: $\varepsilon_c \leq 0.005$

Reinforcing steel tension strain: $\varepsilon_S \leq 0.01$

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 [7.7].

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 [7.7].*

3107F.2.10 Concrete detailing. *For new MOTs, the required development splice length, cover and detailing shall conform to ACI 318 [7.7], 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 reference design values per Section 6 of ANSI/AWC NDS [7.11] may be used.

For deck components, the adjusted design stresses shall be limited to the values of ANSI/AWC NDS [7.11]. 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/AWC NDS [7.11] 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 Section 4 for deck components and Section 6 for timber piles of ANSI/AWC NDS [7.11].

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 [7.12], UFC 3-220-01A [7.13] and Chai [7.14].*

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 [7.12]), and moment, M, is:

$$\Delta = \frac{ML^2}{3EI} \qquad (7\text{-}35)$$

where:

E = *Modulus of elasticity*

I = *Moment of inertia*

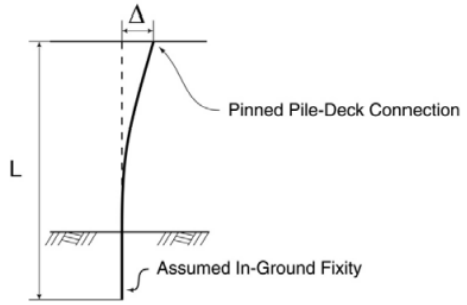

FIGURE 31F-7-15
ASSUMED IN-GROUND FIXITY

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

Assuming linear curvature distribution along the pile, the allowable curvature, ϕ_a, can be established from:

$$\phi_a = \frac{\varepsilon_a}{c} \qquad (7\text{-}36)$$

where:

ε_a = *allowable strain limit according to Section 3107F.3.3.3*

c = *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:

$$\phi = \frac{M}{EI} \quad (7\text{-}37)$$

The maximum allowable moment therefore becomes:

$$M = \frac{2\varepsilon_a}{D_p} EI \quad (7\text{-}38)$$

The displacement capacity is therefore given by:

$$\Delta = \frac{2\varepsilon_a L^2}{3D_p} \quad (7\text{-}39)$$

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/AWC NDS [7.11] may be used.

Timber components for all non-seismic loading combinations shall be designed in accordance with ANSI/AWC NDS [7.11].

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:*

$$V_{demand} = 1.2V_{max} \quad (7\text{-}40)$$

The factored maximum shear stress demand τ_{max}, in a circular pile can then be determined:

$$\tau_{max} = \frac{10}{9}\frac{V_{demand}}{\pi \cdot r^2} \quad (7\text{-}41)$$

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/AWC NDS [7.11] multiplied by a factor of 2.8.

$$\tau_{capacity} = 2.8\tau_{design} \quad (7\text{-}42)$$

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 325 [7.10] or ACI 318 [7.7], respectively. For the determination of static and seismic loads on the sheet pile and sheet pile behavior, the following references are acceptable: Ebeling and Morrison [7.15], Strom and Ebeling [7.16], and PIANC TC-7 (Technical Commentary - 7) [7.17]. 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 established 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 325 [7.10], ACI 318 [7.7], ANSI/AWC NDS [7.11], 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 slab stirrups on one side of joint*

$A_{s,\ deckbottom}$ = *Area of bottom deck steel*

A_{sp} = *Spiral or hoop cross section area*

c = *Depth from extreme compression fiber to neutral axis at flexural strength*

c_0 = *Distance from outside of steel pipe to center of hoop or spiral, or distance from concrete cover to center of hoop or spiral*

c_u = *Neutral axis depth at ultimate strength of section*

d_b = *Diameter of the longitudinal reinforcement, prestressing strand or dowel, as appropriate*

d_c = *Depth from edge of concrete to center of main reinforcement*

d_{st} = *Diameter of the prestressing strand (in)*

D = *Pile diameter or least cross-sectional dimension*

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_c = *Concrete compressive strain*

ε_{cm} = *Maximum extreme fiber compression strain*

ε_{cu} = *Ultimate concrete compressive strain*

ε_p = *Prestressing steel tension strain*

ε_s = *Reinforcing steel tension strain*

ε_{sm} = *Strain at peak stress of confining reinforcement*

ε_u = *Ultimate steel strain*

E = *Modulus of elasticity*

E_c = *Modulus of elasticity for concrete*

E_s = *Modulus of elasticity for steel*

f'_c = *Concrete compression strength*

f'_{cc} = *Confined strength of concrete*

F_p = *Prestress compression force in pile*

f_p = *Yield strength of prestressing strand*

f_{pye} = *Design yield strength of prestressing strand (ksi)*

f_y = *Yield strength of steel*

f_{ye} = *Design yield strength of longitudinal reinforcement, prestressing strand or dowel, as appropriate (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*

g = *Gap distance from bottom of the deck to edge of pipe pile or external confinement (in.)*

h = *Width of pile in considered direction*

h_d = *Deck depth*

I = *Moment of inertia*

I_c = *Moment of inertia of uncracked section*

I_e = *Effective moment of inertia*

I_g = *Gross moment of inertia*

I_s = *Moment of inertia for steel section*

k = *Factor dependent on the curvature ductility $\mu_\phi = \phi/\phi_y$, within the plastic hinge region*

k = *Knowledge factor*

L = *Distance from the critical section of the plastic hinge to the point of contraflexure (Section 3107F.2.5.3), or effective length (Section 3107F.3.3.2)*

L_p = *Plastic hinge length*

l_{dc} = *Minimum development length*

l_d = *Actual development length*

l_{dv} = *Vertical development length*

M = *Maximum allowable moment*

M_c = *Moment capacity of the connection*

$M_{c,r}$ = *Moment capacity at maximum plastic rotation*

M_n = *Moment at secant stiffness*

M_p = *Overstrength moment demand of the plastic hinge (Section 3107F.2.7), or idealized plastic moment capacity (Section 3107F.2.5.4.2)*

M_y = *Moment at first yield*

N = *Pile axial compressive force*

N_u = *External axial compression on pile including seismic load*

ρ_s = *Effective volume ratio of confining steel*

p_t = *Nominal principal tension*

r = *Radius of circular pile*

s = *Spacing of hoops or spiral along the pile axis*

t = *Steel pile wall thickness*

Δ = *Displacement capacity*

θ = *Angle of critical crack to the pile axis*

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*

$\phi_p, \phi_{p,m}$ = *Plastic curvature*

ϕ_u = *Ultimate curvature*

ϕ'_u = *Adjusted ultimate curvature*

ϕ_y = *Yield curvature*

ϕ'_y = *Adjusted yield curvature*

$\tau_{capacity}$ = *Maximum allowable shear stress*

τ_{design} = *Design shear strength*

τ_{max} = *Maximum shear stress*

V_c = *Concrete shear strength*

v_j = *Nominal joint shear stress*

V_{design} = *Design shear strength*

V_{max} = *Maximum shear demand*

V_n = *Nominal shear strength*

V_p = *Contribution to shear strength from axial loads*

> V_s = *Transverse reinforcement shear strength*

V_{pile} = *Shear strength of steel pile*

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Authority: Sections 8750 through 8760, 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 pre-fire planning as discussed in Section 9 of API RP 2001 [8.1] and Chapter 19 of ISGOTT [8.2]. MOT operational and training requirements, as related to fire protection, shall be considered (see 2 CCR 2385 [8.3]). 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, including products not regulated by the Division that may impact development of fire scenarios*
3. *Possible collateral fire damage to adjacent facilities*
4. *Firefighting capabilities, including availability of water (flow rates and pressure), foam type and associated shelf life, proportioning equipment, and vehicular access*
5. *The selection of appropriate extinguishing agents*
6. *Calculation of water and foam capacities, as applicable, consistent with area coverage requirements*
7. *Coordination of emergency efforts*
8. *Emergency escape routes*
9. *Requirements for fire drills, training of personnel, and the use of equipment*
10. *Life safety*
11. *Rescue for terminal and vessel personnel*
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 firefighting equipment locations and condition to ensure operability.

3108F.2.3 Cargo liquid volatility ratings and fire hazard classifications (N/E). *The cargo liquid volatility ratings 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 volatility ratings and the sum of all stored and flowing volumes (V_T), prior to the emergency shutdown (ESD) system stopping the flow of oil.

The stored (V_S) volume is the sum of the H_C and L_C volumes (V_{SH} and V_{SL}, respectively).

During a 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 time shall conform with 2 CCR 2380 [8.3]. The flowing volume (V_F), calculated in Equation (1-1), is the sum of the H_C and L_C liquid volumes (V_{FH} and V_{FL}, respectively).

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 [8.4](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 *Multi-berth terminal piers shall be constructed so as to provide a minimum of 100 ft between adjacent manifolds (N).*

3108F.3.2 Emergency shutdown (ESD) systems. *Emergency shutdown systems are essential to oil spill and fire prevention. These systems may include, but are not limited to, ESD valves, shore isolation valves (SIVs), automatic pump shutdown, controls, actuators and alarms. The ESD systems shall conform to 2 CCR 2380 [8.3] and 33 CFR 154.550 [8.5], and provide:*

1. *Remote actuation stations strategically located, so that ESD valve(s) may be shut within required times (N).*
2. *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 per the California Electrical Code [8.6]. 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).*
3. *Communications or control circuits to synchronize simultaneous closure of the shore isolation valves (SIVs) with the shutdown of loading pumps (N).*

TABLE 31F-8-1
CARGO LIQUID VOLATILITY RATINGS

VOLATILITY RATING	CRITERION	REFERENCE	EXAMPLES
Low (L_C)	Flash Point[1] ≥ 140°F	ISGOTT (Chapter 1), [8.2] —Nonvolatile	#6 Heavy Fuel Oil, residuals, bunker
High (H_C)	Flash Point[1] < 140°F	ISGOTT (Chapter 1), [8.2] —Volatile	Gasoline, JP4, crude oils

1. Flash Point is defined per ISGOTT [8.2].

TABLE 31F-8-2
FIRE HAZARD CLASSIFICATIONS

CLASS	STORED VOLUME (bbls)			FLOWING VOLUME (bbls)		CRITERIA (bbls)*
	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 volatility product
V_{SH} = stored volume of high volatility product
V_{FL} = volume of low volatility product flowing through transfer line during ESD.
V_{FH} = volume of high volatility product flowing through transfer line during 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. A manual reset to restore the ESD system to an operational state after each initiation (N).
5. An alarm to indicate failure of the primary power source (N).
6. A secondary (emergency) power source (N).
7. Periodic testing of the system (N/E).
8. Fire proofing of motors and control-cables that are installed in areas classified as Class I, Group D, Division 1 or 2 per the California Electrical Code [8.6]. Fire proofing shall, at a minimum, comply with the recommendations in Section 6 of API RP 2218 [8.7] (N).

3108F.3.2.1 Emergency shutdown (ESD) valves. ESD valves shall conform to the requirements in Section 3109F.5, as applicable, and the following:

1. Be located near the dock manifold connection or loading arm (N/E).
2. Have "Local" and "Remote" actuation capabilities (N).

3108F.3.2.2 Shore isolation valves (SIVs). Shore isolation valve(s) shall conform to the requirements in Section 3109F.5, as applicable, and the following:

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 shutdown 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).
7. SIVs installed in pipelines carrying H_C liquids, or at a MOT with a spill classification "Medium" or "High" (see Table 31F-1-1), shall be equipped with "Local" and "Remote" actuation capabilities. Local control SIVs may be motorized and/or operated manually (N).

3108F.4 Automated fire detection system. 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 and vessel personnel involved in the transfer operations. Additionally, visual and audible alarms shall be displayed at the MOT'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 [8.8] 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 volatility rating (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. For fire water and foam piping and fittings, see Section 3109F.7.*

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 [8.2] (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 California NFPA 25 [8.9], 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).*

TABLE 31F-8-3
MINIMUM FIRE SUPPRESSION PROVISIONS (N/E)

FIRE HAZARD CLASSIFICATION (From Table 31F-8-2)	VESSEL AND CARGO LIQUID VOLATLITY RATING (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)

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 [8.2]. Connections shall be installed at a safe access distance from the 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 sumps, manifolds 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.6.*

For firewater piping and pipeline systems, see Section 3109F.7. For anchors and supports, see Section 3109F.4.

For equipment anchorages and supports, see Section 3110F.8.

3108F.8 References.

[8.1] American Petroleum Institute (API), 2012, API Recommended Practice 2001 (API RP 2001), "Fire Protection in Refineries," 9th ed., Washington, D.C.

[8.2] 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.

[8.3] California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5 – Marine Terminals Inspection and Monitoring (2 CCR 2300 et seq.)

[8.4] American Petroleum Institute (API), 2008, API Recommended Practice 2003 (API RP 2003), "Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents," 7th ed., Washington, D.C.

[8.5] Code of Federal Regulations (CFR), Title 33, Section 154.550 – Emergency Shutdown (33 CFR 154.550)

[8.6] California Code of Regulations (CCR), Title 24, Part 3, California Electrical Code (Article 500),

[8.7] American Petroleum Institute (API), 2013, API Recommended Practice 2218 (API RP 2218), "Fireproofing Practices in Petroleum and Petrochemical Processing Plants," 3rd ed., Washington, D.C.

[8.8] National Fire Protection Association (NFPA), NFPA 72, "National Fire Alarm and Signaling Code," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

[8.9] National Fire Protection Association (NFPA), California NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," California ed., Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

Authority: Sections 8750 through 8760, 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-freed and physically isolated from sources of oil.*
13. *If a pipeline is "out-of-service" for 3 or more years, it will require a valid and certified Static Liquid Pressure Test (SLPT) and API 570 inspection [9.4] prior to Division approval for re-use (E).*
14. *New piping and pipeline systems require a valid and certified Static Liquid Pressure Test (SLPT) [9.4] and Division approval, prior to operation.*

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 API Standard 2610 [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 (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) (N/E).*
9. *Pressure relief devices shall be used in any piping system that has the possibility of being over pressurized due to surging, considering all plausible normal and abnormal operational scenarios in accordance with ASME B31.4 [9.3] (N/E).*
10. *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 API RP 520 [9.12] (N/E).*
11. *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).*
12. *Threaded, socket-welded, flanged and welded fittings shall conform to Section 8 of API Standard 2610 [9.1] (N/E).*
13. *ESD valves and SIVs shall also conform to the requirements of Sections 3108F.3.2.1 and 3108F.3.2.2.*

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.*
6. *ESD valve and SIV actuators shall also conform to the requirements of Section 3108F.3.2.*

3109F.6 Utility and auxiliary piping and pipeline systems. *Utility and auxiliary piping includes service for:*

1. *Stripping and sampling*
2. *Vapor control*
3. *Natural gas*
4. *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 154.2100(b) [9.13] (N/E).

Compressed air, venting and nitrogen piping and fittings shall conform to ASME B31.3 [9.2] (N).

3109F.7 Fire piping and pipeline systems. *Firewater and foam piping and fittings shall meet the following requirements:*

1. *Conform to NFPA 11 [9.14], NFPA 24 [9.15], and ASME B16.5 [9.16] (N/E).*
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 and appurtenances shall be color-coded per local jurisdiction requirements or per ASME A13.1 [9.17] (N/E).*
5. *Pipeline stress analysis shall be performed for firewater pipelines per Section 3109F.3 (N).*
6. *External visual inspection shall be performed per Section 3102F.3.5.5 (N/E).*

3109F.8 References.

[9.1] American Petroleum Institute (API), 2005, API Standard 2610 (R2010), "Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities," 2nd ed., Washington, D.C.

[9.2] American Society of Mechanical Engineers (ASME), 2015, ASME B31.3-2014 (ASME B31.3), "Process Piping," New York.

[9.3] American Society of Mechanical Engineers (ASME), 2012, ASME B31.4-2012 (ASME B31.4), "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids," New York.

[9.4] *California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5.5 – Marine Terminal Oil Pipelines (2 CCR 2560 et seq.)*

[9.5] *American Society of Mechanical Engineers (ASME), 2008, ASME B31E, "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, December 2013, "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), 2009, API Standard 609, "Butterfly Valves: Double Flanged, Lug- and Wafer-Type," 7th ed., Washington, D.C.*

[9.10] *American Society of Mechanical Engineers (ASME), 2013, ASME B16.34-2013 (ASME B16.34), "Valves Flanged Threaded and Welding End," New York.*

[9.11] *American Petroleum Institute (API), 2010, API Standard 607, "Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats," 6th ed., Washington, D.C.*

[9.12] *American Petroleum Institute (API), API Recommended Practice 520 P1 and P2 (API 520), "Sizing, Selection, and Installation of Pressure-relieving Devices, Part 1 —Sizing and Selection," 2014, 9th ed., and "Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries – Part 2 – Installation," 2015, 6th ed., Washington, D.C.*

[9.13] *Code of Federal Regulations (CFR), Title 33, Section 154.2100 – Vapor Control System, General (33 CFR 154.2100)*

[9.14] *National Fire Protection Association (NFPA), NFPA 11, "Standard for Low-, Medium-, and High-Expansion Foam," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.*

[9.15] *National Fire Protection Association (NFPA), NFPA 24, "Standard for the Installation of Private Fire Service Mains and Their Appurtenances," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.*

[9.16] *American Society of Mechanical Engineers (ASME), 2013, ASME B16.5-2013 (ASME B16.5), "Pipe Flanges and Flanged Fittings," New York.*

[9.17] *American Society of Mechanical Engineers (ASME), 2007, ASME A13.1-2007 (R2013) (ASME A13.1), "Scheme for the Identification of Piping Systems," New York.*

Authority: Sections 8750 through 8760, 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 ASME B31.3 [10.1], 33 CFR 154.510 [10.2] and CCIMF "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*

For each loading arm, the maximum allowable movement envelope limits shall comply with 2 CCR 2380 [10.4].

Loading arms shall meet the seismic criteria defined in Section 3104F.2.1 and the procedure in Section 8.5.3 of ASCE/COPRI 61 [10.5] (N).

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 [10.6].*
2. *The hydraulic drive cylinders shall be mounted and meet either the mounting requirements of NFPA T3.6.7 R3 [10.7] 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 California Electrical Code [10.8].*
2. *Motor controllers and 3-pole motor overload protection shall be installed and sized in accordance with Article 430 of the California Electrical Code [10.8].*
3. *Control circuits shall be limited to 120 volts and shall comply with Articles 500 and 501 of the California Electrical Code [10.8]. Alternatively, intrinsically safe wiring and controls may be provided in accordance with Article 504 of the California Electrical Code [10.8] and UL Std. No. 913 [10.9].*
4. *Grounding and bonding shall comply with the requirements of Article 430 of the California Electrical Code [10.8] 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 [10.4] and 47 CFR Part 15 [10.10] 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 [10.4] and 33 CFR 154.500 [10.11].*

Hoses with nominal diameters of 6 inches or larger shall have flanges that meet ASME B16.5 [10.12], or hoses with nominal diameters of 6 inches or less may have quick disconnect fittings provided that they meet ASTM F1122 [10.13].

The minimum hose length shall safely accommodate the vessel's size and maximum movements during transfer operations and mooring (see Section 3105F.2).

3110F.4 Lifting equipment: winches and cranes. *Lifting equipment for oil service activities, other activities (if operation or failure could cause an oil release) or spill response, shall conform to the provisions in Sections 3110F.4.1 and 3110F.4.2.*

Lifting equipment inspection and maintenance shall conform to ASME B30.4 [10.14], ASME B30.7 [10.15] and ASME HST-4 [10.16], as applicable. Inspections by qualified personnel shall be performed annually. Inspection and maintenance records shall be retained.

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 conditions 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 [10.17], emergency stop switches, radius and locking indicators, shall be provided.*

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 [10.18], Sections 19.B and 21.E of USACE EM 385-1-1 [10.19], Chapter 16.4 of ISGOTT [10.20] 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. *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 Oil sumps and ancillary equipment. *Oil sumps and ancillary equipment shall conform to 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 154.2000 through 154.2181 [10.21] and API Standard 2610 [10.22]. 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 [10.23]. 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 [10.24], FEMA 356 [10.25] or ASCE Guidelines [10.26].

3110F.9 Spill prevention equipment and systems maintenance (N/E). *Mechanical and electrical equipment critical to oil spill prevention and safety, 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 Standard 2610 [10.22]. Firewater pumps providing the wharf fire protection shall be maintained per California NFPA 25 [10.27], 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] American Society of Mechanical Engineers (ASME), 2015, ASME B31.3-2014 (ASME B31.3), "Process Piping," New York.

[10.2] Code of Federal Regulations (CFR), Title 33, Section 154.510 – Loading Arms (33 CFR 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] California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5 – Marine Terminals Inspection and Monitoring (2 CCR 2300 et seq.)

[10.5] American Society of Civil Engineers (ASCE), 2014, ASCE/COPRI 61-14 (ASCE/COPRI 61), "Seismic Design of Piers and Wharves", Reston, VA.

[10.6] American Society of Mechanical Engineers (ASME), 2013, ASME B40.100-2013 (ASME B40.100), "Pressure Gauges and Gauge Attachments," New York.

[10.7] National Fluid Power Association (NFPA), 2009, NFPA T3.6.7 R3-2009 (R2012) (NFPA T3.6.7 R3), "Fluid Power Systems and Products —Square Head Industrial Cylinders - Mounting Dimensions," Milwaukee, WI.

[10.8] California Code of Regulations (CCR), Title 24, Part 3, California Electrical Code.

[10.9] Underwriters Laboratory, Inc., 2013, UL Standard No. 913, "Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations," 8th ed., Northbrook, IL.

[10.10] Code of Federal Regulations (CFR), Title 47, Part 15 – Radio Frequency Devices (47 CFR 15)

[10.11] Code of Federal Regulations (CFR), Title 33, Section 154.500 – Hose Assemblies (33 CFR 154.500)

[10.12] American Society of Mechanical Engineers (ASME), 2013, ASME B16.5-2013 (ASME B16.5), "Pipe Flanges and Flanged Fittings," 13th ed., New York.

[10.13] American Society for Testing and Materials (ASTM), 2010, ASTM F1122-04(2010) (ASTM F1122), "Standard Specification for Quick Disconnect Couplings (6 in. NPS and Smaller)," 4th ed., West Conshohocken, PA.

[10.14] American Society of Mechanical Engineers (ASME), 2010, ASME B30.4-2010 (ASME B30.4), "Portal Tower and Pedestal Cranes," 10th ed., New York.

[10.15] American Society of Mechanical Engineers (ASME), 2011, ASME B30.7-2011 (ASME B30.7), "Winches," 11th ed., New York.

[10.16] American Society of Mechanical Engineers (ASME) 1999, ASME HST-1999 (R2010) (ASME HST-4), "Performance Standard for Overhead Electric Wire Rope Hoists," New York.

[10.17] Code of Federal Regulations (CFR), Title 29, Section 1917.46 – Load Indicating Devices (29 CFR 1917.46)

[10.18] Code of Federal Regulations (CFR), Title 29, Section 1918.22 – Gangways (29 CFR 1918.22)

[10.19] US Army Corps of Engineers (USACE), 2008 (05 Jul 11), EM 385-1-1, "Safety and Health Requirements Manual, Sections 19.B and 21.E, Washington, D.C.

[10.20] International Chamber of Shipping (ICS), Oil Companies International Marine Forum (OCIMF), International Association of Ports and Harbors (IAPH), 2010, "International Safety Guide for Oil Tankers and Terminals (ISGOTT)," 5th ed., Witherby, London.

[10.21] Code of Federal Regulations (CFR), Title 33, Sections 154.2000 through 154.2250 – Vapor Control Systems (33 CFR 154.2000 et. seq.)

[10.22] American Petroleum Institute (API), 2005, API Standard 2610 (R2010), "Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities," 2nd ed., Washington, D.C.

[10.23] Federal Emergency Management Agency, 2003, FEMA 450, "NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures," Washington, D.C.

[10.24] CalARP Program Seismic Guidance Committee, December 2013, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.

[10.25] Federal Emergency Management Agency (FEMA), Nov. 2000, FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.

[10.26] American Society of Civil Engineers (ASCE), 2011, 1997, "Guidelines for Seismic Evaluation and Design of Petrochemical Facilities," 2nd ed., New York.

[10.27] National Fire Protection Association (NFPA), California NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," California ed. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

Authority: Sections 8750 through 8760, 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, including, but not limited to:

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 California Electrical Code [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 Articles 500, 501, 504, 505 and 515 of the California Electrical Code [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 oftags, plates, color coding or other effective means to facilitate troubleshooting and improve safety, and shall conform to the identification carried out for the adjacent onshore facilities (N). Topics for such identification are found in Articles 110, 200, 210, 230, 384, 480 and 504 of the California Electrical Code [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 enclosures for 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.*

Pressurized control rooms shall conform to Chapter 7 of NFPA 496 [11.4].

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. A stored energy emergency power system (SEEPS) shall be provided for control and supervisory circuits associated with ESD systems (N), see Section 3111F.5.1.*

1. *Electrical, instrument and control systems used to activiate 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 per the California Electrical Code [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 [11.5]. 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 [11.6].*

3111F.6 Grounding and bonding (N/E).

1. *All electrical equipment shall be effectively grounded as per Article 250 of the California Electrical Code [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) [11.7].*
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 [11.7] and 33 CFR 154.570 (d) [11.8].*

3111F.9 Communications, control and monitoring systems.

3111F.9.1 Communication systems (N/E). *Communications systems shall comply with 2 CCR 2370 [11.7] and Section 6 of OCIMF "Guide on Marine Terminal Fire Protection and Emergency Evacuation" [11.9].*

3111F.9.2 Overfill monitoring and controls (N/E). *Overfill protection systems shall conform to Appendix C of API Standard 2350 [11.10]. 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 154.2102 [11.11].*

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 Cathodic Protection Systems (CPS) (N/E).

CPS operating, testing, and maintenance criteria for underwater structures shall conform to UFC 3-570-02N [11.12]. Structure-to-electrolyte potential measurements shall be taken at least annually. CPS operating, testing, and maintenance criteria for buried and submerged pipelines shall conform to API 570 [11.13].

All electrical insulating and isolating devices for protection against static, stray and impressed currents shall be tested in accordance with 2 CCR 2341 and 2380 [11.7].

CPS design criteria and location of anodes, electrical leads and rectifiers shall be documented and retained. Periodic CPS measurements, test data and inspection findings shall be retained.

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 (API), 1999, API Recommended Practice 540 (R2004) (API RP 540), "Electrical Installations in Petroleum Processing Plants," 4th ed., Washington, D.C.

[11.2] California Code of Regulations (CCR), Title 24, Part 3, California Electrical Code.

[11.3] American Petroleum Institute (API), 2012 (Errata January 2014), 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," 3rd ed., Washington, D.C.

[11.4] National Fire Protection Association (NFPA), 2012, NFPA 496, "Standard for Purged and Pressurized Enclosures for Electrical Equipment," 2013 ed., Quincy, MA.

[11.5] National Fire Protection Association (NFPA), NFPA 110, "Standard for Emergency and Standby Power Systems," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

[11.6] National Fire Protection Association (NFPA), NFPA 111, "Standard on Stored Electrical Energy Emergency and Standby Power Systems," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

[11.7] California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5 – Marine Terminals Inspection and Monitoring (2 CCR 2300 et seq.)

[11.8] Code of Federal Regulations (CFR), Title 33, Section 154.570 – Lighting (33 CFR 154.570)

[11.9] Oil Companies International Marine Forum (OCIMF), 1987, "Guide on Marine Terminal Fire Protection and Emergency Evacuation," 1st ed., Witherby, London.

[11.10] American Petroleum Institute (API), 2012, API Standard 2350, "Overfill Protection for Storage Tanks in Petroleum Facilities," 4th ed., Washington, D.C.

[11.11] Code of Federal Regulations (CFR), Title 33, Section 154.2102 – Facility Requirements for Vessel Liquid Overfill Protection (33 CFR 154.2102)

[11.12] United Facilities Criteria (UFC), 2004 January 16, UFC 3-570-02N, "Electrical Engineering Cathodic Protection," Washington, D.C.

[11.13] American Petroleum Institute (API), 2009, API 570, "Piping Inspection Code: In-service Inspection, Repair, and Alteration of Piping Systems," 3rd ed., Washington, D.C.

Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Division 12

SECTION 3112F
REQUIREMENTS SPECIFIC TO MARINE TERMINALS THAT TRANSFER LNG

3112F.1 Purpose and applicability. *Section 3112F provides minimum requirements specific to onshore marine terminals that transfer LNG. Sections 3101F through 3111F are also applicable, as appropriate. Offshore marine terminals that transfer LNG are subject to a case-by-case review and approval by the Division.*

3112F.2 Risk and Hazards Analyses.

1. *Prior to LNG transfer at marine terminal, a hazards identification exercise shall be carried out to isolate potential internal and external events that may cause a spill and/or impact to public health, safety and the environment.*
2. *Hazards analysis shall consider every component, part of a structure, equipment item, and system, whose failure could cause a major accident, result in unacceptable incident escalation beyond the design basis, or adversely affect the potential for the passive and active systems to control or shutdown the facility. Safety Critical Components and Safety Critical Systems shall be identified.*
3. *Consequence models shall be developed for credible scenarios to identify Lower Flammability Limit (LFL) hazard regions. Release diameters shall include, at a minimum, 3mm, 10mm, and 50 mm sizes. Scenarios involving the marine loading arms shall consider a full bore release.*
4. *Consequence models shall develop radiant heat zones from jet and pool fires for the 25 kW/m^2, 12.5 kW/m^2, 5 kW/m^2 and 1.6 kW/m^2 thermal endpoints.*
5. *A Cryogenic Exposure Analysis (CEA) shall be conducted to identify equipment and structures susceptible to cryogenic spray and pool exposure due to LNG releases from different size holes.*
6. *A Facility Essential Systems Survivability Assessment (ESSA) shall be conducted to determine the survivability of the Safety Critical Components.*
7. *Impact on Safety Critical Components and Systems shall be mitigated.*

3112F.3 Specific berthing and mooring considerations. *In addition to the minimum design requirements for berthing and mooring in Sections 3103F, 3105F and 3107F of this code, the following shall be satisfied:*

1. *Wind force and moment coefficients for LNG vessels shall be used in accordance with Appendix A of OCIMF MEG 3 [12.1], as appropriate.*
2. *The limiting environmental criteria for which the LNG carrier may safely remain berthed at the terminal shall be determined using dynamic mooring analysis.*
3. *Real time monitoring and recording of environmental conditions including wind, current and waves shall be conducted to assist in mooring system management.*
4. *Vessel hull pressure shall be considered in fender analyses and design.*

3112F.4 Fire protection. *A Fire and Explosion Hazard Analysis (FEHA) for potential pool fires, jet fires, and flash fires, considering LNG releases from different size holes, as specified in Section 3112F.2, shall be conducted and result in recommendations regarding:*

1. *Type, quantity, and location of fire and gas detection devices to detect potential fires and/or gas releases in a specified time frame*
2. *Fire suppression coverage, including fixed and portable systems, and equipment necessary to allow the design scenarios to be mitigated and/or extinguished*
3. *Design application rates for required fire protection systems*
4. *Firefighting requirements, including an analysis of the capability of response by other facilities, USCG, and federal, state and local agencies*

Critical structural supports and equipment within the fire exposed areas identified in the FEHA shall be provided with passive fire protection designed for the duration identified in the analysis.

Emergency shutdown (ESD) systems shall be provided, in accordance with API RP 14C [12.2] and Section 12.3 of NFPA 59A [12.3], to shut down the flow of LNG to/from the terminal and shut down equipment whose continued operation could add to or prolong an emergency event.

The ESD system shall be of a failsafe design or shall be otherwise installed, located, or protected to minimize the possibility that it becomes inoperative in the event of an emergency or failure at the primary control system. ESD system components that may be exposed to fire effects shall be evaluated to confirm that the actuator operation will not be impaired.

3112F.5 LNG pipelines.

1. *All pipe specified for use in cryogenic service shall be furnished in accordance with Paragraph 323.2.2A and Table A-1 of ASME B31.3 [12.4]. The extreme thickness of insulation on cryogenic piping shall be taken into consideration during piping design.*
2. *All piping materials, including gaskets and thread compounds, shall be selected appropriate to the range of temperatures to which subjected. Piping that may be exposed to the low temperature of LNG or to the heat of an ignited spill, during an emergency where such exposure could result in a failure of the piping, shall comply with at least one of the following:*
   (a) *Made of material(s) that can withstand both the normal operating temperature and extreme*

temperature to which the piping may be subjected during the emergency

(b) Protected by insulation or other means to delay failure due to extreme temperatures until corrective action can be taken by the operator.

(c) Capable of being isolated and having the flow stopped where piping is exposed only to the heat of an ignited spill during the emergency

3. *LNG pipelines shall be designed for cool-down with liquid nitrogen where the use of LNG is not possible.*
4. *All LNG drains should be located within a containment area or piped to a collection system or containment area.*
5. *LNG lines shall be analyzed for a start-up case where the top of the pipe is 90 degrees F warmer than the bottom of the pipe. The upward bowing of the pipe shall be limited to 1.25 inches.*
6. *Pipe supports, including any insulation systems used to support pipe whose stability is essential, shall be resistant to or protected against fire exposure, escaping cold liquid, or both if they are subject to such exposure.*
7. *Pipe supports for cold lines shall be designed to minimize excessive heat transfer, which can result in piping failure by ice formations or embrittlement of supporting steel. If icing up of piping and components is unavoidable, the weight of the accumulated ice shall be considered during piping and support design.*
8. *Valves shall comply with ASME B31.5 [12.5].*
9. *Cryogenic valves in liquid cryogenic service shall not be installed in vertical lines. Valves in liquid cryogenic service shall be installed in horizontal lines with the stem in the vertical position or at least 45 degrees vertically from the horizontal centerline of the pipe.*
10. *All cryogenic valves (except butterfly valves, check valves and globe valves) shall have a body cavity relief to the "safe" side of the valve. All cryogenic valves with a body cavity relief shall be marked on the exterior of the body with a letter "V" and an arrow pointing to the direction of the venting side.*
11. *Thermal relief valves shall be installed to protect the equipment and piping from over pressuring as a result of ambient heat input to blocked in LNG or other light hydrocarbon liquids.*
12. *Cryogenic subsea pipeline designs shall be qualified by a certifying agency, acceptable to the Division, in a qualification program that demonstrates that the system has been designed, fabricated and can function as intended with safeguards provided as determined to be necessary.*

3112F.6 Mechanical components and systems.

1. *The CEA analysis shall be used to recommend acceptable cryogenic exposure durations for Safety Critical Components to produce CEA drawings.*
2. *ESD system components, which are exposed to cryogenic effects, shall be evaluated to confirm that the actuators will not be impaired by the potential exposures, thereby preventing the components from failing to a safe position.*
3. *Critical structural supports and equipment within the cryogenically exposed areas shall be provided with cryogenic insulation. The cryogenic insulation and passive fire protection shall be designed for sufficient incident duration.*
4. *For marine loading arms in LNG service, ice formation on non-insolated arms and hoses must be taken into account. Mechanisms for venting, apex venting, purging and cool down of the marine loading arms shall be identified on the P&IDs.*
5. *Areas beneath marine arms shall have restricted access during and after product transfer, until there is no longer danger of falling ice.*

3112F.7 References.

[12.1] Oil Companies International Marine Forum (OCIMF), 2008, "Mooring Equipment Guidelines (MEG3)," 3rd ed., London, England.

[12.2] American Petroleum Institute (API), 2001 (Reaffirmed 2007), API Recommended Practice 14C (API RP 14C), "Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms," 7th ed., Washington, D.C.

[12.3] National Fire Protection Association (NFPA), 2012, NFPA 59A, "Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)," 2013 ed., Quincy, MA.

[12.4] American Society of Mechanical Engineers (ASME), 2015, ASME B31.3-2014 (ASME B31.3), "Process Piping," New York.

[12.5] American Society of Mechanical Engineers (ASME), 2013, ASME B31.5-2013 (ASME B31.5), "Refrigeration Piping and Heat Transfer Components," New York.

Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 32 – ENCROACHMENTS 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	BSC-CG	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 state agency does not adopt sections identified with 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 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 that 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. Stan-

chions or columns that support awnings, canopies, marquees and signs shall be located not less than 2 feet (610 mm) in from 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 noncombustible 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	BSC-CG	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																					
3301				X	X																
3302				X	X																
3303				X	X																
3304				X	X																
3305				X	X																
3306				X	X																
3306.2							X														
3307				X	X																
3308				X	X																
3310																					

The state agency does not adopt sections identified with 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 33
SAFEGUARDS DURING CONSTRUCTION

User note: Code change proposals to sections preceded by the designation [F] will be considered by the International Fire Code Development Committee during the 2016 (Group B) Code Development Cycle. See explanation on page ix.

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 that 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 that 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 that can be affected by any excavation shall be underpinned adequately or otherwise protected against settlement and shall be protected against lateral 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 1804.6. Special inspections of compacted fill shall be in accordance with Section 1705.6.

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 contsruction 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/m^2).

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.

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 that 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 $^{3}/_{4}$-inch (19.1 mm) thick or wood structural panels not less than $^{1}/_{4}$-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 $^{1}/_{4}$ inch (6.4 mm) or $^{5}/_{16}$ inch (23.8 mm) in thickness shall have studs spaced not more than 2 feet (610 mm) on center.
5. Wood structural use panels $^{3}/_{8}$ inch (9.5 mm) or $^{1}/_{2}$ 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 mid-height where the stud spacing is greater than 2 feet (610 mm) on center.
6. Wood structural use panels $^{5}/_{8}$ 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/m^2) 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/m^2) 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.
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 $^{23}/_{32}$ 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 inches by 4 inches (51 mm by 102 mm); 4 feet (1219 mm) in length.
7. A curb that is not less than 2 inches by 4 inches (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 authorized 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. 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 standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipes shall be provided with fire department hose connections at accessible locations adjacent to usable stairways. 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.

CHAPTER 34

RESERVED

Note: Provisions of former Chapter 34, Existing Structures, are now located in Part 10, California Existing Building Code. This change is in keeping with modifications to the 2015 editions of the International Building Code and International Existing Building Code by the International Code Council. See Section 101.4.7.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 34*A* – 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	BSC-CG	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																					

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 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]*** *regulated by the Office of Statewide Health Planning and Development (OSHPD).*

SFM and DSA-AC requirements for existing structures shall be enforced by the Office of Statewide Health Planning and Development (OSHPD).

[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.1.1 Additions, alterations and repairs. *The additions, alterations and repairs shall follow one of the three procedures listed below:*

1. *Provisions in Sections 3403A, 3404A and 3405A; or*
2. *Nonconforming buildings provisions in Section 3411A; or*
3. *Performance based or prescriptive provisions in Section 3412A.*

Items 1 through 3 above shall not be applied in combination with each other, except when explicitly permitted.

The services/systems, utilities and means of egress shall satisfy requirements in Sections 3416A and 3417A.

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, equipment and systems. *Building materials, equipment, and systems shall comply with the requirements of this section.*

3401A.4.1 Existing materials and equipment. *Materials and equipment 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 in accordance with Section 116.*

3401A.4.2 New and replacement materials and equipment. *Except as otherwise required or permitted by this code, materials and equipment 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.

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.

SUBSTANTIAL STRUCTURAL DAMAGE.

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:*

CHANGE IN FUNCTION. *See Section 1224.3.*

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.*

SPC SEISMIC SEPARATION. *Means a building separation in accordance with the California Administrative Code, Chapter 6 Section 3.4.*

UNREINFORCED MASONRY *as used in this chapter means masonry construction where reinforcements in any direction is less than minimum reinforcement specified in TMS 402 Section 7.3.2.6.*

UNREINFORCED CONCRETE *as used in this chapter means plain concrete as defined in ACI 318 Section 2.3.*

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 202, 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 202, 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. *For incidental and minor additions:*

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. *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 202, 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 202, 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 prohibited structural irregularity as defined in this code, 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. *For incidental and minor alterations:*

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. *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. Demands for new or altered existing structural elements need not exceed the maximum load effect that can be transferred to the elements by the system.*
3. *New, relocated or altered nonstructural elements are designed, detailed and connected to existing or new structural elements as required by Chapter 16A.*
4. *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.*

Wind loads 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.* <

3405A.2.3 Extent of repair for noncompliant buildings. *If the evaluation does not establish compliance of the pre-damage 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. 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. 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. 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 202, 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 202, are not required to comply with the flood design requirements for new construction.

SECTION 3406A
Reserved

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 OR FUNCTION

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 the use or occupancy. 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.1.1 Change in function. *A change in function shall require compliance with all the functional requirements for new construction in this code, including requirements in Sections 1224, 1225, 1226, and 1227.*

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 Structural. *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
Reserved

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, Ie, equal to or greater than 1.0. Alterations or repairs to the existing affected lateral force-resisting systems shall be made to conform to the requirements of Sections 3404A or 3405A respectively using importance factor, Ie, equal to or greater than 1.0.*

3411A.1.1.1 Nonstructural components. *Component importance factor, Ip, shall be permitted to be 1.0.*

Exception: *Components required for life-safety purposes after an earthquake, including emergency and standby power systems, mechanical smoke removal systems, fire protection sprinkler systems, fire alarm control panels, and egress stairways shall have a component importance factor (Ip) of 1.5.*

3411A.1.2 Major structural alteration, additions or repairs. *Major structural alterations, additions or repairs shall be in accordance with Sections 3412A.1.1.a or 3412A.1.1.c, as applicable.*

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. When load combinations which do not include seismic forces are required, the new building code provisions of this code shall be applicable.

3412A.1.1 ASCE 41 Section 1.4 – Performance Objectives. *Target building performance level shall be as follows:*

a. For general acute care hospital buildings along with all structures required for their continuous operation or access/egress.

I. Immediate Occupancy (IO) Structural Performance Level (S-1) as defined in Section 2.3.1.1 at Basic Safety Earthquake 1N (BSE-1N) Seismic Hazard Level; and

II. Life Safety (LS) Structural performance level (S-3) as defined in Section 2.3.1.3 at Basic Safety Earthquake 2N (BSE-2N) Seismic Hazard Level;

III. The nonstructural components shall satisfy the requirements of this code for new construction.

Exception: *Performance objectives for upgrading nonconforming hospital buildings to SPC-4D and for incidental or minor alterations or repairs of SPC-4D buildings shall be in accordance with Section 3412A.2.3.2 of this code.*

b. For incidental and minor additions, alterations or repairs of pre-1973 hospital buildings which will not be used for general acute care services after January 1, 2030:

I. Life Safety Structural Performance (S-3) Level as defined in ASCE 41 Section 2.3.1.3 at the Basic Safety Earthquake 1E (BSE-1E) Seismic Hazard Level; and

II. Collapse Prevention (CP) building performance level (5-D) in accordance with Section 2.3.3.4 at the Basic Safety Earthquake 2E (BSE-2E) Seismic Hazard Level; and

III. The nonstructural components shall satisfy the requirements of Position Retention Nonstructural Performance Level (N-B) in accordance with ASCE 41 Section 2.3.2.2 at BSE-1E Seismic Hazard Level.

c. All other hospital buildings:

I. Operational Building Performance Level of (1-A) as defined in Section 2.3.3.1 at Basic Safety Earthquake 1N (BSE-1N) Seismic Hazard Level;

II. Life Safety (LS) building performance level (S-3) as defined in Section 2.3.1.3 at Basic Safety Earthquake 2N (BSE-2N) Seismic Hazard Level.

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 agency.*

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 agency.*

3412A.1.5 Alternative modeling parameters and acceptance criteria. *Where analysis/modeling parameters or acceptance criteria for structural elements are not provided in ASCE 41 or are considered to be inadequate, the analysis/modeling parameters or acceptance criteria shall be permitted to be established on the basis of test, using a criteria acceptable to the building official, and ASCE 41 Section 7.6.3.*

3412A.1.6 Construction, 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 for compliance with the California Administrative Code, Chapter 6. *Not withstanding 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. When load combinations that do not include seismic forces are required, the new building provisions of this code shall be applicable.*

3412A.2.1 SPC 5 and NPC 5. *New hospitals (facility) or new building(s), larger than 4000 sq ft, designed and built to the requirements of this code for general acute care hospital buildings shall be considered to satisfy the requirements of SPC 5 and NPC 5.*

3412A.2.2 SPC 5 using ASCE 41. *Structures shall be considered to comply with SPC 5 requirements of Table 2.5.3, Chapter 6 of the California Administrative Code where all of the following are satisfied:*

I. Immediate Occupancy structural performance level (S-1) in accordance with Section 2.3.1.1 of ASCE 41 at BSE-1N;

II. Life Safety performance level S-3 in accordance with Section 2.3.1.3 of ASCE 41 at BSE-2N; and

III. Items identified in Chapter 6, Article 10 of the California Administrative Code, satisfying the requirements of Operational Nonstructural performance level (N-A) in accordance with Section 2.3.2.1 of ASCE 41 at BSE-1N.

3412A.2.3 SPC-4D. *Nonconforming hospital buildings satisfying the following requirements and one of Sections 3412A.2.3.1, 3412A.2.3.2 or 3412A.2.3.3, but not a combination thereof, shall be considered to satisfy the requirements of SPC-4D.*

1. Approval of construction documents based on building characterization in accordance with the California Administrative Code (CAC) Chapter 6 Section 2.1.2.1, material properties in accordance with the

CAC Chapter 6 Section 2.1.2.2 and Section 3413A.1.3 of this code, and a complete rational structural analysis shall be required.

2. *Where the SPC-4D upgrade involves construction, a building permit prior to construction shall be required.*
3. *Where multiple building permits are used to upgrade a building to SPC-4D, a complete rational structural analysis to justify compliance with SPC-4D for the building in its final configuration, shall be submitted as part of the construction documents submittal to the Office for the last project.*
4. *Where the SPC-4D upgrade involves construction, buildings shall be assigned to SPC-4D after all projects required for SPC-4D are closed in compliance.*

3412A.2.3.1 Prescriptive compliance provisions for SPC-4D using the California Building Code, 1980 (CBC 1980). *Nonconforming buildings shall satisfy the following requirements:*

1. *The California Building Code, 1980 (CBC 1980), as used in this chapter, consists of the Uniform Building Code, 1979 (UBC 1979) along with requirements contained in:*
   a) *California Code of Regulations, Title 24-Building Standards, dated February 2, 1980 (Revision record for Register 80, No. 5).*
   b) *California Code of Regulations, Title 22 – Social Security, dated October 13, 1979 (Revision Record for Register 79, No 41).*
   c) *California Code of Regulations, Title 17 – Public Health, dated October 13, 1979 (Revision Record for Register 79, No 41-B).*
2. *All existing structural elements of Seismic Force Resisting System (SFRS) shall satisfy the detailing requirements in the CBC 1980 or demonstrate that the level of seismic performance is equivalent to that given in the CBC 1980, as determined by the building official.*
3. *A continuous load path or paths with adequate strength and stiffness to transfer all the forces from the point of origin to final point of resistance shall be justified by analysis.*
4. *Site data report in accordance with the CBC 1980 shall establish that seismically induced differential settlement does not exceed 1" in 40'.*
5. *Adjacent buildings shall satisfy the SPC building separation requirements in accordance with the California Administrative Code, Chapter 6 Section 3.4.*
6. *The addition of new structural elements or strengthening of existing structural elements for retrofit of nonconforming buildings to SPC-4D shall comply with the following:*
   a) *The seismic demand (forces or displacements) shall be in accordance with the CBC 1980;*
   b) *Capacity, detailing and connections for new structural elements shall satisfy the requirements in this code (CBC 2016) for new construction; and*
   c) *The strengthening of existing structural elements shall use capacities determined in accordance with this code (CBC 2016) for new construction consistent with the detailing and connections used in the strengthened member.*
7. *All construction, quality assurance and quality control shall be in accordance with the new construction provisions of this code (CBC 2016).*
8. *Elements not part of the Seismic Force Resisting System (SFRS), including those identified in the California Administrative Code Chapter 6, Article 10, shall be evaluated using seismic forces and the requirements of the CBC 1980.*
9. *Any column or wall that forms part of two or more intersecting SFRS and is subjected to axial load due to seismic forces acting along either principal plan axis equaling or exceeding 20 percent of the axial design strength of the column or wall shall be evaluated for the most critical load effect due to application of seismic force in any direction. The most critical load effect may be deemed to be satisfied if members and their foundations are evaluated for 100 percent of the forces for one direction plus 30 percent of the forces for the perpendicular direction, whereby the combination produces the maximum effect.*

   Exceptions: *The following buildings (with structural irregularities or unusual configuration/system) shall not be eligible for the SPC-4D upgrade using the prescriptive provisions in this section:*

   1. *Buildings with prohibited irregularities in accordance with Section 1616A.1.10 of this code.*
   2. *Buildings taller than 5-stories or 65' height above the base having horizontal or vertical irregularities in accordance with ASCE 7 Tables 12.3-1 Items # 1a, 1b and 3 or 12.3-2 Items #1a, 1b, 5a and 5b.*
   3. *Buildings with unusual configuration or structural system, as determined by the building official.*

3412A.2.3.2 SPC-4D using ASCE 41. *Structures shall be deemed to comply with the SPC-4D requirements of*

Table 2.5.3, Chapter 6 of the California Administrative Code, when all of the following are satisfied:

1. *Damage control structural performance level (S-2) in accordance with Section 2.3.1.2.1 of ASCE 41 at BSE-1E; and*
2. *Collapse Prevention Structural Performance Level (S-5) in accordance with Section 2.3.1.5 of ASCE 41 at BSE-2E; and*
3. *Items identified in Chapter 6, Article 10 of the California Administrative Code satisfy the requirements of Position Retention nonstructural performance level (N-B) in accordance with Section 2.3.2.2 at BSE-1E.*

3412A.2.3.3 Prescriptive compliance provisions for SPC-4D using the new building design requirements of this code. *Structures satisfying the requirements of this code for new general acute care hospital buildings design shall be deemed to satisfy the SPC-4D requirements of Table 2.5.3, Chapter 6 of the California Administrative Code.*

All existing structural elements of Seismic Force Resisting System (SFRS) shall satisfy the detailing requirements of this code for new construction or demonstrate that the level of seismic performance is equivalent, as determined by the building official. A demonstration of equivalence shall consider the regularity, overstrength, redundancy, and ductility of the structure.

Elements not part of the Seismic Force Resisting System (SFRS), including those identified in the California Administrative Code Chapter 6, Article 10, shall be evaluated using seismic forces and the requirements of this code for new general acute care hospital buildings.

3412A.2.4 SPC 2 using ASCE 41. *Structures shall be considered to comply with SPC 2 requirements of Table 2.5.3, Chapter 6 of the California Administrative Code, when all of the following are satisfied:*

I. *Life Safety structural performance level (S-3) in accordance with Section 2.3.1.3 of ASCE 41 at BSE-1E; and*

II. *Items identified in Chapter 6, Article 10 of the California Administrative Code satisfying the requirements of Position Retention nonstructural performance level (N-B) in accordance with Section 2.3.2.2 at BSE-1E.*

3412A.2.5 NPC. *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.*

3412A.2.5.1 NPC-4 and NPC-5 using ASCE 41. *Nonstructural components for Operational Nonstructural performance level (N-A) in Section 2.3.2.1 or NPC-4 shall satisfy the requirements of this code for new construction. Nonstructural components for NPC-5 shall satisfy Operational performance level N-A/NPC-4 and Section 1616A.1.40 Items 1 & 2 of this code.*

3412A.2.5.2 NPC-2, NPC-3 and NPC-3R using ASCE 41. *Operational Nonstructural performance level (N-A) and Position Retention nonstructural performance level (N-B) of ASCE 41 at BSE-1N 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 of 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) *Supports and attachments of nonstructural components, except those listed in Item 4 below, 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) *Supports and attachments of nonstructural components, except those listed in Item 4 below, in buildings in seismic performance categories SPC 1 or SPC 2 with a performance level of NPC 3 or higher, and SPC 3, SPC 4 or SPC-4D, 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.*
4) *Supports and attachments for systems listed under NPC-2 and NPC-5 (excluding those specifically listed for NPC-3/NPC-3R and NPC-4) in the California Administrative Code, Chapter 6, Table 11.1 shall satisfy the requirements of this code for new construction and Items 2 and 3 above shall not be applicable.*

5) *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 requirement, 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.1.14.*

3413A.1.1 ASCE 41 Section 1.1. *Modify ASCE 41 Section 1.1 with the following:*

Seismic evaluations shall be performed for performance objective specified in Section 3412A of this code (CBC) using procedure of this standard (ASCE 41) as follows:

1. *Structural components shall be evaluated in accordance with Tier 3 systematic evaluations procedure in Chapter 6.*
2. *Nonstructural components shall be evaluated in accordance with Chapter 13.*

Exception: *For general acute care hospitals, seismic evaluation shall be permitted to be in accordance with Chapter 6 of the California Administrative Code (CAC) when required by provisions of that chapter.*

3413A.1.2 ASCE 41 Section 2.4 Seismic Hazard. *Modify ASCE 41 Section 2.4 by the following:*

Response spectra and acceleration time histories shall be constructed in accordance with Sections 1613A, 1616A, and 1803A.6.

3413A.1.3 ASCE 41 Section 6.2. *Modify ASCE 41 Section 6.2 with the following:*

Data Collection Requirements. *The extent of data collection shall be at Comprehensive level for all structures, including structures upgraded to SPC-4D. A testing program for materials properties shall be approved by the enforcement agent prior to commencement of material testing work. Previously approved material test results shall be permitted to be used to satisfy part of the comprehensive data collection requirements.*

Exception: *Data collection at Usual level shall be permitted for structures with SPC-2 or lower target performance objective.*

Tension testing of reinforcing bars shall be in accordance with ASTM A370 Annex A9. All test specimens shall be the full section of the bar as rolled (8-in. gage length) and shall not be reduced.

At test sample locations, structural members, slabs and walls shall be repaired to a state that is equivalent to their original condition.

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 7.3.2.1. *Modify ASCE 41 Section 7.3.2.1 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.1.5 ASCE 41 Section 7.5.1. *Modify ASCE 41 Section 7.5.1 with the following:*

Acceptance Criteria – 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-1E or BSE-1N, as applicable.*

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.1.6 ASCE 41 Section 7.5.1.4. *Modify ASCE 41 Section 7.5.1.4 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 8 through 12 and shall be based exclusively on materials tests.*

3413A.1.7 ASCE 41 Section 8.4. *Modify ASCE 41 Section 8.4 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.1.8 ASCE 41 Section 8.4.1.1. *Replace ASCE 41 Section 8.4.1.1 as follows:*

Prescriptive Expected Capacities. *Not permitted by OSHPD.*

3413A.1.9 ASCE 41 Section 8.5. *Modify ASCE 41 Section 8.5 with the following:*

The product of RRS_{bsa} x RRS_e, shall not be less than 0.7.

The combined effect of kinematic interaction and foundation damping shall meet the following:

1. *The site specific response spectrum modified for soil-structure interaction effects shall not be taken as less than 80 percent of the spectral acceleration as determined from a site-specific response spectrum in accordance with ASCE 7 Section 21.3, or*
2. *The site specific response spectrum modified for soil-structure interaction effects shall not be taken as less than 70 percent of the spectral acceleration as determined from the design response spectrum and MCE_R response spectrum in accordance and with ASCE 7 Sections 11.4.5 and 11.4.6 respectively.*

Exception*: For the seismic retrofit of existing nonconforming buildings, design ground motion shall be consistent with performance objectives in Section 3412A.*

3413A.1.10 ASCE 41 Section 8.6. *Modify ASCE 41 Section 8.6 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.1.11 ASCE 41 Section 10.7.1.1. *Modify ASCE 41 Section 10.7.1.1 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 Po 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 10-19 through 10-22.

3413A.1.12 ASCE 41 Section 11.1. *Modify ASCE 41 Section 11.1 by the following:*

Scope: *Unreinforced Masonry walls (including unreinforced infill walls) and partitions are not permitted for General Acute Care (GAC) hospital buildings.*

3413A.1.13 ASCE 41 Section 14.1. *Modify ASCE 41 Section 14.1 by the following:*

Scope: *For buildings located in Seismic Design Category F, verification of the interstory lateral displacements, the strength adequacy of the seismic force resisting system and anchorage to the foundation shall be accomplished using the Nonlinear Dynamic Procedure.*

3413A.1.14 ASCE 41 Chapter 15. *Not permitted by OSHPD.*

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 similar to the 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 or a timeframe mutually agreed to by the Owner, Registered Design Professional (RDP) and the Office.*

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 submit 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 the hospital buildings 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 the hospital buildings 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 a conforming building 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 conforming 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 hospital buildings, additions, alterations, and remodels of conforming (SPC-3, -4, -4D, or -5) hospital buildings. *Services/systems and utilities for new hospital buildings and additions, and alterations or remodels to existing conforming buildings shall originate in hospital buildings that are conforming or 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 that could be 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 that could be 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.1.2 Jurisdiction. *Services/systems and utilities 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. *Means of egress 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.1.1.1.1 through 3417A.1.1.1.6.*

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 are conforming or 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 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.1.1.1.3 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 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.1.1.1.4 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.1.1.1.2.*

3417A.1.1.1.5 Other 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 hospital buildings, 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.1.1.1.1 through 3417A.1.1.1.4.*

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.1.1.1.1 or 3417A.1.1.1.3.*
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.1.1.1.2 or 3417A.1.1.1.4.*

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.1.2 Jurisdiction. *Means of egress shall only pass through buildings that are under the jurisdiction of the Office of Statewide Health Planning and Development (OSHPD).*

SECTION 3418A
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.1.1 Buildings without approved extensions. *A SPC 1 hospital building without an approved delay in compliance requirements in accordance with the California Administrative Code (CAC) Chapter 6 Section 1.5.2 or past the extension date granted in accordance with the CAC Chapter 6 Section 1.5.2 shall not be issued a building permit until a project to remove the subject SPC 1 building from general acute care services has been approved, permitted, and closed in compliance by the Office.*

Exception: *Building permits for seismic compliance, maintenance and repair shall be permitted to be issued.*

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 building, as defined in Section 202 and the California Administrative Code, Chapter 6, Section 1.2.*

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, SPC-4D, 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.1.1.1.6.*

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 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 in the adjacent SPC-1 and SPC-2 buildings have no connection to any SPC-3, SPC-4, SPC-4D, 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.*

   Exception: *Flexible connections for 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 utilities in the adjacent SPC-1 and SPC-2 buildings have no connection to any SPC-3, SPC-4, SPC-4D, and SPC-5 buildings providing general acute care service.*

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.1.1.1.5, 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 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 utilities in the adjacent SPC-1 and SPC-2 buildings have no connection to any SPC-3, SPC-4, SPC-4D, 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 freestanding 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&SC §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&SC§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 housekeeping 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 housekeeping 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, setback, 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
HOSPITAL BUILDINGS REMOVED FROM GENERAL ACUTE CARE SERVICES

3419A.1 General. *The requirements of this section and Section 3418A 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	BSC-CG	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	X	X								
Adopt entire chapter as amended (amended sections listed below)			X	X	X	X															
Adopt only those sections that are listed below							X														
Chapter/Section																					
A227-06 (2011)				X	X																
A229-12				X	X																
ASME							X														
ASME A17.1/CSA B44-13			*X*				X														
ASME A18.1-2008							*X*														
ASME BPE-2009			X																		
ASTM E648-04			X																		
ASTM E662-09			X																		
ASTM F1292-99							*X*														
ASTM F1292-04							*X*														
ASTM F1487-01							*X*														
ASTM F1951-99							*X*														
BHMA							X														
BHMA A156.10-2011							*X*														
BHMA A156.19-2013							*X*														
CPSC																					
FM 3260-00			X																		
FM3011-99			X																		
FM4430-12			X																		
FM4430-80			X																		
ICC/ANSI A117.1-09				†	†	†															
ICC ES AC 331			X																		
ICC ES AC 77			X																		
NFPA							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																		

(continued)

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 35 – REFERENCED STANDARDS—continued

Adopting agency	BSC	BSC-CG	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	X	X								
Adopt entire chapter as amended (amended sections listed below)			X	X	X	X															
Adopt only those sections that are listed below							X														
Chapter / Section																					
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 720-15				X	X	X															
NFPA 1124-13			X																		
NFPA 2001-12			X																		
SFM 12-3			X																		
SFM 12-7-3			X																		
SFM 12-7A-1			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																		
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-*2008*				X	X	X															
UL 2075-2013				*X*	*X*	*X*															

The state agency does not adopt sections identified with 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 pur su ant 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, *as applicable.*

[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 and 22A.*

AA

Aluminum Association
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209

Standard reference number	Title	Referenced in code section number
ADM1—2015	Aluminum Design Manual: Part 1—A Specification for Aluminum Structures	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 AAMA/WDMA/CSA 101/I.S.2/A440—08	Standard Specifications for Aluminum Siding, Soffit and Fascia	1404.5.1
	North American Fenestration Standard/Specifications for Windows, Doors and Skylights	1709.5.1, 2405.5
501.4-09	*Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts*	*2410.1*
501.6-09	*Recommended Dynamic Test Method for Determining the Seismic Drift Causing Glass Fallout from a Wall*	*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—14	Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies	Table 721.1(2), 722.1
318—14	Building Code Requirements for Structural Concrete	1604.3.2, 1615.3.1, 1615.4.1, 1704.5, Table 1705.3, 1705.3.2, 1705.12.1, 1808.8.2, Table 1808.8.2, 1808.8.5, 1808.8.6, 1810.1.3, 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, 1810.3.10.1, 1810.3.11.1, 1901.2, 1901.3, 1902.1, 1903.1, 1904.1, 1904.2, 1905.1, 1905.1.1, 1905.1.2, 1905.1.3, 1905.1.4, 1905.1.5, 1905.1.6, 1905.1.7, 1905.1.8 1906.1, 2108.3, 2206.1, *Table 1705A.2.1, Table 1705A.3, 1810A.3.10.4, 1901.3.4.4, 1903A, 1904A, 1905A, 1910A.5.4, 1909.2, 1909.3*
355.2—07	*Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary*	*I616A.1.19*
355.4—11	*Qualification of Post-Installed Adhesive Anchors in Concrete*	*I616A.1.19*
440.2R-08	*Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures*	*1911A.3*
503.7—07	*Specification for Crack Repair by Epoxy Injection*	*1911A.2*
506—05	*Guide to Shotcrete*	*1908A.1, 1908A.3, 1908A.12, 1911A.2*

ACI—continued

530—13	Building Code Requirements for Masonry Structures	1405.6, 1405.6.1, 1405.6.2, 1405.10, 1604.3.4, 1705.4, 1705.4.1, 1807.1.6.3, 1807.1.6.3.2, 1808.9, 2101.2, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, *2114.7, 2114.8, 2107A.5, 2107A.6*
530.1—13	Specifications for Masonry Structures	1405.6.1, 1705.4, 1807.1.6.3, 2103.1, 2103. 2.1, 2103.3, 2103.4, 2105.1

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	1613.4.1, 1705.12.1.1, 1705.12.1.2, 1705.13.1.2, 2205.2.1.1, 2205.2.1.2, 2205.2.2, 2206.2.1, *1705A.2.1, 1707.2*,2, 1708.3, *2212.2, 2205A*, *2206A*
358-10	*Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications including Supplements No.1 & 2*	*2205A, 2206A.2, 2212.3, 3413A*
360—10	Specification for Structural Steel Buildings	722.5.2.2.1, 1604.3.3, 1705.2.1, 2203.1, 2203.2, 2205.1, 2205.2.1.1, 2206.1, *1705A.2.1, Table 1705A.2.1, 2212.1.1,2204A.4, 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, 2012	1604.3.3, 1905.1.8, 2203.1, 2203.2, *1905A.1, 1913.3.8, 2210A.2, 2211A.1, 2212A.1.2*
AISI S110—07/ S1-09 (2012)	Standard for Seismic Design of Cold-Formed Steel Structural Systems—Special Moment Frames, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)	2210.2
AISI S200—12	North American Standard for Cold-Formed Steel Framing-General Provisions	2203.1, 2203.2, 2211.1, Table 2603.12.1, Table 2603.12.2
AISI S210—07(2012)	North American Standard for Cold-Formed Steel Framing-Floor and Roof System Design (Reaffirmed 2012)	2211.5
AISI S211—07/ S1-12(2012)	North American Standard for Cold-Formed Steel Framing-Wall Stud Design, 2007 including Supplement 1, dated 2012 (Reaffirmed 2012)	2211.4
AISI S212—07(2012)	North American Standard for Cold-Formed Steel Framing-Header Design, 2007, (Reaffirmed 2012)	2211.2
AISI S213—07/ S1-09 (2012)	North American Standard for Cold-Formed Steel Framing-Lateral Design, with Supplement 1, dated 2009, (Reaffirmed 2012)	2211.6
S214—12	North American Standard for Cold-formed Steel Framing-Truss Design, 2012	2211*A*.3, 2211.3.1, 2211.3.2, 2212.5.1.2
AISI S220—11	North American Standard for Cold-formed Steel Framing-Nonstructural Members	2203.1, 2203.2, 2211.1, Table 2506.2, Table 2507.2
AISI S230—07/ S3-12(2012)	Standard for Cold-formed Steel Framing-Prescriptive Method for One- and Two-family Dwellings, 2007, with Supplement 3, dated 2012 (Reaffirmed 2012)	1609.1.1, 1609.1.1.1, 2211.7

ALI

Automotive Lift Institute
P.O. Box 85
Courtland, NY 13045

Standard reference number	Title	Referenced in code section number
ALI ALCTV—2011	Standard for Automotive Lifts—Safety Requirements for Construction, Testing and Validation (ANSI)	3001.2

AMCA

Air Movement and Control Association International
30 West University Drive
Arlington Heights, IL 60004

Standard reference number	Title	Referenced in code section number
540—08	Test Method for Louvers Impacted by Wind Borne Debris	1609.1.2.1

ANSI

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—2007	Scheme for the Identification of Piping Systems	415.11.6.5
A108.1A—99	Installation of Ceramic Tile in the Wet-set Method, with Portland Cement Mortar	2103.2.3
A108.1B—99	Installation of Ceramic Tile, quarry Tile on a Cured Portland Cement Mortar Setting Bed with Dry-set or Latex-Portland Mortar	2103.2.3
A108.4—99	Installation of Ceramic Tile with Organic Adhesives or Water-cleanable Tile-setting Epoxy Adhesive	2103.2.3.6
A108.5—99	Installation of Ceramic Tile with Dry-set Portland Cement Mortar or Latex-Portland Cement Mortar	2103.2.3.1, 2103.2.3.2
A108.6—99	Installation of Ceramic Tile with Chemical-resistant, Water Cleanable Tile-setting and -grouting Epoxy	2103.2.3.3
A108.8—99	Installation of Ceramic Tile with Chemical-resistant Furan Resin Mortar and Grout	2103.2.3.4
A108.9—99	Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout	2103.2.3.5
A108.10—99	Installation of Grout in Tilework	2103.2.3.7
A118.1—99	American National Standard Specifications for Dry-set Portland Cement Mortar	2103.2.3.1
A118.3—99	American National Standard Specifications for Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy and Water Cleanable Tile-setting Epoxy Adhesive	2103.2.3.3
A118.4—99	American National Standard Specifications for Latex-Portland Cement Mortar	2103.2.3.2, 2103.3.2.4
A118.5—99	American National Standard Specifications for Chemical Resistant Furan Mortar and Grouts for Tile Installation	2103.2.3.4
A118.6—99	American National Standard Specifications for Cement Grouts for Tile Installation	2103.2.3.7
A118.8—99	American National Standard Specifications for Modified Epoxy Emulsion Mortar/Grout	2103.2.3.5
A136.1—99	American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile	2103.2.3.6
A137.1—12	American National Standard Specifications for Ceramic Tile	202
A190.1—12	Structural Glued Laminated Timber	*1705A.5.4,* 2303.1.3, 2306.1
S3.41	*American National Standard Specifications for Audible Emergency Evacuation Signal*	*907.5.2.1.3*
Z 97.1—14	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, 2409.2, 2409.3, 2409.4.1

APA

APA - Engineered Wood Association
7011 South 19th
Tacoma, WA 98466

Standard reference number	Title	Referenced in code section number
ANSI/A 190.1—12	Structural Glued Laminated Timber	*1705A.5.4,* 2303.1.3, 2306.1
ANSI/APA PRP 210—08	Standard for Performance-Rated Engineered Wood Siding	2303.1.5, 2304.7, 2306.3, Table 2306.3(1)
ANSI/APA PRR 410—11	Standard for Performance-Rated Engineered Wood Rim Boards	2303.1.13
APA PDS—12	Panel Design Specification	2306.1
APA PDS Supplement 1—12	Design and Fabrication of Plywood Curved Panels (revised 2013)	2306.1
APA PDS Supplement 2—12	Design and Fabrication of Plywood-lumber Beams (revised 2013)	2306.1
APA PDS Supplement 3—12	Design and Fabrication of Plywood Stressed-skin Panels (revised 2013)	2306.1
APA PDS Supplement 4—12	Design and Fabrication of Plywood Sandwich Panels (revised 2013)	2306.1

APA—continued

APA PDS Supplement 5—12	Design and Fabrication of All-plywood Beams (revised 2013)	2306.1
APA PRG 320—11	Standard for Performance-Rated Cross-Laminated Timber	2303.1.4
EWS R540—12	Builders Tips: Proper Storage and Handling of Glulam Beams	2306.1
EWS S475—07	Glued Laminated Beam Design Tables	2306.1
EWS S560—10	Field Notching and Drilling of Glued Laminated Timber Beams	2306.1
EWS T300—07	Glulam Connection Details	2306.1
EWS X440—08	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—2013	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 June 1998 (R2008)	Diaphragm Design of Metal-clad, Wood-frame Rectangular Buildings	2306.1
EP 486.2 OCT 2012	Shallow-post and Pier Foundation Design	2306.1
EP 559.1 W/Corr.1 AUG 2010	Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies	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
5—13	Building Code Requirements for Masonry Structures	1405.6, 1405.6.1, 1405.6.2, 1405.10, 1604.3.4, 1705.4, 1705.4.1, 1807.1.6.3, 1807.1.6.3.2, 1808.9, 2101.2, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, *2114.7, 2114.8*, *2107A.5, 2107A.6*
6—13	Specification for Masonry Structures	1405.6.1, 1705.4, 1807.1.6.3, 2103.1, 2103.2.1, 2103.3, 2103.4, 2104.1, 2105.1
7—10	Minimum Design Loads for Buildings and Other Structures with Supplement No. 1 *and 2, excluding Chapter 14 and Appendix 11A*	202, Table 1504.8, 1602.1, 1604.3, Table 1604.5, 1604.8.2, 1604.10, 1605.1, 1605.2.1, 1605.3.1, 1605.3.1.2, 1605.3.2, 1605.3.2.1, 1607.8.1, 1607.8.1.1, 1607.8.1.2, 1607.8.3, 1607.12.1, 1608.1, 1608.2, 1608.3, 1609.1.1, 1609.1.2, 1609.3, 1609.5.1, 1609.5.3, 1609.6, 1609.6.1, 1609.6.1.1, 1609.6.2, Table 1609.6.2, 1609.6.3, 1609.6.4.1, 1609.6.4.2, 1609.6.4.4.1, 1611.2, 1612.4, 1613.1, 1613.3.2, Table 1613.3.3(1), Table 1613.3.3(2), 1613.3.5, 1613.3.5.1, 1613.3.5.2, 1613.4, 1613.4.1, 1613.5.1, 1613.6, 1614.1, 1704.6.1, 1705.12, 1705.12.4, 1705.13.2, 1705.13.3, 1705.13.4, 1803.5.12, 1808.3.1, 1810.3.6.1, 1810.3.9.4, 1810.3.11.2, 1810.3.12, 1905.1.1, 1905.1.2, 1905.1.8, 2205.2.1.1, 2205.2.1.2, 2205.2.2, 2206.2.1, 2209.1, 2210.2, 2304.6.1, 2404.1, 2505.1, 2505.2, 2506.2.1 *104.11, Table 1504.8, 1510.7.1, 1603A.2 1613A, 1616A, 1616.2, 1616.9, 1616.10, 1803A.6, 2410.1.1, 2410.1.2, 3419.7.2*
8—14	Standard Specification for the Design of Cold-formed Stainless Steel Structural Members	1604.3.3, 2210.1, 2210.2
19—*10*	Structural Applications of Steel Cables for Buildings	2208.1, 2208.2, *2208A.1*

ASCE/SEI—continued

24—*14*	Flood Resistant Design and Construction	1612*A*.4, 1612*A*.5, 1203.4.2, 1612.4, 1612.5, 2702.1.7, 3001.2
29—14	Standard Calculation Methods for Structural Fire Protection	722.1
32—01	Design and Construction of Frost Protected Shallow Foundations	1809.5
41—13	*Seismic Evaluation and Retrofit of Existing Buildings*	*1603A.2, 1616A.1.30, 3401.5, 3412A, 3413A, 3417.5, 3417.8, 3418.1, 3419.1, 3419.2, 3419.5, 3419.7.2, 3419.8, 3419.9, 3420.1, 3421.2.2, 3406A, 3412A, 3413A*
49—*12*	Wind Tunnel Testing for Buildings and Other Structures	1609.1.1, *1609A.1.1*
55—10	Tensile Membrane Structures	3102.1.1

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Standard reference number	Title	Referenced in code section number
ASME/A17.1—13 CSA B44—2013	Safety Code for Elevators and Escalators	907.3.3, 911.1.5, 1009.4, *11B-407.1, 11B-407.1.1, 11B-407.4.9, 11B-408.1, 11B-409.1, 11B-411.1, 11B-810.9,* 1607.9.1, 3001.2, 3001.4, 3002.5, 3003.2, 3007.1, 3008.1.3, 3008.7.1
A18.1—2008	Safety Standard for Platform Lifts and Stairway Chairlifts	*11B-410.1*
A90.1—09	Safety Standard for Belt Manlifts	3001.2
B16.18—2012	Cast Copper Alloy Solder Joint Pressure Fittings	909.13.1
B16.22—2001(R2010)	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	909.13.1
B20.1—2009	Safety Standard for Conveyors and Related Equipment	3001.2, 3004.3
BPE—2009	*Bio-processing Equipment Standard*	
B31.3—2012	Process Piping	415.11.6

ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

Standard reference number	Title	Referenced in code section number
A6/A6M—11	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet	1810.3.2.3, 1810.3.5.3.1, 1810.3.5.3.3
A36/A36M—08	Specification for Carbon Structural Steel	1810.3.2.3
A153/A153M—09	Specification for Zinc Coating (Hot-dip) on Iron and Steel Hardware	*2304.10.1.1,* 2304.10.5
A227—06 (2011)	*Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs*	*1211.1.1*
A229—12	*Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs*	*1211.1.1*
A240/A240M—13A	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)
A252—10	Specification for Welded and Seamless Steel Pipe Piles	1810.3.2.3
A283/A283M—12A	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates	1810.3.2.3
A370—13	*Standard Test Methods and Definitions for Mechanical Testing of Steel Products*	*3413A.1.3*
A416/A416M—12A	Specification for Steel Strand, Uncoated Seven-wire for Prestressed Concrete	1810.3.2.2
A463/A463M—10	Standard Specification for Steel Sheet, Aluminum-coated, by the Hot-dip Process	Table 1507.4.3(2)
A572/A572M—12A	Specification for High-strength Low-alloy Columbium-Vanadium Structural Steel	1810.3.2.3
A588/A588M—10	Specification for High-strength Low-alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point with Atmospheric Corrosion Resistance	1810.3.2.3
A615/A615M—12	Specification for Deformed and Plain Billet-steel Bars for Concrete Reinforcement	1704.5, 1810.3.10.2
A653/A653M—11	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), 2304.10.5.1
A690/A690M—07(2012)	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
A706/A706M—09b	Specification for Low-alloy Steel Deformed and Plain Bars for Concrete Reinforcement	1704.5, 2107.4, 2108.3

ASTM—continued

A722/A722M—12	Specification for Uncoated High-strength Steel Bar for Prestressing Concrete	1810.3.10.2, *1811A.4, 1812A.4.2*
A755/A755M—2011	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)
A792/A792M—10	Specification for Steel Sheet, 55% Aluminum-zinc Alloy-coated by the Hot-dip Process	Table 1507.4.3(1), Table 1507.4.3(2)
A875/A875M—13	Standard Specification for Steel Sheet Zinc-5 percent, Aluminum Alloy-coated by the Hot-dip Process	Table 1507.4.3(2)
A924/A924M—13	Standard Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-dip Process	Table 1507.4.3(1)
A1064—13	*Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete*	*1903A.8*
B42—10	Specification for Seamless Copper Pipe, Standard Sizes	909.13.1
B43—09	Specification for Seamless Red Brass Pipe, Standard Sizes	909.13.1
B68—11	Specification for Seamless Copper Tube, Bright Annealed (Metric)	909.13.1
B88—09	Specification for Seamless Copper Water Tube	909.13.1
B101—12	Specification for Lead-coated Copper Sheet and Strip for Building Construction	1404.5.3, Table 1507.2.9.2, Table 1507.4.3(1)
B209—10	Specification for Aluminum and Aluminum Alloy Steel and Plate	Table 1507.4.3(1)
B251—10	Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube	909.13.1
B280—08	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	909.13.1
B370—12	Specification for Copper Sheet and Strip for Building Construction	1404.5.2, Table 1507.2.9.2, Table 1507.4.3(1)
B695—04(2009)	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel Strip for Building Construction	*2304.10.1.1,* 2304.10.5.1, 2304.10.5.3
C5—10	Specification for Quicklime for Structural Purposes	Table 2507.2
C22/C22M-00(2010)	Specification for Gypsum	Table 2506.2
C27—98(2008)	Specification for Classification of Fireclay and High-alumina Refractory Brick	2111.6
C28/C28M—10	Specification for Gypsum Plasters	Table 2507.2
C31/C31M—12	Practice for Making and Curing Concrete Test Specimens in the Field	Table 1705.3
C33/C33M—13	Specification for Concrete Aggregates	722.3.1.4, 722.4.1.1.3
C35/C35M-1995(2009)	Specification for Inorganic Aggregates for Use in Gypsum Plaster	Table 2507.2
C55—2011	Specification for Concrete Building Brick	Table 722.3.2
C59/C59M—00 (2011)	Specification for Gypsum Casting Plaster and Molding Plaster	Table 2507.2
C61/C61M—00 (2011)	Specification for Gypsum Keene's Cement	Table 2507.2
C62—13	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)	1807.1.6.3
C67—13	Test Methods of Sampling and Testing Brick and Structural Clay Tile	721.4.1.1.1, 2109.3.1.1
C73—10	Specification for Calcium Silicate Brick (Sand-lime Brick)	Table 722.3.2
C90—14	Specification for Loadbearing Concrete Masonry Units	Table 722.3.2, 1807.1.6.3, *2105A.2*
C91—12	Specification for Masonry Cement	Table 2507.2
C94/C94M—*14a*	Specification for Ready-Mixed Concrete	110.3.1, *1705A.3.3.1*
C114—10	*Standard Test Methods for Chemical Analysis of Hydraulic Cement*	*1903A.6, 1913.2.3*
C140—13	Test Method Sampling and Testing Concrete Masonry Units and Related Units	722.3.1.2
C144—04	*Standard Specification for Aggregate for Masonry Mortar*	*2103A.8*
C150—12	Specification for Portland Cement	*1909.2.4, 1910A,* 1903.1, Table 2507.2
C172/C172M—10	Practice for Sampling Freshly Mixed Concrete	Table 1705.3
C199—84 (2011)	Test Method for Pier Test for Refractory Mortars	2111.6, 2111.9, 2113.12
C206—13	Specification for Finishing Hydrated Lime	Table 2507.2
C208—12	Specification for Cellulosic Fiber Insulating Board	Table 1508.2, 2303.1.6
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E605—93 (2011)	Test Method for Thickness and Density of Sprayed Fire-resistive Material (SFRM) Applied to Structural Members. 1705.14.4.1, 1705.14.4.2, 1705.14.4.5, 1705.14.5
E648–04	*Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 804.4.1, 804.4.2*
E662—09	*Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials. 804.4.1, 804.4.2*
E681—2009	Test Methods for Concentration Limits of Flammability of Chemical Vapors and Gases 202
E736—00 (2011)	Test Method for Cohesion/Adhesion of Sprayed Fire-resistive Materials Applied to Structural Members 704.13.2, 1705.14.6
E814—2013	Test Method of Fire Tests of Through-penetration Firestops 202, 714.3.1.2, 714.3.2, 7143.4.1.1.2
E970—2010	Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source 720.3.1
E1300—12AE1	Practice for Determining Load Resistance of Glass in Buildings 2404.1, 2404.2, 2404.3.1, 2404.3.2, 2404.3.3, 2404.3.4, 2404.3.5
E1354—2013	Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter. 424.2
E1592—05(2012)	Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference 1504.3.2
E1602—02(2010)E1	Guide for Construction of Solid Fuel-burning Masonry Heaters. 2112.2
E1886—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
E1966—07A(2011)	Test Method for Fire-resistant Joint Systems. 202, 715.3
E1996—2012A	Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes 1609.1.2, 1609.1.2.2
E2072—10	Standard Specification for Photoluminescent (Phosphorescent) Safety Markings 1025.3
E2174—10AE1	Standard Practice for On-Site Inspection of Installed Fire Stops 1705.17.1
E2178—13	Standard Test Method for Air Permeance of Building Materials 202
E2273—03(2011)	Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies. 1408.4.1
E2307—2010	Standard Test Method for Determining Fire Resistance of a Perimeter Joint System Between an Exterior Wall Assembly and Floor Assembly Using the Intermediate-scale, Multistory Test Apparatus. 715.4
E2393—10A	Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barrier 1705.17.2

ASTM—continued

E2397—11	Standard Practice for Determination of Dead Loads and Live Loads Associated with Green Roof Systems	1607.12.3.1
E2404—2013E1	Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Vinyl Wall or Ceiling Coverings to Assess Surface Burning Characteristics	803.1.4
E2556—10	Standard Specification for Vapor Permeable Flexible Sheet Water-Resistive Barriers Intended for Mechanical Attachment	1404.2, 2510.6
E2568—09e1	Standard Specification for PB Exterior Insulation and Finish Systems	1408.2
E2570—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, 1705.16.1
E2573—12	Standard Practice for Specimen Preparation and Mounting of Site-fabricated Stretch Systems to Assess Surface Burning Characteristics	803.13
E2599—11	Standard Practice for Specimen Preparation and Mounting of Reflective Insulation Materials and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics	2614.3
E2634—11	Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems	1903.4
E2751—11	Standard Practice for Design and Performance of Supported Glass Walkways	2409.1
F547—(2012)	Terminology of Nails for Use with Wood and Wood-based Materials	Table 2506.2
F606—14	*Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators and Rivets*	*2213A.1*
F1292—99	*Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment*	*11B-1008.2.6.2*
F1292—04	*Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment*	*11B-1008.2.6.2*
F1487—01	*Standard Consumer Safety Performance Specification for Playground Equipment for Public Use*	*202-USE ZONE*
F1951—99	*Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment*	*11B-1008.2.6.1*
F1346—91 (2010)	Performance Specification for Safety Covers and Labeling Requirements for All Covers for Swimming Pools, Spas and Hot Tubs	3109.4, 3109.4.1.8
F1667—11AE1	Specification for Driven Fasteners: Nails, Spikes and Staples	Table 721.1(2), Table 721.1(3), 1507.2.6, 1507.17.5, 2303.6, Table 2506.2
F2006—00 (2005) 10	Standard/Safety Specification for Window Fall Prevention Devices for Nonemergency Escape (Egress) and Rescue (Ingress) Windows	1015.8
F2090—10	Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms	1015.8, 1015.8.1
F2200—2013	Standard Specification for Automated Vehicular Gate Construction	3110.3
G152—06	Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials	1504.6
G154—06	Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials	1504.6
G155—05a	Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials	1504.6

AWC

American Wood Council
222 Catoctin SE, Suite 201
Leesburg, VA 20175

Standard reference number	Title	Referenced in code section number
AWC WCD No. 4—2003	Wood Construction Data—Plank and Beam Framing for Residential Buildings	2306.1.2
AWC WFCM—2015	Wood Frame Construction Manual for One- and Two-Family Dwellings	1609.1.1, 1609.1.1.1, 2301.2, 2308.2.4, 2309.1
ANSI/AWC NDS—2015	National Design Specification (NDS) for Wood Construction with 2012 Supplement	202, 722.1, 722.6.3.2, Table 1604.3, 1711.1.1, 1711.1.2.1, 1809.12, 1810.3.2.4, Table 1810.3.2.6, 1905.1.8, *1905A.1.8,* 2302.1, 2304.13, 2306.1, 2306.2, Table 2306.2(1), Table 2306.2(2), Table 2306.3(1), Table 2306.3(2), 2307.1
AWC STJR—2015	Span Tables for Joists and Rafters	2306.1.1, 2308.4.2.1, 2308.7.1, 2308.7.2
ANSI/AWC PWF—2015	Permanent Wood Foundation Design Specification	1805.2, 1807.1.4, 2304.10.5.2
AWC SDPWS—2015	Special Design Provisions for Wind and Seismic	202, 2305.1, 2305.2, 2305.3, 2306.2, 2306.3, Table 2306.3(1), Table 2306.3(3), 2307.1

AWCI

Association of the Wall and Ceiling Industry
513 West Broad Street, Suite 210
Falls Church, VA 22046

Standard reference number	Title	Referenced in code section number
12-B—04	Technical Manual 12-B Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-resistive Materials; an Annotated Guide, Second Edition	1705.15

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—11	Standard for the Care of Preservative-treated Wood Products	1810.3.2.4.1, 2303.1.9
U1—14	USE CATEGORY SYSTEM: User Specification for Treated Wood Except Section 6, Commodity Specification H	1403.6, Table 1507.9.6, 1807.1.4, 1807.3.1, 1809.12, 1810.3.2.4.1, *1812A.2,* 2303.1.9, 2304.12.1, 2304.12.2, 2304.12.3, 2304.2.4, 2304.12.5

AWS

American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126

Standard reference number	Title	Referenced in code section number
D1.1—10	*Structural Welding Code—Steel*	*Table 1705A.2.1, 1705A.2.5, 2212.6.2, 2213A.2*
D1.3—08	*Structural Welding Code—Sheet Steel*	*Table 1705A.2.1, 1705A.2.5*
D1.4/D1.4M—2011	Structural Welding Code-Reinforcing Steel Including Metal Inserts and Connections In Reinforced Concrete Construction	1704.5, 1705.3.1, Table 1705.3, *Table 1705A.2.1,* 2107.4
D1.8—09	*Structural Welding Code – Seismic Supplement*	*1704A.3.1.4, 1705A.2.5, 2204A.1.1, 2204A.1.3, 2211.1*
QC1—07	*Standard for AWS Certification of Welding Inspectors.*	*1704A.3.1.4, 1705A.2.5*

BHMA

Builders Hardware Manufacturers' Association
355 Lexington Avenue, 17th Floor
New York, NY 10017-6603

Standard reference number	Title	Referenced in code section number
A 156.10—2011	Power Operated Pedestrian Doors	1010.1.4.2, *11B-404.2.9, 11B-404.3*
A 156.19—2013	Standard for Power Assist and Low Energy Operated Doors	1010.1.4.2, *11B-404.2.9, 11B-404.3, 11B-408.3.2.1, 11B-409.3.1*
A 156.27—11	Power and Manual Operated Revolving Pedestrian Doors	1010.1.4.1

CEN

European Committee for Standardization (CEN)
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.	406.7.1
BS EN 15250—2007	Slow Heat Release Appliances Fired By Solid Fuel Requirements and Test Methods	2112.2, 2112.5

CGSB

Canadian General Standards Board
Place du Portage 111, 6B1
11 Laurier Street
Gatineau, Quebec, Canada KIA 1G6

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
19465 Deerfield Avenue, Suite 306
Leesburg, VA 20176

Standard reference number	Title	Referenced in code section number
ANSI A135.4—2012	Basic Hardboard	1404.3.1, 2303.1.7
ANSI A135.5—2012	Prefinished Hardboard Paneling	2303.1.7, 2304.7
ANSI A135.6—2012	Engineered Wood Siding	1404.3.2, 2303.1.7
A208.1—09	Particleboard	2303.1 8, 2303.1. 8.1

CPSC

Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814-4408

Standard reference number	Title	Referenced in code section number
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, 2409.2, 2409.3.1, 2409.4.1
16 CFR Part 1209 (2002)	Interim Safety Standard for Cellulose Insulation	720.6
16 CFR Part 1404 (2002)	Cellulose Insulation.	720.6
16 CFR Part 1500 (2009)	Hazardous Substances and Articles; Administration and Enforcement Regulations	202
16 CFR Part 1500.44(2009)	Method for Determining Extremely Flammable and Flammable Solids	202
16 CFR Part 1507 (2002)	Fireworks Devices.	202
16 CFR Part 1630 (2007)	Standard for the Surface Flammability of Carpets and Rugs	804.4.1

CSA

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario Canada L4W 5N6

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	Specifications for Windows, Doors and Unit Skylights	1709.5.1, 2405.5

CSSB

Cedar Shake and Shingle Bureau
P. O. Box 1178
Sumas, WA 98295-1178

Standard reference number	Title	Referenced in code section number
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

Standard reference number	Title	Referenced in code section number
ANSI/DASMA 107—1997 (R2012)	Room Fire Test Standard for Garage Doors Using Foam Plastic Insulation	2603.4.1.9
108—12	Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference	1709.5.2
115—12	Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure.	1609.1.2.3

DOC

U.S. Department of Commerce
National Institute of Standards and Technology
1401 Constitution Avenue NW
Washington, DC 20230

Standard reference number	Title	Referenced in code section number
PS-1—09	Structural Plywood.	2303.1.5, 2304.7, Table 2304.7(4), Table 2304.7(5), Table 2306.2(1), Table 2306.2(2)
PS-2—10	Performance Standard for Wood-based Structural-use Panels	2303.1.5, 2304.7, Table 2304.7(5), Table 2306.2(1), Table 2306.2(2)
PS 20—05	American Softwood Lumber Standard.	202, 1810.3.2.4, 2303.1.1

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 (2009)	Air Contaminants	202

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	202
49 CFR Parts 173.137 (2009)	Shippers—General Requirements for Shipments and Packaging—Class 8—Assignment of Packing Group	202
49 CFR—1998	Specification of Transportation of Explosive and Other Dangerous Articles, UN 0335, UN 0336 Shipping Containers	202

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	*Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment-frame Buildings*	*3419.2*
FEMA-TB-11—01	Crawlspace 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—15	*Approval Standard for Seismic Sway Braces for Pipe, Tubing and Conduit*	*1705A.13.2*
3260—00	*Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling.*	
3011—99	*Approval Standard for Central Station Service for Fire Alarm and Protective Equipment Supervision*	
FM 4430—12	*Approved Standard for Smoke and Heat Vents.*	*910.3.2*
4430—80	*Acceptance Criteria for Smoke and Heat Vents*	*910.3.1*
4470 (2012)	Approval Standard for Single-Ply Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) And Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction	1504.7
4474 (2011)	American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures	1504.3.1, 1504.3.2
4880-2010	Approval Standard for Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall Systems	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—13	Application and Finishing of Gypsum Panel Products	Table 2508.1, 2509.2
GA 600—09	Fire-Resistance Design Manual, 20th Edition	Table 721.1(1), Table 721.1(2), Table 721.1(3)

HPVA

Hardwood Plywood Veneer Association
1825 Michael Faraday Drive
Reston, VA 20190

Standard reference number	Title	Referenced in code section number
HP-1—2013	Standard for Hardwood and Decorative Plywood	2303.3, 2304.7

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	ICC Standard on Bleachers, Folding and Telescopic Seating and Grandstands.	1029.1.1, Table 1607.1
ICC 400—12	Standard on Design and Construction of Log Structures	2301.2
ICC 500—14	ICC/NSSA Standard on the Design and Construction of Storm Shelters.	202, 423.1, 423.3, 423.4
ICC 600—14	Standard for Residential Construction in High-wind Regions	1609.1.1, 1609.1.1.1, 2308.2.1
*ICC-ES AC 01—15**	*Acceptance Criteria for Expansion Anchors in Masonry Elements*	*1616A.1.19*
*ICC-ES AC 58—15**	*Acceptance Criteria for Adhesive Anchors in Masonry Elements*	*1616A.1.19*

ICC—continued

*ICC-ES AC 70—15**	*Acceptance Criteria for Fasteners Power-Driven into Concrete, Steel and Masonry Elements*	*1616A.1.20*
ICC-ES AC 77	*Acceptance Criteria for Smoke Containment Systems Used with Fire-resistance-rated Elevator Hoistway Doors and Frames*	*707.14.1*
*ICC-ES AC 106—15**	*Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry*	*1616A.1.19*
*ICC-ES AC 125—15**	*Acceptance Criteria for Concrete, and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems*	*1911A.3*
*ICC-ES AC 156—15**	*Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components*	*1705A.13.3*
*ICC-ES AC 178—15**	*Acceptance Criteria for Inspection and Verification of Concrete, and Reinforced and Unreinforced Masonry Strengthening Using Fiber-Reinforced Polymer (FRP) Composite Systems*	*1911A.3*
*ICC-ES AC 193—15**	*Acceptance Criteria for Mechanical Anchors in Concrete Elements*	*1616A.1.19*
*ICC-ES AC 232—15**	*Acceptance Criteria for Anchor Channels in Concrete Elements*	*1616A.1.19, 1901.3.2*
*ICC-ES AC 308—15**	*Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements*	*1616A.1.19, 1901.3.3*
ICC-ES AC 331	*Acceptance Criteria for Smoke and Heat Vents*	*910.3.1*
*ICC-ES AC 358—15**	*Acceptance Criteria for Helical Foundation Systems and Devices*	*1810A.3.1.5.1*
*ICC-ES AC 446—15**	*Acceptance Criteria for Headed Cast-in Specialty Inserts in Concrete*	*1616A.1.19, 1901.3.2*
SBCCI SSTD 11—97	Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles	1504.2.1.1, 1504.2.1.2

** Refers to International Building Code, 2015 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
ISO 8115—86	Cotton Bales—Dimensions and Density	Table 307.1(1), Table 415.11.1.1.1
ISO 8336—09	Fiber-Cement Flat Sheets - Product Specification and Test Methods	1404.10, 1405.16.1, 1405.16.2, Table 2509.2
ISO 9001—15	*Quality Management Systems - Requirements*	*1705A.13.3*
ISO 17020-12	*Conformity Assessment - Requirements for the Operation of Various Types of Bodies Performing Inspection*	*1704A.2*
ISO 17025—05	*General Requirement for Competence of Testing and Calibration Laboratories*	*1703A.4*

MHI

Material Handling Institute
8720 Red Oak Blvd. Suite 201
Charlotte, NC 28217

Standard reference number	Title	Referenced in code section number
ANSI MH29.1—08	Safety Requirements for Industrial Scissors Lifts	3001.2

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
FP 1001—07	Guide Specifications for Design of Metal Flag Poles	1609.1.1

NCMA

National Concrete Masonry Association
13750 Sunrise Valley
Herndon, VA 22071-4662

Standard reference number	Title	Referenced in code section number
TEK 5—84 (1996)	Details for Concrete Masonry Fire Walls	Table 721.1(2)

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

Standard reference number	Title	Referenced in code section number
11—10	Low-, Medium- and High-Expansion Foam	904.7
12—11	Standard on Carbon Dioxide Extinguishing Systems	904.8, 904.11
12A—09	Standard on Halon 1301 Fire Extinguishing Systems	904.9
13—*16*	Installation of Sprinkler Systems, *as amended**	708.2, 903.3.1.1, 903.3.2, 903.3.8.2 903.3.8.5, 904.11, 905.3.4, 907.6.4, 1019.3

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.

Revise Section 8.15.1.2.15 as follows:

8.15.1.2.15 Exterior columns under 10 ft^2 (0.93 m^2) 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.

Add new Section 8.15.5.6.1 as follows:

8.15.5.6.1 *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 exterior canopies, roofs, porte-cocheres, 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 ft^3 (4.5 m^3) 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 11.2.3.1.5.2(9)].

(3) Concealed spaces over isolated small roofs, or canopies not exceeding 55 ft^2 (5.1 m^2).

Delete language to Section 8.15.7.4 and reserve Section number.
8.15.7.4. Reserved.

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.

NFPA—continued

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 8.16.1.1.1.4 and 8.16.1.1.1.5 as follows:

8.16.1.1.1.4 *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.*

8.16.1.1.1.5 *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.*

Add new Sections 8.16.1.6, 8.16.1.6.1, 8.16.1.6.1.1, 8.16.1.6.1.2, 8.16.1.6.1.3 and 8.16.1.6.2, as follows:

8.16.1.6 Sectional Valves.

8.16.1.6.1 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.

8.16.1.6.1.1 *Sectional control valves are not required when the fire service main system serves less than six fire appurtenances.*

8.16.1.6.1.2 *Sectional control valves shall be indicating valves in accordance with Section 6.6.1.3.*

8.16.1.6.1.3 *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.*

8.16.1.6.1.4 *The number of fire appurtenances between sectional control valves is allowed to be modified by the authority having jurisdiction.*

8.16.1.6.2 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 *Power-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 9.3.5.12.5 as follows:

9.3.5.12.5 *Lag screws or power-driven fasteners shall not be used to attach braces to the building structure.*

Replace 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 9.3.5.12.8.4 as follows:

9.3.5.12.8.4 Concrete anchors other than those shown in Table 9.3.5.12.2(a) through Table 9.3.5.12.2(f) *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.

NFPA—continued

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. Power-driven fasteners for attaching restraint is allowed to be used provided that the restraint component does not support the dead load.*

Revise Section 10.4.3.1.1 as follows:

10.4.3.1.1 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 10.4.3.2

2. Alternate designs may be utilized where designed by a registered professional engineer and approved by the enforcing agency.

Revise Section 11.2.3.1.5.2(9) as follows:

11.2.3.1.5.2(9) *Exterior columns under 10 ft^2 (0.93 m^2) 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.*

Revise Section 11.2.3.2.3.1 as follows:

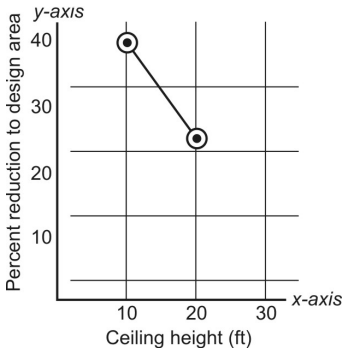
11.2.3.2.3.1 Where listed quick-response sprinklers, excluding extended coverage quick-response sprinklers, are used throughout a system or portion of a system having the same hydraulic design basis, the system area of operation shall be permitted to be reduced without revising the density as indicated 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 ft^2 (3 m^2).



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.

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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*.

NFPA—continued

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 360ºF (182ºC) or 100ºF (56ºC) above the operating temperature of the sprinklers, whichever is higher.*

Revise Section 25.1 as follows:

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 25.2).*

(3) Complete and sign the appropriate contractor's material and test certificate(s) *(see Figure 25.1).*

(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 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.

(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."

Revise Section 25.5.1 as follows:

25.5.1 The installing contractor shall identify a hydraulically designed sprinkler system with a permanentiy 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. *"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 as follows:

25.5.2 The sign shall include the following information:

(1) Location of the design area or areas

(2) Discharge densities over the design area or areas

(3) Required flow and pressure of the system at the base of the riser

(4) Occupancy classification or commodity classification and maximum permitted storage height and configuration

(5) Hose stream allowance included in addition to the sprinkler demand

(6) The name of the installing contractor

(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 *The installing contractor shall provide a general information sign used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements required by NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2013 California Edition.*

NFPA—continued

13D—*16* Standard for the Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes *as amended** 903.3.1.3

NFPA 13D, Amended Sections as follows:

Revise Section 6.2.2 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.

Add new Section 6.2.2.1 as follows:

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.*

Add new Section 6.2.4 as follows:

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.*

Revise Section 8.3.4 to read as follows:

8.3.4* Sprinklers shall not be required in *detached* garages, open attached porches, carports *with no habitable space above,* and similar structures.

Add new Sections 8.3.10 and 8.3.10.1 as follows:

8.3.10 Solar photovoltaic panel structures

8.3.10.1 *Sprinklers shall be permitted to be omitted from the 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—*16* 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 Sections 6.6.10 and 6.10.1 as follows:

6.6.10 Solar photovoltaic panel structures

6.6.10.1 *Sprinklers shall be permitted to be omitted from the 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 as follows:

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.

NFPA—continued

(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—15 Standard for the Installation of Foam-water Sprinkler and Foam-water Spray Systems. 904.7, 904.11

17—13 Standard for Dry Chemical Extinguishing Systems. 904.6, 904.11

17A—13 Standard for Wet Chemical Extinguishing Systems 904.5, 904.11

20—*16* Installation of Stationary Pumps for Fire Protection 913.1, 913.2.1, 913.5, 913.6

22—13 *Water Tanks for Private Fire Protection*

24—16 *Installation of Private Fire Service Mains and Their Appurtenances, as amended**

NFPA 24, Amended Sections as follows:

Amend Section 4.2.1 as follows:

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.*

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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.*

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Add Sections 6.6.1.1, 6.6.1.2, 6.6.1.4 as follows:

6.6.1.1 *Sectional control valves are not required when the fire service main system serves less than six fire appurtenances.*

6.6.1.2 *Sectional control valves shall be indicating valves in accordance with NFPA 13 Section 6.7.1.3.*

6.6.1.3 *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.*

6.6.1.4 *The number of fire appurtenances between sectional control valves is allowed to be modified by the authority having jurisdiction.*

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NFPA—continued

Revise Section 10.4.3.1.1 as follows:

10.4.3.1.1 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 10.4.3.2

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.*

25—*13* CA *California NFPA 25 Edition (Based on the 2011 Edition)* Inspection, Testing and Maintenance of Water-based Fire Protection Systems . . . . . Chapter 31F
30—12 Flammable and Combustible Liquids Code 415.6, 507.8.1.1.1, 507.8.1.1.2
31—11 Standard for the Installation of Oil-burning Equipment 2113.15
32—11 Dry Cleaning Plants, *as amended** 2101.1.1, 2107.1, 2107.3

****NFPA 32, Amended Sections as follows:***

Delete the following publications from Section 2.2:

2.2 NFPA Publications.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2010 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2011 edition.
NFPA 70, *National Electrical Code®,* 2011 edition.
NFPA 101®, *Life Safety Code®,* 2009 edition.
NFPA 5000®, *Building Construction and Safety Code®,* 2009 edition.

Revise Section 4.4.1.1 to read as follows:

4.4.1.1 General building and structure design and construction shall be in accordance with *California Building Code.*

Delete language to Sections 4.4.1.2 and 4.4.1.3 and reserve section numbers.

4.4.1.2 Reserved

4.4.1.3 Reserved

Revise Section 4.4.4 to read as follows:

4.4.4 Means of Egress. Means of egress shall confonn with the provisions of *the California Building Code.*

Revise Section 4.6.2 to read as follows:

4.6.2 Automatic Sprinkler Systems. Where required by this standard, automatic sprinkler systems shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* and periodically inspected, tested, and maintained in accordance with *California Code of Regulations, Title 19, Division 1, Chapter 5.*

Revise Section 4.6.4 to read as follows:

4.6.4 Portable Fire Extinguishers. Suitable numbers and types of portable fire extinguishers shall be installed and maintained throughout the drycleaning plant in accordance *California Code of Regulations, Title 19, Division 1, Chapter 3.*

Revise Section 7.3.2 to read as follows:

7.3.2 Electrical Installations. Electrical equipment and wiring in a Type II drycleaning room shall comply with the provisions of *California Electrical Code*, for use in Class I, Division 2 hazardous locations.

37—15 *Installation and Use of Stationary Combustion Engines and Gas Turbines*
40—11 Standard for the Storage and Handling of Cellulose Nitrate Film 409.1
52—13 Vehicular Gaseous Fuel Systems Code
54—15 *National Fuel Gas Code*

NFPA—continued

58—14	Liquefied Petroleum Gas Code	415.9.2
61—13	Prevention of Fires and Dust Explosions in Agricultural and Food Product Facilities	426.1
70—14	National Electrical Code	108.3, 415.11.1.8, 904.3.1, 907.6.1, 909.12.2, 909.16.3, 1205.4.1, 2701.1, 2702.1.2, G501.4, G1001.6, H106.1, H106.2, K101, K111.1
72—*16*	National Fire Alarm *and Signaling* Code, *as amended**	901.6, 903.4.1, 904.3.5, 907.2, 907.2.6, 907.2.11, 907.2.13.2, 907.3, 907.3.3, 907.3.4, 907.5.2.1.2, 907.5.2.2, 907.5.2.2.5, 907.5.2.3.5, 907.6, 907.6.1, 907.6.2, 907.6.6, 907.7, 907.7.1, 907.7.2, 911.1.5, 3006.5, 3007.6

NFPA 72, Amended Sections as follows:

Revise Section 10.3.1 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.*

Revise Section 10.3.3 as follows:

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.

Revise Section 10.7.1 as follows:

10.7.1 *Where approved by the authority having jurisdiction,* ECS priority signals when evaluated by stakeholders through risk analysis in accordance with 24.3.11 shall be permitted to take precedence over all other signals.

Revise Section 12.3.8.1 as follows:

12.3.8.1 The outgoing and return (redundant) circuit conductors shall be permitted in the same cable assembly (i.e., multiconductor cable), enclosure, or raceway only under the following conditions:

(1) For a distance not to exceed 10 ft (3.0 m) where the outgoing and return conductors enter or exit the initiating device, notification appliance, or control unit enclosures

(2) Single drops installed in the raceway to individual devices or appliances

(3)*1n a single room not exceeding 1000 ft^2 (93 m^2) in area, a drop installed in the rooeway to multiple devices or appliances that does not include any emergency control function devices

(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.

Revise Section 14.4.6.1 as follows:

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.

Revise Section 17.15 as follows:

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.*

Revise Section 21.3.6 as follows:

21.3.6 Smoke detectors shall not be installed in unsprinklered elevator hoistways unless they are installed to activate the eleva- tor hoistway smoke relief equipment *or where required by Chapter 30 of the California Building Code*.

Revise Section 12.3.7 as follows:

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.

NFPA—continued

Revise Section 23.8.5.1.2 as follows:

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.*

Revise Section 23.8.5.4.1 as follows:

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.

Revise Section 29.3.1 as follows:

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* the for the purposes for which they are intended.

Revise Section 29.5.2.1.1 as follows:

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.

Note: Exception to 29.5.2.1.1 not adopted by the SFM.

Add Section 29.7.2.1 as follows:

29.7.2.1 *The alarm verification feature shall not be used for household fire warning equipment.*

Add Section 29.7.6.7.1 as follows:

29.7.6.7.1 *The alarm verification feature shall not be used for household fire warning equipment.*

Revise Section 29.8.3.4 as follows:

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 40ºF (4ºC) or exceed 100ºF (38ºC).

(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.

Exceptions: *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.

NFPA—continued

(5) Effective January 1, 2016, smoke alarms and smoke detectors used in household fire alarm systems installed between 6 ft (1.8 m) and 20 ft (6.1 m) along a horizontal flow path from a stationary or fixed cooking appliance shall be listed for resistance to common nuisance sources from cooking.

(6) 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.

(7) 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.

(8) 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.

(9) 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.

(10) 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.

(11) 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.

(12) Smoke alarms and detectors installed in rooms with joists or beams shall comply with the requirements of 17.7.3.2.4 of NFPA 72.

(13) Heat alarms and detectors installed in rooms with joists or beams shall comply with the requirements of 17.6.3 of NFPA 72

80—*16*	Fire Doors and Other Opening Protectives	410.3.5, 509.4.2, 716.5, 716.5.7, 716.5.8.1, 716.5.9.2, 716.6, 716.6.4, 1010.1.4.3
82—14	Standard on Incinerators and Waste and Linen Handling Systems and Equipment	713.13
85—11	Boiler and Combustion System Hazards Code	415.8.1
92—15	Standard for Smoke Control Systems	909.7, 909.8
99—15	Health Care Facilities Code	407.10, 425.1
101—15	Life Safety Code	*807.4.3.2,* 1028.6.2
105—*16*	Standard for Smoke Door Assemblies and Other Opening Protectives	405.4.2, 710.5.2.2, 716.5.3.1, 909.20.4.1
110—*16*	Emergency and Standby Power Systems	2702.1.2
111—*16*	Stored Electrical Energy Emergency and Standby Power Systems	2702.1.2
120—15	Fire Prevention and Control in Coal Mines	426.1
130—14	*Standard for Fixed Guideway Transit and Passenger Rail Systems*	*443*

****NFPA 130, Amended Sections as follows:***

Amend Section 2.2 and amend publications to read as follows:

2.2 NFPA Publications.

NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, *2013 California edition.*

Amend Section 3.3.44.2 and amend publications to read as follows:

3.3.44.2* Open Station. A station that is constructed such that it is directly open to the atmosphere and smoke and heat are allowed to disperse directly into the atmosphere.

The following enclosed areas in open stations are permitted:

1. Ticket/pass booths not exceeding 150 square feet (13.9 m^2) in area.

2. Mechanical and electrical spaces typically not used for human occupancy and necessary for the operation of a fixed guideway transit system. Such spaces shall be limited to two per level.

3. Restrooms not exceeding 150 square feet (13.9 m^2) in area. A maximum of four restrooms are permitted per level.

NFPA—continued

Add a new definition as 3.3.44.3 to read as follows:

3.3.44.1.1 Underground Station. *A station or portion thereof that is located beneath the surface of the earth or of the water.*

Amend Section 5.2.2.1 to read as follows:

5.2.2.1 Building construction for all new enclosed stations shall be not less than *Type IA, Type IB or Type IIA construction and shall not exceed in area or height the limits specified in the California Building Code Table 503,* for the station configuration or as determined by fire hazard analysis of potential fire exposure hazards to the structure.

Add Section 5.2.2.1.1 –5.2.2.1.3 to read as follows:

5.2.2.1.1 *Underground stations shall be a minimum Type IA or Type IB constructions.*

5.2.2.1.2 *Open stations may be of Type IIB construction and shall not exceed in area or height as required by Table 503 for Type IIA.*

5.2.2.1.3 *Open at grade stations may be of any construction type allowed by the California Building Code.*

Delete Section 5.2.2.2.

Amend Section 5.2.4.3 to read as follows:

5.2.4.3 Ancillary Spaces. Fire resistance ratings of separations between ancillary occupancies shall be established as required by the *California Building Code*.

Amend Section 5.2.4.3.1 to read as follows:

5.2.4.3.1 *The following areas shall be separated by a two-hour fire barrier:*

1. *Electrical control rooms, auxiliary electrical rooms and associated battery rooms*
2. *Trash rooms*
3. *Train control rooms and associated battery rooms*
4. *Fan rooms*
5. *Emergency generator rooms*

Amend Section 5.2.4.5 to read as follows:

5.2.4.5* Separation Between System and Nonsystem Occupancies. All station public areas shall be fire separated from adjacent non-system occupancies *by a one hour fire barrier, unless otherwise required by other provisions of the California Building Code.*

Amend Section 5.3.1.1 to read as follows:

5.3.1.1 The provisions for means of egress for a station shall comply with Chapter *10 of the California Building Code,* except as herein modified.

Amend Section 5.3.2.1 to read as follows:

5.3.2.1* The occupant load for a station shall be based on the train load of trains simultaneously entering the station on all tracks in normal traffic direction plus the simultaneous entraining load awaiting trains.

(1) The train load shall consider only one train at any one track.

(2) The basis for calculating train and entraining loads shall be the peak period ridership figures as projected for design of a new system or as updated for an operating system.

(3) Exiting shall be provided for occupant loads recalculated upon increase in service and/ or every five years.

Amend Section 5.3.3.5 to read as follows:

5.3.3.5 Travel Distance. The maximum travel distance on the platform to a point at which a means of egress route leaves the platform shall not exceed *91 440 mm (300 feet).*

NFPA—continued

Amend Section 5.3.3.7 to read as follows:

5.3.3.7 Alternate Egress. At least two means of egress remote from each other shall be provided from each station platform as follows:

(1)*A means of egress used as a public circulation route shall be permitted to provide more than 50 percent of the required egress capacity from a station platform or other location.

(2) Means of egress from separate platforms shall be permitted to converge.

(3) Where means of egress routes from separate platforms converge, the subsequent capacity of the egress route shall be sufficient to maintain the required evacuation time from the incident platform.

(4) Enclosed station platforms shall have a minimum of one exit within 2.5 times the least width of the enclosed station platform up to a maximum of 50 feet (insert mm) from each end.

(5) Routes from platform ends into the underground guideway shall not be considered as exits for calculating exiting requirements.

Amend Section 5.3.11.1 to read as follows:

5.3.11.1 Illumination of the means of egress in stations, including escalators that are considered a means of egress, shall be in accordance with *Chapter 10* of the *California Building Code*.

Amend Section 5.3.11.2 to read as follows:

5.3.11.2 Means of egress, including escalators considered as means of egress, shall be provided with a system of emergency lighting in accordance with *Chapter 10* of the *California Building Code.*

Amend Section 5.4.1.1 to read as follows:

5.4.1.1 Enclosed stations shall be provided with a fire command center in accordance with *Section 911.1.1 through 911.5 of the California Building Code.*

Amend Section 5.4.4.1 to read as follows:

5.4.4.1* An automatic sprinkler protection system shall be provided *where required by Section 903 of the California Building Code.*

Delete Section 5.4.4.2.

Amend Section 5.4.5.1 to read as follows:

5.4.5.1* Class I standpipes shall be installed *where required by Chapter 9 of the California Building Code* in accordance with NFPA 14 except as modified herein.

Amend Section 7.3.2.1 to read as follows:

7.3.2.1 The fan inlet airflow hot temperature shall be determined by an engineering analysis, however, this temperature shall not be less than *482*°C (*250*°F). *Ventilation fans and related components shall be capable of withstanding the maximum anticipated plus/minus pressure transients induced by train operations.*

Add Section 7.6.1.1 to read as follows:

***7.6.1.1** Ventilation of stations shall not terminate at grade on any vehicle roadway.*

Amend Section 7.7.1 to read as follows:

7.7.1 Operation of the emergency ventilation system components shall be *capable of automatic and manual initiation in accordance with 909.12.3 of the California Building Code.*

Amend Section 7.8.1 to read as follows:

7.8.1 The design of the power for the emergency ventilation system shall comply with the requirements of Article 700 of *the California Electrical Code and Section 909 of the California Building Code.*

170—15 Standard for Fire Safety and Emergency Symbols 1025.2.6.1
211—13 Chimneys, Fireplaces, Vents and Solid Fuel-burning Appliances. 2112.5
221—15 Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls 706.2
252—12 Standard Methods of Fire Tests of Door Assemblies . . . . . 715.4.2, 715.4.3, 715.4.7.3.1, Table 716.3, 716.3.1, 716.4, 716.5.1, 716.5.3, 716.5.8, 716.5.8.1.1
253—15 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source. 406.8.3, 424.2, 804.2, 804.3
257—12 Standard for Fire Test for Window and Glass Block Assemblies . . . . . Table 716.3, 716.4, 716.5.3.2, 716.6, 716.6.1, 716.6.2, 716.6.7.3

NFPA—continued

259—13	Test Method for Potential Heat of Building Materials	2603.4.1.10, 2603.5.3
265—11	Standard Methods 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—12	Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source	1406.2.1.1, 1406.2.1.1.1, 1406.2.1.1.2, 2603.5.7, D105.1
275—13	Standard Method of Fire Tests for the Evaluation of Thermal Barriers	1407.10.2, 2603.4
276—11	Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies With Combustible Above-Deck Roofing Components	1508.1, 2603.3, 2603.4.1.5
285—12	Standard Fire Test Method for the Evaluation of Fire Propagation Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components	718.2.6, 1403.5, 1407.10.4, 1409.10.4, 1510.6.2, 2603.5.5
286—15	Standard Methods of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth	402.6.4.4, 803.1.2, 803.1.2.1, 803.11, 2603.4, 2603.7.2, 2603.9, 2604.2.4, 2614.4
288—12	Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal in Fire-resistance-rated *Assemblies*	712.1.13.1
289—13	Standard Method of Fire Test for Individual Fuel Packages	402.6.2, 424.2
409—*16*	Aircraft Hangars	412.4.6, Table 412.4.6, 412.4.6.1, 412.6.5
418—11	Standard for Heliports	412.8.4
484—15	Standard for Combustible Metals	426.1
502—14	*Standard for Road Tunnels, Bridges, and Other Limited Access Highways*	*429*
654—13	Standard for the Prevention of Fire & Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids	426.1
655—12	Standard for the Prevention of Sulfur Fires and Explosions.	426.1
664—12	Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities	426.1
701—10	Standard Method of Fire Tests for Flame-Propagation of Textiles and Films	410.3.6, 424.2, 801.4, 806.1, 806.3, 806.4, 3102.3, 3102.3.1, 3102.6.1.1, 3105.4, D102.2.8, H106.1.1
704—12	Standard System for the Identification of the Hazards of Materials for Emergency Response	202, 415.5.2
720—15	Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment	9151.6.1, 915.1.6.2, *915.4.1, 915.5.1, 915.5.2, 915.5.6, 915.5.7*
1124—*13*	Manufacture, Transportation, Storage *and Retail Sales* of Fireworks and Pyrotechnic Articles	415.6.1.1
2001—15	Clean Agent Fire Extinguishing Systems, *as amended**	Table 901.6.1, 904.10

NFPA 2001, Amended Sections as follows:

Add Sections 4.3.5.1.1 and 4.3.5.2.1 to read 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—11	Design for Fire Resistance of Precast Prestressed Concrete	722.2.3.1
MNL 128—01	Recommended Practice for Glass Fiber Reinforced Concrete Panels	1903.3
PCI 120—10	*PCI Design Handbook 7th Edition.*	*1905A.1.1, 1905A.1.2*

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	*Recommendations for Prestressed Rock and Soil Anchors (4th Edition)*	*1810A.3.10.4, 1811A.2, 1812A.4, 1812A.5,1813A.2*
PTI DC—10.5-12	Standard Requirements for Design and Analysis of Shallow Concrete Foundations on Expansive Soils	1808.6.2

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—12	Specification for Design, Testing and Utilization of Industrial Steel Storage Racks	2209.1

SBCA

Structural Building Components Association
6300 Enterprise Lane
Madison, WI 53719

Standard reference number	Title	Referenced in code section number
ANSI/FS 100-12	Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing Used in Exterior Wall Covering Assemblies	2603.10

SDI

Steel Deck Institute
P. O. Box 426
Glenshaw, PA 15116

Standard reference number	Title	Referenced in code section number
ANSI/NC1.0—10	Standard for Noncomposite Steel Floor Deck	2210.1.1.1
ANSI/RD1.0—10	Standard for Steel Roof Deck	2210.1.1.2
SDI-C—2011	Standard for Composite Steel Floor Deck Slabs	2210.1.1.3
SDI-QA/QC—2011	Standard for Quality Control and Quality Assurance for Installation of Steel Deck	1705.2.2

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	*Releasing Systems for Security Bars in Dwellings*	1029.4
12-7-3	*Fire-testing Furnaces*	NA
12-7A-1	*Exterior Wall Siding and Sheathing*	703A.7, 707A.2
12-7A-2	*Exterior Window*	703A.7, 708A.2.1
12-7A-3	*Under Eave.*	703A.7, 707A.8
12-7A-4	*Decking.*	703A.7, 709A.3
SFM 12-7A-4A	*Decking Alternate Method A*	703A.7, 709A.3
SFM 12-7A-5	*Ignition Resistant Building Material*	703A.7, 709A.3
12-8-100	*Room Fire Tests for Wall and Ceiling Materials*	NA
12-10-1	*Power Operated Exit Doors*	NA
12-10-2	*Single Point Latching or Locking Devices*	NA
12-10-3	*Emergency Exit and Panic Hardware*	NA

(The Office of the State Fire Marshal standards referred to above are found in the California Code of Regulations, Title 24, Part 12.)

SJI

Steel Joist Institute
1173B London Links Drive
Forest, VA 24551

Standard reference number	Title	Referenced in code section number
CJ—10	Standard Specification for Composite Steel Joists, CJ-series	1604.3.3, 2203.2, 2207.1
JG—10	Standard Specification for Joist Girders	1604.3.3, 2203.2, 2207.1
K—10	Standard Specification for Open Web Steel Joists, K-series	1604.3.3, 2203.2, 2207.1
LH/DLH—10	Standard Specification for Longspan Steel Joists, LH-series and Deep Longspan Steel Joists, DLH-series	1604.3.3, 2203.2, 2207.1

SPRI

Single-Ply Roofing Institute
411 Waverly Oaks Road, Suite 331B
Waltham, MA 02452

Standard reference number	Title	Referenced in code section number
ANSI/SPRI/ FM4435-ES-1—11	Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems	1504.5
ANSI/SPRI RP-4—13	Wind Design Guide for Ballasted Single-ply Roofing Systems	1504.4
ANSI/SPRI VF1—10	External Fire Design Standard for Vegetative Roofs	1505.10

TIA

Telecommunications Industry Association
2500 Wilson Boulevard
Arlington, VA 22201-3834

Standard reference number	Title	Referenced in code section number
222-G—05	Structural Standards for Antenna Supporting Structures and Antennas, including—Addendum 1, 222-G-1, Dated 2007, Addendum 2, 222-G-2 Dated 2009 Addendum 3, 222-3 dated 2013 and Addendum 4, 222-G-4 dated 2014	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
216—2013	Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies	Table 721.1(2), 722.1
302—2012	Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls	1207.2.1
402—2013	Building Code for Masonry Structures	1405.6, 1405.6.1, 1405.6.2, 1405.10, 1604.3.4, 1705.4, 1705.4.1, 1807.1.6.3, 1807.1.6.3.2, 1808.9 2101.2, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, *1411.2.1, 2107A.5, 2107A.6, 2114.7, 2114.8*
602—2013	Specification for Masonry Structures	1405.6.1, 1705.4, 1807.1.6.3, 2103.1, 2103.2.1, 2103.3, 2103.4, 2104.1, 2105.1

TPI

Truss Plate Institute
218 N. Lee Street, Suite 312
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
TPI 1—2014	National Design Standard 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—2009	Fire Tests of Window Assemblies	715.5.2, 716.3.2, 716.4, 716.5.3.2, 716.6, 716.6.1, 716.6.2, 716.6.8.1
10A—2009	Tin Clad Fire Doors	716.5
10B—2008	Fire Tests of Door Assemblies—with Revisions through April 2009	716.5.2
10C—2009	Positive Pressure Fire Tests of Door Assemblies	716.5.1, 716.5.3, 1010.1.10.1
13—96	*Power-limited Circuit Cables*	
14B—2008	Sliding Hardware for Standard Horizontally mounted Tin Clad Fire Doors—with Revisions through May 3, 2013	716.5
14C—06	Swinging Hardware for Standard Tin Clad Fire Doors Mounted Singly and in Pairs—with Revisions through May 2013	716.5
38—99	*Manually Actuated Signaling Boxes—with revisions through February 2, 2005 as amended.**	
	***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.*	
55A—04	Materials for Built-Up Roof Coverings	1507.10.2
103—2010	Factory-built Chimneys, for Residential Type and Building Heating Appliances—with Revisions through July 2012	718.2.5.1
127—2011	Factory-built Fireplaces	718.2.5.1, 2111.11
193—04	*Alarm Valves for Fire-Protection Service*	
199—95	*Automatic Sprinklers for Fire Protection Service—with Revisions through August 19, 2005*	
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 April 2012	907.2.11
228—97	*Door Closers/Holders, with or without Integral Smoke Detectors—with Revisions through January 26, 2006*	
260—04	*Dry Pipe and Deluge Valves for Fire Protection Service*	
262—04	*Gate Valves for Fire Protection Service*	
263—11	Standard for Fire Tests of Building Construction and Materials	703.2, 703.2.1, 703.2.3, 703.3, 703.4, 703.6, 704.12, 705.7, 705.8.5, 707.7, 711.3.2, 714.3.1, 714.4.1.1, 715.1, 716.2, Table 716.3, 716.5.6, 716.5.8.1.1, 716.7.1, 717.5.2, 717.5.3, 717.6.2.1, Table 721.1(1), 1407.10.2, 2103.1, 2603.4, 2603.5.1
268—09	Smoke Detectors for Fire Alarm Systems	407.8, 907.2.6.2, 907.2.11.7
268A—98	*Smoke Detectors for Duct Application—with revisions through October 22, 2003*	
300—05	Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas	904.11
294—1999	Access Control System Units—with Revisions through September 2010	1010.1.9.6, 1010.1.9.8, 1010.1.9.9
300—05(R2010)	Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment—with Revisions through July 16, 2010	904.11

UL—continued

300A—06	Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces	407.2.6, 904.13
305—2012	Panic Hardware	1010.1.10.1
312—04	*Check Valves for Fire-Protection Service*	
325—02	Door, Drapery, Gate, Louver and Window Operations and Systems—with Revisions through June 2013	406.3.6, 3110.4
346—05	*Waterflow Indicators for Fire Protective Signaling Systems*	
464—03	*Audible Signal Appliances—with revisions through October 10, 2003*	
497B—04	*Protectors for Data Communication and Fire Alarm Circuits*	
521—99	*Heat Detectors for Fire Protective Signaling Systems—with Revisions through July 20, 2005*	
539—00	*Single- and Multiple-Station Heat Detectors—with Revisions through August 15, 2005*	
555—2006	Fire Dampers—with Revisions through May 2012	717.3
555C—2006	Ceiling Dampers—with Revisions through May 2010	717.3
555S—99	Smoke Dampers—with Revisions through May 2012	717.3, 717.3.1
580—2006	Test for Uplift Resistance of Roof Assemblies—with Revisions through July 2009	1504.3.1, 1504.3.2
632—00	*Electrically Actuated Transmitters*	
641—2010	Type L Low-temperature Venting Systems—with Revisions through May 2013	2113.11.1.4
710B—2011	Recirculating Systems	904.11
723—2008	Standard for Test for Surface Burning Characteristics of Building Materials—with Revisions through September 2010	202, 402.6.4.4, 406.7.2, 703.5.2, 720.1, 720.4, 803.1.1, 803.1.4, 803.10, 803.11, 806.7, 1404.12.1, 1407.9, 1407.10.1, 1409.9, 1409.10.1, 1510.6.2, 1510.6.3, 2303.2, 2603.3, 2603.4.1.13, 2606.3.5.4, 2603.7.1, 2603.7.2, 2603.7.3, 2604.2.4, 2606.4, 2612.3, 2614.3, 3105.4
753—04	*Alarm Accessories for Automatic Water Supply Valves for Fire Protection Service*	
790—04	Standard Test Methods for Fire Tests of Roof Coverings—with Revisions through October 2008	1505.1, 2603.6, 2610.2, 2610.3
793—08	Standards for Automatically Operated Roof Vents for Smoke and Heat—with Revisions through September 2011	406.8.5.1.1, 910.3.1
813—96	*Commercial Audio Equipment—with revisions through December 7, 1999*	
857—13	*Busways*	*1705A.13.3.1*
864—03	*Control Units for Fire Protective Signaling Systems, as amended*—with revisions through February 2010*	421.6.2, 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.*

***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—with Revisions through February 2011	1013.5
1040—96	Fire Test of Insulated Wall Construction—with Revisions through October 2012	1407.10.3, 1409.10.3, 2603.4, 2603.9

UL—continued

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 October 2012	202, 714.3.1.2, 714.3.2, 714.4.1.2, 714.4.4
1482—2011	Solid-Fuel-type Room Heaters	2112.2, 2112.5
1703—02	Flat-Plate Photovoltaic Modules and Panels—with Revisions through November 2014	1505.9, 1507.17.1, 1507.17.6, 1509.7.4
1715—97	Fire Test of Interior Finish Material—with Revisions through January 2013	1407.10.3, 1409.10.2, 1409.10.3, 2603.4, 2603.9, 2614.4
1777—2007	Chimney Liners—with Revisions through July 2009	2113.11.1, 2113.19
1784—01	Air Leakage Tests of Door Assemblies—with Revisions through July 2009	710.5.2.2, 710.5.2.2.1, 716.5.3.1, 716.5.7.1, 716.5.7.3, 3006.3, 3007.6.3, 3008.6.3
1897—12	Uplift Tests for Roof Covering Systems	1504.3.1
1975—06	Fire Test of Foamed Plastics Used for Decorative Purposes	402.6.2, 402.6.4.5, 424.2
1994—04	Luminous Egress Path Marking Systems—with Revisions through November 2010	411.7, 1025.2.1, 1025.2.3, 1025.2.4, 1025.4
2017—2008	Standards for General-purpose Signaling Devices and Systems—with Revisions through May 2011	406.8.5.1.1, 3109.4.1.8
2034—2008	Standard for Single- and Multiple-Station Carbon Monoxide Alarm—with Revisions through February 2009	915.4.2, 915.4.3
2075—2013	Standard for Gas and Vapor Detectors and Sensors	421.6.2, 406.8.5.1.1, 915.5.1, 915.5.3
2079—04	Tests for Fire Resistance of Building Joint Systems—with Revisions through December 2012	202, 715.3, 715.6
2196—2001	Tests for Fire Resistive Cables—with Revisions through March 2012	913.2.2, 2702.3
2200—2012	Stationary Engine Generator Assemblies—with Revisions through June 2013	2702.1.1

ULC

Underwriters Laboratories of Canada
7 Underwriters Road
Toronto, Ontario, Canada M1R3B4

Standard reference number	Title	Referenced in code section number
CAN/ULC S 102.2—2010	Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies—with 2000 Revisions	720.4

USC

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	202

WCLIB

West Coast Lumber Inspection Bureau
P. O. Box 23145
Portland, OR 97281

Standard reference number	Title	Referenced in code section number
AITC Technical Note 7—96	Calculation of Fire Resistance of Glued Laminated Timbers	722.6.3.3
AITC 104—03	Typical Construction Details	2306.1
AITC 110—01	Standard Appearance Grades for Structural Glued Laminated Timber	2306.1
AITC 111—05	*Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection*	*2303.1.3.1*
AITC 113—10	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

WCLIB—continued

AITC 200—09	Manufacturing Quality Control Systems Manual for Structural Glued Laminated Timber	2306.1
AITC 404—05	*Standard for Radially Reinforcing Curved Glued Laminated Timber Members to Resist Radial Tension*	*2303.1.3.1*

WDMA

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—11	Specifications for Windows, Doors and Unit Skylights	1709.5.1, 2405.5

WRI

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	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

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, 5 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 this code and the *California Building, Mechanical* and *Plumbing Codes* and *International Fuel Gas Codes*. 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, 5 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—15	*California* Building Code	A101.2
IMC—15	International Mechanical Code	A101.2
IPC—15	International Plumbing Code	A101.2
IFGC—15	International Fuel Gas Code	A101.2

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX B – BOARD OF APPEALS

(Not adopted by state agencies)

Adopting agency	BSC	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

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 5 years; one for 4 years; one for 3 years; one for 2 years; and one for 1 year.
2. Thereafter, each new member shall serve for 5 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 5 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 10 years' experience, 5 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 10 years' experience, 5 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 10 years' experience, 5 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 10 years' experience, 5 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	BSC-CG	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 m^2.

a. See Section C102 for unlimited area under certain conditions.

SECTION C103
MIXED OCCUPANCIES

C103.1 Mixed occupancies. Mixed occupancies shall be protected in accordance with Section 508.

SECTION C104
EXITS

C104.1 Exit facilities. Exits shall be provided in accordance with *Chapters 11A or 11B as applicable.*

Exceptions:

1. The maximum travel distance from any point in the building to an approved exit shall not exceed 300 feet (91 440 mm).
2. One exit is required for each 15,000 square feet (1393.5 m^2) of area or fraction thereof.

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX D – FIRE DISTRICTS

(Not adopted by state agencies)

Adopting agency	BSC	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

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 11.

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 E84 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 noncombustible 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 E84—2013A	Test Method for Surface Burning Characteristics of Building Materials	D102.2.8
NFPA 268—12	Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source	D105.1
NFPA 701—10	Methods of Fire Tests for Flame-Propagation of Textiles and Films	D102.2.8
UL 723—08	Standard for Test for Surface Burning Characteristics of Building Materials, with Revisions through September 2010	D102.2.8

APPENDIX E
RESERVED

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX F – RODENTPROOFING

(Not adopted by state agencies)

Adopting agency	BSC	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

APPENDIX F
RODENTPROOFING

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

User note: Code change proposals to this chapter will be considered by the IBC – Structural Code Development Committee during the 2016 (Group B) Code Development Cycle. See explanation on page ix.

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 foodstuffs 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 ventilation 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 $^1/_4$ 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 be not greater than $^3/_8$ 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 be not 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 rodentproof-

ing 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 be not 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 that have sills 12 inches (305 mm) or more above 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 that provides a continuous pathway from the ground to the floor.
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	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

APPENDIX G
FLOOD-RESISTANT CONSTRUCTION

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or 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 that may increase flood damage or erosion potential.
4. Prevent or regulate the construction of flood barriers that will divert floodwaters or that can increase flood hazards.
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:

1. The subdivision of land.
2. Site improvements and installation of utilities.
3. Placement and replacement of manufactured homes.
4. Placement of recreational vehicles.
5. New construction and repair, reconstruction, rehabilitation or additions to new construction.
6. Substantial improvement of existing buildings and structures, including restoration after damage.
7. Installation of tanks.
8. Temporary structures.
9. Temporary or permanent storage, utility and miscellaneous Group U buildings and structures.
10. Certain building work exempt from permit under Section 105.2 and other buildings and development activities.

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. All applications for permits must comply with the following:

1. The building official shall review all permit applications to determine whether proposed development is located in flood hazard areas established in Section G102.2.
2. Where a proposed development site is in a flood hazard area, all development to which this appendix is applicable as specified in Section G102.1 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 ensure 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 submits an engineering analysis prepared by a registered design professional, demonstrating 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, prepared by a registered design professional, along with supporting technical data, demonstrating that such development will not cause any increase of the base flood level.

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, prepared by a registered design professional, demonstrating 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 that 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 coastal high-hazard areas and coastal A zones, the building official shall require submission of an engineering analysis, prepared by a registered design professional, demonstrating 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.

G103.9 Inspections. Development for which a permit under this appendix is required shall be subject to inspection. The building official or the building official's designee shall make, or cause to be made, inspections of all development in flood hazard areas authorized by issuance of a permit under this appendix.

SECTION G104
PERMITS

G104.1 Required. Any person, owner or owner's 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. Include in subdivision proposals and other proposed developments with more than 50 lots or larger than 5 acres (20 234 m^2), base flood elevation data in accordance with Section 1612.3.1 if such data are not identified for the flood hazard areas established in Section G102.2.
5. Indicate the use and occupancy for which the proposed development is intended.
6. Be accompanied by construction documents, grading and filling plans and other information deemed appropriate by the building official.
7. State the valuation of the proposed work.
8. 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 that 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 113 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 do not meet one or more of the following designations:

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.
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.
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 where all of the following criteria are met:

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.
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 man-made 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 that 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 that 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 verify all of the following:

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.
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, coastal high-hazard areas and coastal A zones, 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.

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, and prepared by a registered design professional, that the proposed encroachment will not result in any increase in the base flood level.

G401.2 Coastal high-hazard areas and coastal A zones. In coastal high-hazard areas and coastal A zones:

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 R322 of the *California Residential Code*.

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 that 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.

G501.4 Protection of mechanical equipment and outside appliances. Mechanical equipment and outside appliances shall be elevated to or above the design flood elevation.

Exception: Where such equipment and appliances are designed and installed to prevent water from entering or accumulating within their components and the systems are constructed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding up to the elevation required by Section R322 of the *California Residential Code*, the systems and equipment shall be permitted to be located below the elevation required by Section R322 of the *California Residential Code*. Electrical wiring systems shall be permitted below the design flood elevation provided they conform to the provisions of *California Electrical Code*.

G501.5 Enclosures. Fully enclosed areas below elevated manufactured homes shall comply with the requirements of Section R322 of the *California Residential Code*.

SECTION G601
RECREATIONAL VEHICLES

G601.1 Placement prohibited. The placement of recreational vehicles shall not be authorized in coastal high-hazard areas 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 Tanks. Underground and above-ground tanks shall be designed, constructed, installed and anchored in accordance with ASCE 24.

SECTION G801
OTHER BUILDING WORK

G801.1 Garages and accessory structures. Garages and accessory structures shall be designed and constructed in accordance with ASCE 24.

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 1804.4.

G801.5 Swimming pools. Swimming pools shall be designed and constructed in accordance with ASCE 24. Above-ground swimming pools, on-ground swimming pools and in-ground swimming pools that involve placement of fill in floodways shall also meet the requirements of Section G103.5.

G801.6 Decks, porches, and patios. Decks, porches and patios shall be designed and constructed in accordance with ASCE 24.

G801.7 Nonstructural concrete slabs in coastal high-hazard areas and coastal A zones. In coastal high-hazard areas and coastal A zones, nonstructural concrete slabs used as parking pads, enclosure floors, landings, decks, walkways, patios and similar nonstructural uses are permitted beneath or adjacent to buildings and structures provided that the concrete slabs shall be constructed in accordance with ASCE 24.

G801.8 Roads and watercourse crossings in regulated floodways. Roads and watercourse crossings that encroach into regulated floodways, including roads, bridges, culverts, low-water crossings and similar means for vehicles or pedestrians to travel from one side of a watercourse to the other, shall meet the requirement 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 that are in accordance with ASCE 24 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 constructed in accordance with ASCE 24.

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; 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 *California Electrical Code*.

SECTION G1101
REFERENCED STANDARDS

ASCE 24—13	Flood Resistant Design and Construction	G103.1, G401.3, G401.4, G701.1, G801.1, G801.5, G801.6, G801.7, G901.1, G1001.4
HUD 24 CFR Part 3280 (2008)	Manufactured Home Construction and Safety Standards	G201
IBC—15	*California Building Code*	G102.2, G1001.1, G1001.3
IRC—15	*California Residential Code*	G501.2, G501.4, G501.5
NFPA 70—11	*California Electrical Code*	G501.4, G1001.6

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX H – SIGNS

(Not adopted by state agencies)

Adopting agency	BSC	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

APPENDIX H

SIGNS

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or 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 m^2).
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 that 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 that is regularly moved from structure to structure at periodic intervals.

PROJECTING SIGN. A sign other than a wall sign that projects from and is supported by a wall of a building or structure.

ROOF SIGN. A sign erected on 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 that 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 *California Electrical Code* 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 be not 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 *California Electrical Code*.

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 that burn at a rate no faster than 2.5 inches per minute (64 mm/s) when tested in accordance with ASTM D635 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 that 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 (10 668 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 or 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 that 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 $^3/_8$ 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 or 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 $^3/_8$ 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 $^5/_8$-inch (15.9 mm) bolt or lag screw, by an expansion shield. Turnbuckles 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 that 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 mm^2.

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 D635—10	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—11	*California* Electrical Code	H106.1, H106.2
NFPA 701—10	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	BSC-CG	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 adopted by a state agency, or 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
DEFINITION

I102.1 General. The following term shall, for the purposes of this appendix, have the meaning shown herein. Refer to Chapter 2 of the *California Building Code* for general definitions.

PATIO COVER. A structure with open or glazed walls that 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 more than 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 $3^1/_2$ 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	BSC-CG	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																
Adopt only those sections that are listed below																					
Chapter / Section																					
J104.1				X	X																

APPENDIX J
GRADING

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or 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. Unless the applicant has submitted an engineering analysis, prepared in accordance with standard engineering practice by a registered design professional, that demonstrates the proposed work will not result in any increase in the level of the base flood, grading, excavation and earthwork construction, including fills and embankments, shall not be permitted in floodways that are in 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.

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 Sections 105.3 *and 1.8.4, as applicable,* 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.
4. Where necessary, slope stability studies, and recommendations and conclusions regarding site geology.

Exception: A geotechnical report is not required where the building 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_s) 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.

Exception: A liquefaction study is not required where the building official determines from established local data that the liquefaction potential is low.

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 1705.6 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 not more than one unit vertical in two units horizontal (50-percent slope) unless the owner or the owner's 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).

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 one unit vertical in five units horizontal (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 that is at least 10 feet (3048 mm) in width and 2 feet (610 mm) in depth.

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 D1557, Modified Proctor, in lifts not exceeding 12 inches (305 mm) in depth.

J107.6 Maximum slope. The slope of fill surfaces shall be no steeper than is safe for the intended use. Fill slopes steeper than one unit vertical in two units horizontal (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 be not 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 one unit vertical in three units horizontal (33-percent slope).

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 one unit vertical in 20 units horizontal (5-percent slope) 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 depth not less than 12 inches (305 mm) and a width not less than 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 m^2) (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 be not less than one unit vertical in 50 units horizontal (2-percent slope). 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.

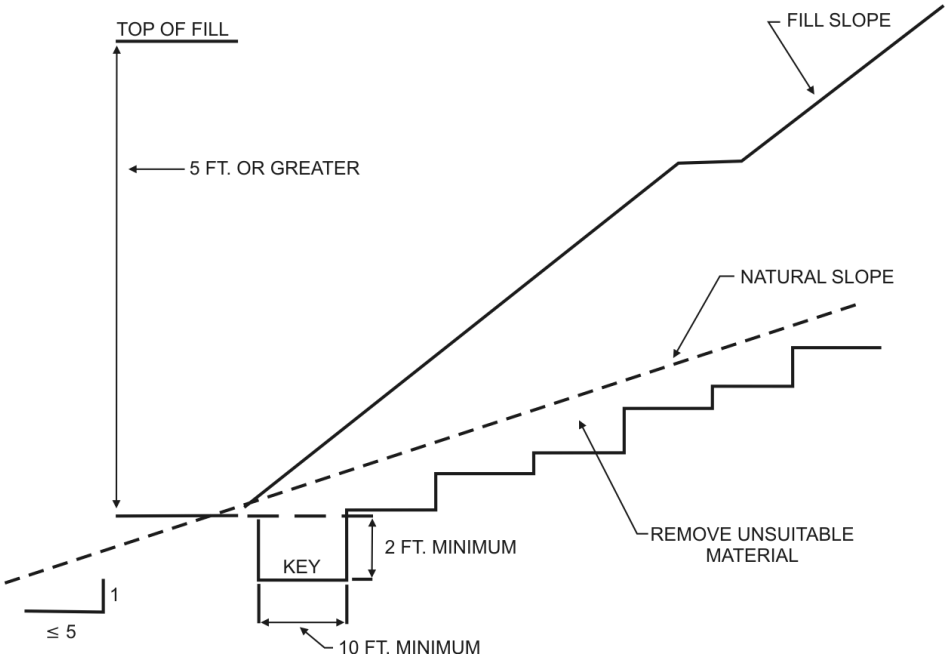
Exception: Erosion control measures need not be provided on cut slopes not subject to erosion due to the erosion-resistant character of the materials.

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.

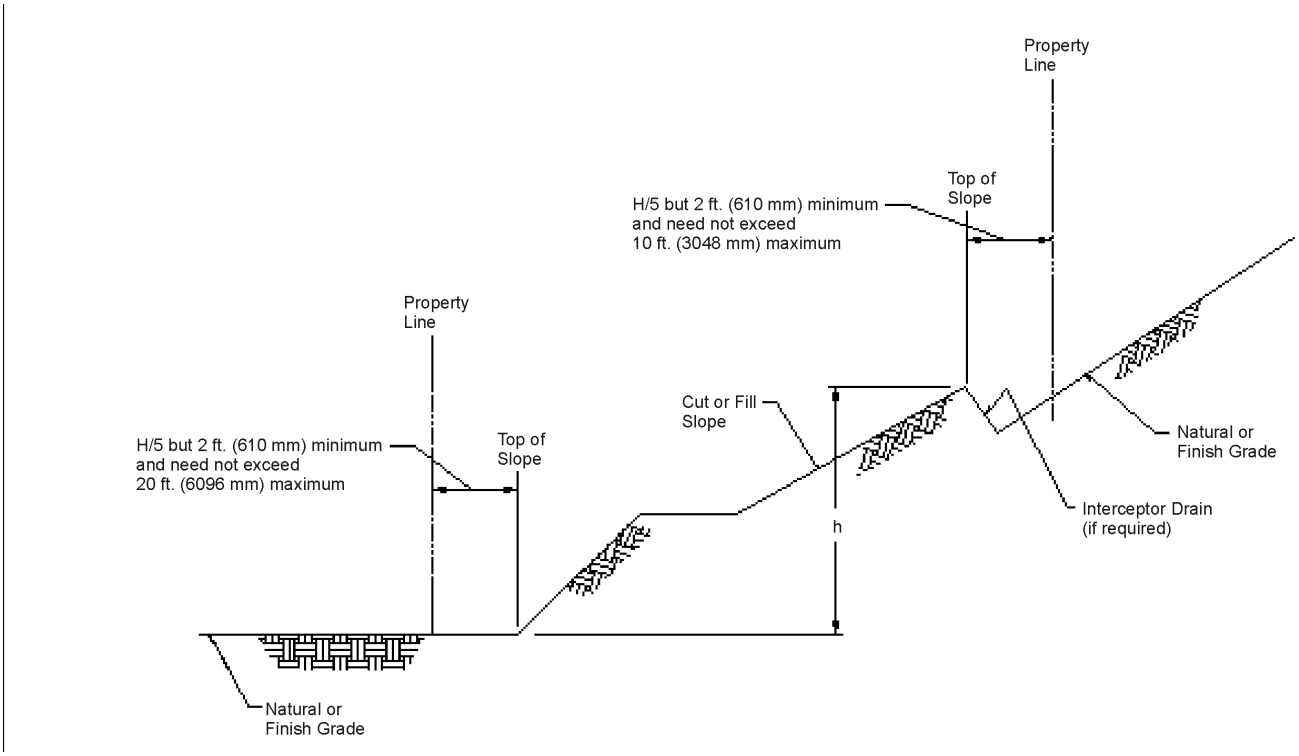
SECTION J111
REFERENCED STANDARDS

ASTM D1557-12	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lb/ft^3 (2,700kN-m/m^3)].	J107.5



For SI: 1 foot = 304.8 mm.

FIGURE J107.3
BENCHING DETAILS



For SI: 1 foot = 304.8 mm.

FIGURE J108.1
DRAINAGE DIMENSIONS

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
APPENDIX K – GROUP R-3 AND GROUP R-3.1 OCCUPANCIES PROTECTED BY THE FACILITIES OF THE CENTRAL VALLEY FLOOD PROTECTION PLAN

(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	BSC-CG	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																					

APPENDIX K

GROUP R-3 AND GROUP R-3.1 OCCUPANCIES PROTECTED BY THE FACILITIES OF THE CENTRAL VALLEY FLOOD PROTECTION PLAN

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or referenced in the adopting ordinance.

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 m^2) 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.*

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.*

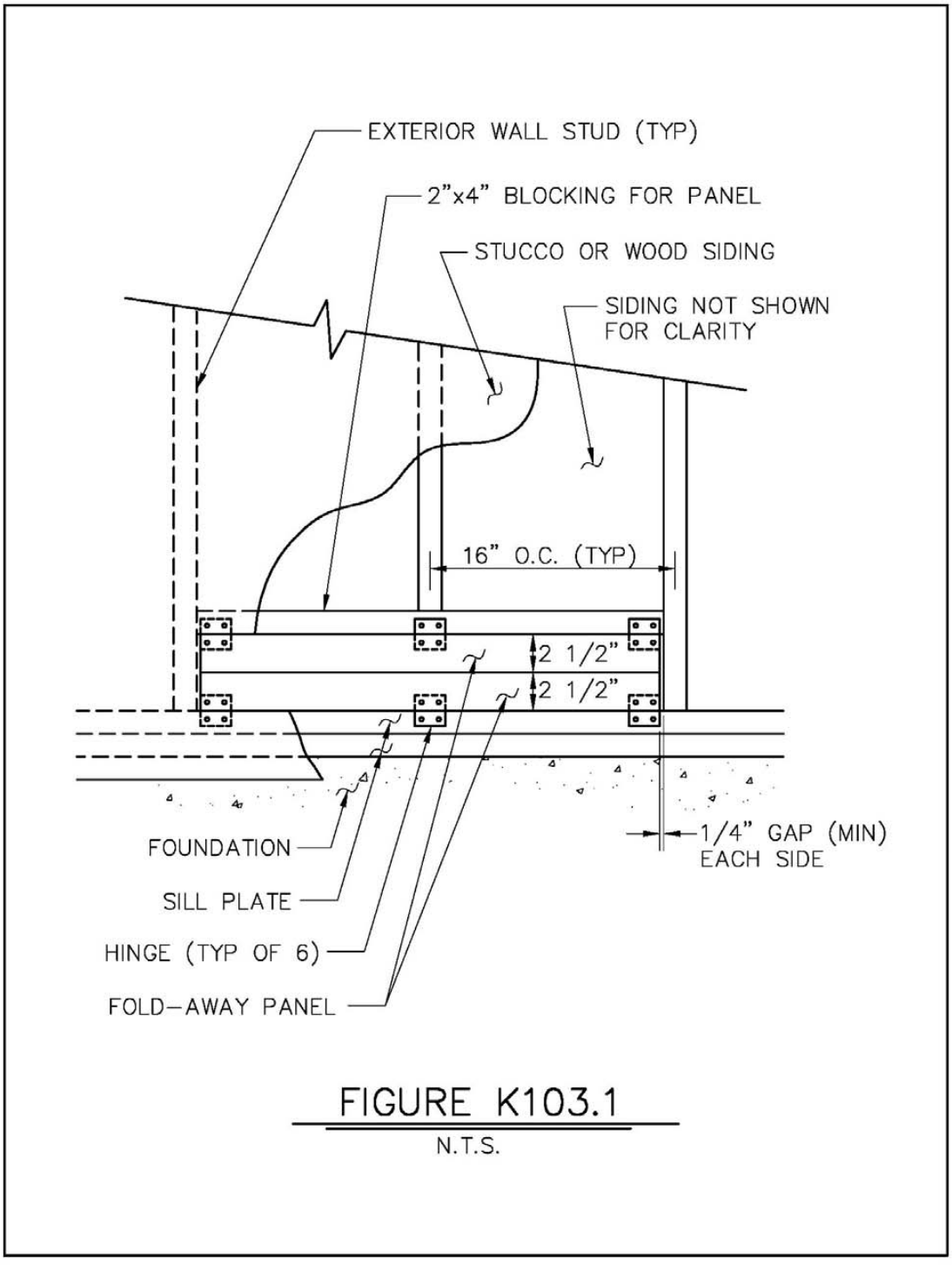


FIGURE K103.1

N.T.S.

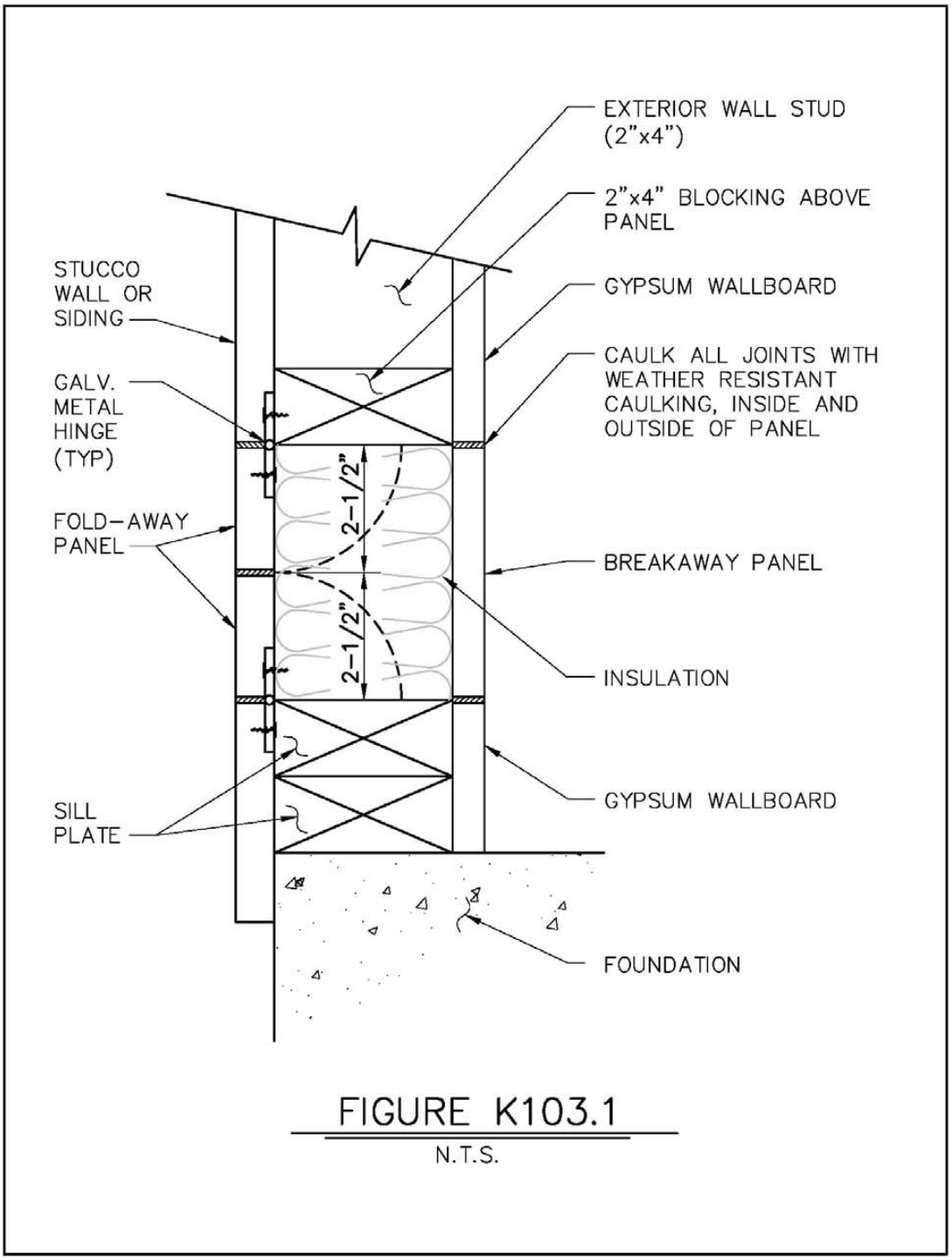


FIGURE K103.1
N.T.S.

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	BSC-CG	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								
Adopt only those sections that are listed below																					
Chapter / Section																					
L101										X			X								
L102										X		X	X								
L103										X											

APPENDIX L
EARTHQUAKE RECORDING INSTRUMENTATION

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or 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 10 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 & 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 (25 mm) block letters shall be posted in a conspicuous location.

> *[OSHPD 1 & 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	BSC-CG	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)																					
Adopt only those sections that are listed below																					
Chapter / Section																					

APPENDIX M
TSUNAMI-GENERATED FLOOD HAZARD

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or 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 that 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 Categories 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—12	Guidelines for Design of Structures for Vertical Evacuation from Tsunamis	M101.4

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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* 2013 Triennial Edition, effective January 1, 2014.

1. (BSC 05/15, SFM 06/15, DSA-AC 01/15, DSA-SS 02/15, HCD 03/15, OSHPD 02/15 & 04/15, SLC 01/15) - Adopt the 2015 edition of the *International Building Code* published by the International Code Council, for incorporation into the 2016 *California Building Code,* CCR Title 24, Part 2 with amendments for State regulated occupancies, effective on January 1, 2017.