

Division VI-R

EARTHQUAKE EVALUATION AND DESIGN FOR RETROFIT OF EXISTING HOSPITAL BUILDINGS

Section ~~1640B~~ 1640A - GENERAL

~~1640B.1~~ 1640A.1 **Minimum Seismic Design.** All modifications, alterations, and/or repairs to existing structures or portions thereof shall, as a minimum, be designed and constructed to resist the effects of seismic ground motions as provided in Division ~~III~~VI-R.

1640A.1.1 Minimum Seismic Design. The purpose of this division is to provide a minimum level of seismic performance. At this essential life-safety level (seismic performance category SPC-2), in general, persons in and around the building will be able to safely exit or be evacuated from the building or its vicinity following an earthquake. It does not mean that persons will not be injured or not be in need of medical attention. This level of seismic performance is presumed to be achieved when a) the building has some margin against either total or partial collapse of the structural system even though significant damage may have occurred that may not be economical to repair; b) major structural elements have not fallen or been dislodged so as to pose a life-safety threat; and c) nonstructural systems or elements that are heavy enough to cause severe injuries either within or outside the building have not been dislodged so as to pose a life-safety threat.

For buildings in seismic performance categories SPC-3 through 5, the purpose of the division is to provide the immediate occupancy level of seismic performance. At this level, the building and essential nonstructural systems will be reasonably capable of functioning following an earthquake.

~~1640B.2~~ 1640A.2 The requirements of this Division III-R apply to ~~all state-owned structures, including all buildings owned by the University of California and California State University, and~~ hospital buildings where Chapter 6, Part 1, Title 24, Building Standards Administrative Code, so requires, wherever the structure is to be retrofitted, repaired, or modified and: ~~a) total construction cost, not including cost of furnishings, fixtures and equipment, or normal maintenance, for the building exceeds 25% of the construction cost for the replacement of the existing building; or, b~~ 1) there is change in occupancy; or e2) changes to structural elements that reduce the lateral load capacity by more than 5% at any story; or, e3) repair of structural elements where the damage has reduced the lateral load

capacity by more than 10% at any story; ~~e~~4) changes in live or dead load that increase the story shear by more than 5%; or ~~f~~5) where required by Section 1635B8A or Chapter 6, Part 1, Title 24, Building Standards Administrative Code. The changes in ~~Item a)~~ Items 2), 3), and 4) are cumulative for past alterations to the building that occurred after adoption of Division III and did not require the application of Division III-R.

1640A.2.1 Evaluation required. *If the criteria in Section 1640A.2 apply to the project under consideration, the design professional of record shall provide an evaluation in accordance with Section 1643A to determine the seismic performance of the building in its current configuration and condition. If the structure's seismic performance is evaluated as satisfactory, the peer reviewer(s) (when Method B of Section 1648A is used) concur, and the findings are approved by the enforcement agency, then no structural retrofit is required*

Exception: *In some cases a technical review and evaluation may be waived under the Exception of Section 1648A.1, where the life-safety threat posed by the building is clearly minimal.*

1640A.2.2 Retrofit required. *Where the evaluation indicates the building does not meet the SPC performance objective of this division, the owner shall take appropriate steps to ensure that the building's structural system is retrofitted in accordance with the provisions of this division. Appropriate steps are either 1) undertake the seismic retrofit as part of the modifications, alterations and/or repairs; or 2) provide a plan, acceptable to the enforcement agent, to complete the seismic retrofit in a timely manner.*

1640B.3 1640A.3 *The modification to any existing building may be prepared in accordance with the requirements for a new building, ~~Section 16B, Division III~~ Chapter 16A, Division IV, Part 2, Title 24, California Code of Regulations 2001 Edition.*

1640B.4 1640A.4 *The requirements of the UBC Appendix Chapter 16A, Sections 1650A-1661A, are to apply to the use of seismic isolation for the repair, modification or retrofit of an existing structure. When seismic isolation and/or passive energy dissipation is used, the project must have project peer review as prescribed in Section 1649A.*

Exception: *For hospital buildings the requirements of Appendix Chapter 16BA, Section 1650BA-1661BA apply in lieu of those of the*

UBC for repair, modification or retrofit to existing hospital buildings.

1640A.5 *Where Method B of Section 1648A is used or is required by Section 1643A.7, the proposed method of building evaluation and design procedures must be accepted by the enforcement agent prior to the commencement of the work.*

~~1640B.5~~ 1640A.6 *The structural system allowances of Chapter 34 do not apply to any building to which Division ~~III~~VI-R applies.*

Section 1641A - DEFINITIONS

For the purposes of this ~~D~~division ~~III~~VI-R certain terms are defined in addition to those in Section 1627A and Chapter 6, Part 1, Title 24, Building Standards Administrative Code, as follows:

ACTIVE EARTHQUAKE FAULT...

CODE-COMPLYING SYSTEM *is a system that complies with the Seismic Zone 3 and 4 requirements for lateral-force-resisting systems and materials as given in the 1976 or later editions of ~~the Uniform Building Code~~ Title 17 and Title 24.*

CODE-COMPLYING SYSTEM...

DESIGN BASIS EARTHQUAKE *is the earthquake ground motion defined in Section 1648A.2.2.1.*

DISTANCE FROM AN ACTIVE EARTHQUAKE FAULT... ESSENTIAL LIFE SAFETY...

IMMEDIATE OCCUPANCY. *The retrofit or repair of a structure to a goal of immediate occupancy as a level of expected performance is taken to mean the post-earthquake damage state in which only limited structural and nonstructural damage has occurred. The original strength and stiffness of the structure is substantially retained, with minor cracking and yielding of structural elements. Basic access and life-safety systems, including doors, stairways, elevators, emergency lighting, fire alarms, and suppression systems, remain operable, provided that utilities are available. It is expected that occupants could safely remain in the building, although normal use may be impaired and some cleanup, inspection, and limited structural and nonstructural repairs may be required.*

INELASTIC DEMAND RATIO (IDR)...

PROBABLE STRENGTH...

REPAIR as used in this Division ~~III~~R means all the design and construction work undertaken to restore or enhance the structural and nonstructural load resisting system participating in the lateral response of a structure that has experienced damage from earthquakes or other destructive events.

USABLE STRENGTH or FACTORED STRENGTH...

Section 1642A - Symbols and Notations

1642A.1 The following symbols and notations apply to Division ~~III~~VI-R in addition to those of Section ~~1626B~~ 1628A:

NC_n = usable strength or capacity of an element as determined in the materials chapters where N is the strength reduction factor.

C_w = ...

E = seismic load action on an element due to the specified total design base shear.

H = ...

IDR = ...

IDR_L = ...

$\$$ = ...

W_o = Seismic Force Amplification Factor set forth in Table 16A-N.

D_s = Design Level Response Displacement, which is the total drift or total story drift that occurs when the structure is subjected to the specified Seismic Forces.

D_M = Maximum Inelastic Response Displacement, which is the total drift or total story drift given by $0.7 R D_s$.

Section 1643B 1643A-Criteria Selection

1643B.1 1643A.1 Basis for Evaluation and Design....

~~1643B.1.1~~ 1643A.1.1 Special Procedures:...

~~1643B.1.1.1~~ 1643A.1.1.1...

~~1643B.1.1.2~~ 1643A.1.1.2...

~~1643B.1.1.3~~ 1643A.1.1.3...

~~1643B.1.1.4~~ 1643A.1.1.4 The SAC Interim Guidelines for the Evaluation, Repair, Modification, and Design of Welded Steel Moment Frame Structures, FEMA 267, August 1995 ~~or subsequent editions~~. The ground motion specifications of this Division ~~III-R~~ shall be used when the SAC procedures are applied.

~~1643B.2~~ 1643A.2 Existing Conditions...

~~1643B.3~~ 1643A.3 Site Geology and Soil Characteristics. Soil profile ~~type and site coefficient, S~~ , shall be ~~established~~ assigned in accordance with the requirements of Section ~~1627B.3~~ 1629A.3 and ~~Table 16B-J~~.

~~1643B.4~~ 1643A.4 Occupancy Categories. For purposes of earthquake-resistant design, each structure shall be placed in one of the occupancy categories in accordance with the requirements of Section ~~1627B.2~~ 1629A.2 and ~~Table 16B-K~~. [OSHPD 1: For hospital buildings, $I=1.0$ for category SPC-2 and $I=1.5$ for SPC-3 through SPC-5, as determined in accordance with the requirements of Chapter 6, Part 1, Title 24, Building Standards Administrative Code].

~~1643B.5~~ 1643A.5 Configuration Requirements. Each structure shall be designated as being structurally regular or irregular in accordance with the requirements of Section ~~1627B.5~~ 1629A.5 and ~~Table 16B-L and Table 16B-M~~.

1643A.6 Selection of the Design Method...

~~1643B.7~~ 1643A.7 The requirements of Method A (Sections ~~1644B~~ 1644A-1647B 1647A) may be used except under the following conditions, where Method B or special Procedures as defined in Section 1643A.1.1 must be used:

~~1643B.7.1~~ 1643A.7.1...

~~1643B.7.2~~ 1643A.7.2...

~~1643B.7.3~~ 1643A.7.3 For any building which has an importance factor I greater than 1.00, ~~Table 16B-K~~ 16A-K.

Exception 1: For hospital buildings, Method A may be used for retrofitting SPC 1 structures to SPC-2 structures where: a) the building has four or fewer stories, but with continuous diaphragms; or, b) where the building is of Type V construction; or, c) located in Zone 3.

Exception 2: *For hospital buildings, Method A may be used for retrofit or repair of nonstructural components and systems.*

1643B.7.4 1643A.7.4...

1643B.7.5 1643A.7.5...

1643B.7.6 1643A.7.6...

1643B.8 1643A.8 Seismic Hazard Factor *The Seismic Hazard Factor H shall be determined according to the following procedure.*

1643B.8.1. 1643A.8.1. *When the Importance Factor, I, is equal to 1 then H is the lesser of either equal to:*

Exception: *[OSHPD 1: For hospitals this value of H may be used where I is equal to 1.0 if: a) the assigned performance category is SPC-2, in Zone 3; or, b) the assigned performance category is SPC-2 in Zone 4 and the structure is more than 5 kilometers in distance from an active earthquake fault.]*

1643B.8.1.1 1643A.8.1.1 *Three-quarters (0.75) when the seismic coefficients C_a and C_v are determined from Table 16A-Q and Table 16A-R. of the Z value for the site as determined from Table 16B-I; or,*

1643B.8.1.2 1643A.8.1.2 *The effective peak ground acceleration (EPA) Unity (1.0) when the seismic coefficients C_a and C_v are determined from a 5 percent damped acceleration response spectrum with a 20% probability of exceedance in 50 years determined from a probabilistic seismic hazard analysis for the specific site. The smoothed response spectrum value at the period of 0.3 seconds provides the value of $2.5 C_a g$ and the spectrum at 1.0 seconds provides the value of $C_v g$, where g is the gravity constant.*

Exception 1: *When there has been a Section ~~1643B.8.1.2~~ 1643A.8.1.2 analysis performed, the Enforcement Agent may accept the results of this prior study on a case by case basis.*

Exception 2: *The results of a community-wide probabilistic seismic analysis (Section ~~1643B.8.1.2~~ 1643A.8.1.2) may be used when the responsible Enforcement Agent has accepted a probabilistic seismic hazard study for the jurisdiction to determine the value required by ~~1643B.8.1.2~~ 1643A.8.1.2 for sites within the jurisdiction, provided that the study on which it is based was accepted by reviewers, who were selected and charged consistent with the professional requirements of Section*

~~1649B~~ 1649A.

1643A.8.2 ~~Otherwise, the H value is equal to Z as determined from Table 16B-I or, the effective peak ground acceleration (EPA) unity (1.0), and the seismic coefficients C_a and C_v may be determined either from Table 16A-Q and Table 16A-R or from a 5 percent damped acceleration response spectrum with a 10% probability of exceedance in 50 years determined from a probabilistic seismic hazard analysis for the specific site.~~

Exception 1: ~~Exception 1 of Section 1643B.8.1.2~~ 1643A.8.1.2 applies.

Exception 2: ~~For Section 1643A.8.2, when the importance factor, I, is greater than 1 and less than or equal to 1.25, then I may be set equal to 1 for subsequent load determinations if H is determined as the 10% in 100 year EPA value from a probabilistic analysis; when I is greater than 1.25 and less than or equal to 1.5, then I may be set equal to 1.0 for subsequent load determinations if H is determined as the 10% in 200 year EPA value from a probabilistic analysis the seismic coefficients C_a and C_v are determined from a 5 percent damped response spectrum with a 10% probability of exceedance in 100 years determined from a probabilistic analysis for the specific site.~~

~~1643B.9~~ 1643A.9 Capacity Requirements...

~~1643B.10~~ 1643A.10 New Elements...

~~1643B.11~~ 1643A.11 Deformation Compatibility...

~~**1643B.12 Structural Observation:** Structural observation as used in this chapter shall mean visits to the project site by the responsible design professional to observe existing conditions and to review the construction work for general compliance with approved plans, specifications, and applicable structural regulations. Such visits should occur at significant construction stages and at the completion of the structural retrofit. Structural observation shall be provided in Seismic Zones 3 and 4 for all structures regulated by Division III-R. The owner shall directly employ the engineer or architect, or their designee, responsible for the structural design to perform structural observation. Observed deficiencies shall be reported in writing to the owner's representative, project inspector, contractor and the Enforcement Agent. The structural observer shall notify the Enforcement Agent in writing in a timely manner how the structural deficiencies are to be corrected. If satisfactory resolution of the deficiency is not obtained, the Enforcement Agent shall be notified for any necessary action. At the conclusion of construction, the structural observer shall submit to the Enforcement Agent a written statement that the required site visits have~~

~~been made and that the observed structural deficiencies have been resolved and/or listing those, to the best of the structural observer's knowledge and belief, that have not been satisfactorily corrected.~~

~~[OSHPD 1: **Exception 1:** The requirements of Chapter 17B or the testing and inspection requirements of Chapters 18B through 24B take precedence when they are more restrictive than the requirements of Section 1643B.12].~~

1643A.12 Structural Observation, Testing, and Inspections: Construction testing, inspection and observation requirements shall be as set forth in Chapter 7, Article 4, Part 1, Title 24, Building Standards Administrative Code, Chapter 17A, and the testing and inspection requirements of Chapters 18A through 24A.

1643B.13 1643A.13 Temporary actions...
Section 1644B 1644A—Method B A

1644B.1 1644A.1 General

1644B.1.1 1644A.1.1...

1644B.1.2 1644A.1.2

1644B.1.3 Design snow loads of 30 pounds per square foot (psf) (1.44 kN/m²) or less need not be included. Where design snow loads exceed 30 psf (1.44 kN/m²) the design snow load shall be included, but may be reduced up to 75 percent where consideration of siting, configuration and load duration warrant when approved by the Enforcement Agent Agency.

1644B.1.4 1644A.1.4...

1644B.2 1644A.2...

1644B.2.2 1644A.2.1...

1644B.2.3 1644A.2.2...

1644B.2.3 1644A.2.3 Modeling requirements. The mathematical model of the physical structure shall comply with Section 1630A.1.2.

1644B.3 1644A.3 General. Structural systems shall be classified with the requirements of Section ~~1627B.6~~ 1629A.6 as one of the types listed in Table ~~16B-N~~ 16A-N and defined in this subsection. The system selected for an existing building to be most appropriate for a given existing building may contain non-complying elements and/or elements which essentially comply to the required provisions and details for that system provided that all the non-complying and essentially complying elements have been properly classified as "non-ductile," "limited-ductile," or "ductile" and the corresponding ϕ values are applied to their

seismic load.

~~1644B.3.1~~ **1644A.3.1** The system R value shall be taken as ~~6~~ 4.5 for all existing structural systems except for the following conditions:

~~1644B.3.1.1~~ **1644A.3.1.2** R may be taken as ~~8~~ 5.5 if the system constructed meets the requirements for a Building Frame System as defined in Section ~~1629B.6.3~~ 1629A.6.3.

~~1644B.3.1.2~~ **1644A.3.1.2** For structures designed to meet all of the seismic provisions of the 1976 or later editions of the Uniform Building Code or California Building Code, ~~R_w~~ R may be taken as ~~$8/K$~~ for the ~~1976 designs where K is the system factor in the 1976 Code, and may be taken as equal to the appropriate R_w corresponding to the original design based on a later edition of the Code~~ the value given in Table 16A-N for the corresponding basic structural system.

1644BA.4 Static Force Procedure.

1644BA.4.1 Design base shear. The total design base shear in a given direction shall be determine from the following formula:

$$V = \frac{HIC}{R_w} W \quad (44B-1)$$

Where:

~~R_w = Structural System Factor as prescribed in Section 1644B.3~~

~~H = Seismic Hazard Factor as prescribed in Section 1643B.8~~

$$C = 1.25 \frac{S}{T^{2/3}} \quad (44B-2)$$

~~The value of C need not exceed 2.75 and this value may be used for any structure without regard to soil type or structure period.~~

The minimum ratio of C/R_w shall be 0.075.

$$V = \frac{HC_v I}{RT} W \quad (44A-1)$$

where: The total design base shear need not exceed the following:

$$V = \frac{2.5HC_aIW}{R} \quad (44A-2)$$

The total design base shear shall not be less than the following:

$$V = 0.11HC_aIW \quad (44A-3)$$

In addition, for Seismic Zone 4, the total base shear shall also not be less than the following:

$$V = \frac{0.8HZN_vIW}{R} \quad (44A-4)$$

1644BA.4.1.1 *Strength Basis for Evaluation and Design.* Elements subject to seismic force action E due to the specified base shear V shall have the usable strength capacity fC_n to resist the following load combinations:

- (A) For the case where the actions $D\perp$, $L\perp$, and E are all in the same sense, where the live load L is the realistic live load, but is not less than the design load specified for the occupancy.

$$fC_n = 1.05D\perp + 0.25L\perp + 1.4bE \quad (44BA-35)$$

- (B) For the case where the action E is opposite to the sense of $D\perp$.

$$fC_n = 1.4bE - 0.9D\perp \quad (44BA-46)$$

In the load combinations (44BA-35) and (44BA-46) the seismic load penalty factor b represents the limited inelastic deformation capability of non-ductile and limited-ductile elements for an associated mode of failure. Values of b for specific types of elements and modes of failure are given in Section 1645BA.

Exception: See Exceptions 1 and 2 in Section 1643BA.9.

1644BA.4.1.2 Allowable or Working Stress Basis for Evaluation and Design. Allowable or working stress method along with the one third allowable stress increase as permitted by Section ~~1603B.5~~ 1612A3.2 may be used to establish the allowable or working stress capacity C_w of an element. The capacity C_w shall

meet the following load combination requirements:

- (C) For the case where the actions DL , LL , and E are all in the same sense,

$$C_w = DL + LL + bE \quad C_w = D + L + \frac{bE}{1.4} \quad (44BA-57)$$

- (D) For the case where the action E is opposite to the sense of DL ,

$$C_w = bE - 0.85DL \quad C_w = \frac{bE}{1.4} - 0.9D \quad (44BA-68)$$

Exception: Section 1644BA.4.1.2 may not be used for reinforced concrete.

1644BA.4.2 Structure period.

1644BA.5 Combinations of Structural Systems. General.

1644BA.6 Vertical Distribution of Force.

1644BA.7 Horizontal Distribution of Shear.

1644BA.8 Horizontal Torsional Moments.

1644BA.9 Overturning.

1644BA.9.1 General. . Every structure shall be designed to resist the overturning effects caused by earthquake forces specified in Section ~~1628B.4~~ 1630A.5. At any level, the overturning moments to be resisted shall be determined using those seismic forces (F_t and F_x) which act on levels above the level under consideration. At any level, the incremental changes of the design overturning moment shall be distributed to the various resisting elements in the manner prescribed in Section ~~1628B.5~~ 1630A.5. Overturning effects on every element, wherever possible, shall be carried down directly in a linear path to the foundation. See load combinations in Section ~~1631B~~ 1644A.4.1.1 and 1644A.4.1.2 for combining gravity and seismic forces.

1644BA.9.2 Seismic Zones 3 and 4. In Seismic Zones 3 and 4, where a lateral load-resisting element is discontinuous, such as for vertical irregularity Type 4 in Table 16BA-L or plan irregularity Type 4 in Table 16BA-M, columns supporting such elements shall have the strength to resist the axial force resulting from the following load combinations, in addition to all other applicable load combinations:

$$jC_n = DL + 0.8LL + \frac{3R_w}{8} bE \quad \Phi C_n = D + 0.8L + \Omega_o bE \quad (44BA-79)$$

$$jC_n = \frac{3R_w}{8} bE - 0.9DL \quad \Phi C_n = \Omega_o bE - 0.9D \quad (44BA-810)$$

$\frac{3R_w}{8} W_b bE$ in Formulas (44BA-79) and (44BA-810) need not exceed $R_w E$.

1644BA.9.2.1

1644BA.9.2.2

1644BA.9.2.3 ~~Such columns shall either resist the above-described axial forces without exceeding the usable axial capacity (NC_n), or~~ In order to qualify for a b value equal to 1.0, such columns shall meet the following detailing and member limitations:

1. Chapter 19BA, Section 1921BA.4, for concrete, and Chapter 22BA, Sections 2210A, 2211A.4 and 2211BA.5, for steel in structures in seismic Zones 3 and 4, except for welded steel moment connections where the ~~current SAC Guidelines for columns apply:~~ SAC Interim Guidelines for the Evaluation, Repair, Modification, and Design of Welded Steel Moment Frame Structures, FEMA 267, August, 1995, provisions for columns apply, ~~or subsequent editions.~~

2. ~~Chapter 19B, Section 1921B.8, for concrete and Chapter 22BA, Divisions I and IX, special provisions for developing plastic hinges at ultimate loading, for steel in structures in Seismic Zone 2.~~

1644BA.9.2.4 Transfer girders that support such columns or that provide support for the discontinuous lateral load-resisting element shall resist the above-described axial forces or support reactions without exceeding the capacity jFC_n for each mode of failure. For this case, the ϕ factor shall correspond to the properties of the girder.

1644BA.9.3 At Foundation. See Section 1809BA.4 for overturning moments to be resisted at the foundation soil interface. The foundation soil interface shall be capable of resisting the following load combinations on the allowable stress basis of Section 1809BA.2 and Table 18BA-1-A, and other load combinations need not apply:

$$\frac{DL+LL+E}{D+L+\frac{E}{1.4}} \quad (44BA-911)$$

$$\frac{E-0.85DL}{1.4}-0.9D \quad (44BA-1012)$$

*In order to determine the strength design basis loads for the elements of the foundation structure, the soil pressures and pile or caisson reactions due to these load combinations shall be load factored by 1.4. The resulting bending moments, shears, axial loads on the sections of the foundation structure are to be factored by the appropriate **b** value and shall be resisted by the corresponding usable strength N_{FC_n} of the section. If piles or caissons are required for overturning moment tension resistance due to the load combination (44BA-1012), then the minimum tensile load-carrying resistance N_{FC_n} shall be $E/4014$.*

1644BA.10 Drift and Story Drift Limitation.

Drift or horizontal displacements of the structure shall be computed where required by this code. For both Allowable Stress Design and Strength Design, the Maximum Inelastic Response Displacement, D_M , of the structure caused by the Design Basis Ground Motion shall be determined in accordance with this section. The drifts corresponding to the design seismic forces of Section 1644A.4.1, D_S , shall be determined in accordance with Section 1644A.10.1. To determine D_M , these drifts shall be amplified in accordance with Section 1644A.10.2.

***1644BA.10.1 Defined Determination of D_S .** Story drift is the displacement of one level relative to the level above or below due to the design lateral forces. Calculated drift shall include translational and torsional displacements. A static, elastic analysis of the lateral force-resisting system shall be prepared using the design seismic forces from Section 1644A.4.1 and 1644A.6. The mathematical model shall comply with Section 1644A.2.3. The resulting deformations, denoted as D_S shall be determined at all critical locations in the structure. Calculated drift shall include translational and torsional deflections.*

***1644B.10.2 Calculated Determination of D_M .** Calculated story drift shall not exceed $0.04/R_w$ or 0.005 times the story height for structures having a fundamental period of less than 0.7 second. For structures having a fundamental period of 0.7 second or greater, the calculated story drift shall not exceed $0.03/R_w$ or 0.004 times the story height.*

~~**Exception:** These drift limits may be exceeded when it is demonstrated that a maximum drift equal to $(0.7)R_w$ times the calculated story drift can be tolerated without failure by both structural elements and nonstructural elements that could affect life safety.~~

The Maximum Inelastic Response Displacement, D_M , shall be computed as follows:

$$D_M = 0.7 R D_S \quad (44A-13)$$

~~**1644BA.10.3 Deriving forces Story drift defined.** The design lateral forces used to determine the calculated drift may be derived from a value of C based on the period determined from Formula (44B-2) neglecting the lower bound ratio for C/R_w of 0.075 of Section 1644B.4.1 and the 30 percent limitations of Section 1628B.2.2, Item 2. Story drift is the displacement of one level relative to the level above or below using the Maximum Inelastic Displacement, D_M , at each level.~~

~~**1644A.10.4 Story drift limits.** Calculated story drift using D_M shall not exceed 0.025 times the story height for structures having a fundamental period of less than 0.7 second. For structures having a fundamental period of 0.7 second or greater, the calculated story drift shall not exceed 0.020 times the story height.~~

~~**EXCEPTION:** These story drift limits may be exceeded when it is demonstrated that greater drift can be tolerated by both structural elements and nonstructural elements that could affect life safety for buildings in seismic performance categories SPC-1 and SPC-2, and life safety and continued operation in SPC-3 through SPC-5 buildings.~~

~~**1644BA.11 P-) Effects.** The resulting member forces and moments and the story drifts induced by P-) effects shall be considered in the evaluation of overall structural frame stability and shall be evaluated using the specified design forces and their corresponding displacements D_S . P-) need not be considered when the ratio of secondary moment to primary moment does not exceed 0.10; the ratio may be evaluated for any story as the product of the total dead, floor live load, and snow load as required in Section 1603BA.6, above the story times the seismic drift in that story divided by the product of the seismic shear in that story times the~~

height of that story. In Seismic Zones 3 and 4, P -) need not be considered where the story drift ratio does not exceed $0.02/R_w$.

1644BA.12 Vertical Component. The following requirements apply in Seismic Zones 3 and 4 only.

Horizontal cantilever components shall have the usable strength capacity ϕF_c to resist $(0.7) H C_a W_p$, or have an allowable or working stress capacity C_w to resist $(0.5) H C_a W_p$. The value of the seismic hazard factor H shall be as prescribed by Section 1643BA.9 according to the occupancy and conditions of the building.

1644BA.13 Lateral Force on Elements of Structures, Nonstructural Components and Equipment Supported by Structures...

1644BA.13.1 Design for Total Lateral Force. Critical nonstructural components and systems, as defined in Table 11.1, Chapter 6, Part, California Building Standards Administrative Code, and all components and systems in buildings in seismic performance categories SPC-3 through SPC-5 shall meet the requirements ~~The provisions for new buildings, of Division III Section 16302BA.~~ All other elements of structures, nonstructural components and equipment supported by structures shall comply with provisions of Section 1645A.7 apply with the following exceptions and this section to Section 1630B.2.

The total design lateral seismic force, F_p , shall be determined from the following formula:

$$F_p = \phi H C_a W_p \quad (44B-11)$$

~~where ϕ is for the connection, not the element to which it is attached. This force shall be resisted at an allowable or working stress basis. For strength design the usable capacity NC_n shall equal or exceed $1.4F_p$.~~

~~The value I_p shall be the values used for the structure from Table 16B-K. The value of ϕ may be taken as 1.00 for code complying or ductile connections and shall be taken as 4.00 for non-ductile connections.~~

$$F_p = \phi H C_a I_p W_p \quad (44A-14)$$

Alternatively, F_p may be calculated using the following formula:

$$F_p = \hat{a} a_p H C_a I_p (1 + 3h_x/h_r) W_p/R_p \quad (44A-15)$$

Except that:

$$F_p \text{ shall not be less than } 0.7 \$ H C_a I_p W_p \text{ and} \\ \text{Need not be more than } 4 \$ H C_a I_p W_p. \quad (44A-16)$$

Where:

\$ is the value for the connection, not the element to which it is attached. The values of \$ for connections, bracing, and materials shall be as prescribed in Section 1645A.7.2.

I_p is the value used for the structure selected from Table 16A-K.

h_x is the element or component attachment elevation with respect to grade. h_x shall not be taken less than 0.0.

h_r is the structure roof elevation with respect to grade. The value of h_x/h_r need not exceed 1.0.

a_p is the in-structure Component Amplification Factor that varies from 1.0 to 2.5.

A value for a_p shall be selected from Table 16A-O.

R_p is the Component Response Modification Factor that shall be taken from Table 16A-O, except that R_p for anchorages shall equal 1.5 for shallow expansion bolts, shallow chemical anchors, or shallow cast-in-place anchors. Shallow anchors are those with an embedment length-to-diameter ratio of less than 8. Where anchorage is constructed of nonductile materials, or has nonductile behavior, or the component is attached with an adhesive surface joint, R_p shall equal 1.0.

The design lateral forces determined using Formula (44A-14) or (44A-15) shall be distributed in proportion to the mass distribution of the element or component.

[OSHPD 1: The values for \$ for connections, bracing, and materials shall be as prescribed in Section 1645B.7.2]

Forces determined using Formula (44A-14) or (44A-15) shall be used to design members and connections that transfer these forces to the seismic-resisting systems. Members and connections shall use the load combinations and factors specified in Section 1644A.4.1.1 or 1644A.4.1.2. The member or connection actions due to F_p are the earthquake load E to be used in the load combinations.

Exception: Where a probabilistic hazard analysis has been performed, the Exception 2 of Section 1643BA.8.2 may be applied for the term H_{I_p} in formula 44BA-11.

To determine the out-of-plane loading for elements such as walls or wall panels that have points of attachment at two or more different elevations, the following procedure may be used. For the vertical span of the element having a unit weight w_p between two successive attachment elevations h_x and h_{x+i} evaluate the force coefficients F_p/W_p at each of the two points, observing the minimum and maximum limits, and compute the average of the two values. The resulting average coefficient times the unit weight w_p provides the distributed seismic load for the span between the attachment points, and this load may be extended to the top of any wall parapet above the roof attachment point at h_r

Section 1645BA—Procedures for the Classification of Elements Into the Ductile, Limited-ductile, and Non-ductile Categories

1645BA.1 General:...

1645BA.1.1 Ductile Category:...

1645BA.1.2 Non-Ductile Category:...

1645BA.1.3 Limited-Ductile Category:...

1645BA.2...

1645BA.2.1...

1645BA.2.2...

1645BA.3 Reinforced Concrete:...

1645BA.3.1 Reinforced concrete frame elements

1645BA.3.1.1. Any frame element in conformance with the requirements of 1976 UBC Section 2626 or later editions (Section 1921A.1 through 1921A.56 of 1994 UBC for Seismic Zones 3 and 4) may be classified as ductile and the ϕ value taken as 1.0.

Exception 1: For SPC 3 or higher seismic performance category the Hooked bar development length shall comply with 1994 UBC Section 1921A.5.4 to qualify the bar anchorage as ductile.

Exception 2:...

1645BA.3.1.2. Any frame element in essential conformance with the requirements of 1994 UBC Section 1921A.8 or equivalent requirements of earlier editions, shall be classified as limited ductile and assigned a ϕ value equal to or greater than that given in Table 16BA-R-1.

1645BA.3.1.3. Any column members in essential compliance with the requirements of ~~1994 UBC~~ Section 1921A.7.2 and 1921A.7.3 shall be classified as limited-ductile and assigned a ϕ value equal to or greater than that given in Table 16BA-R-1.

1645BA.3.4. Any element not meeting the requirements of Sections 1645BA.3.1.1, 1645BA.3.1.2 or 1645BA.3.1.3 shall be classified as non-ductile, with corresponding ϕ value equal to or greater than that given in Table 16BA-R-1, except where Section 1645BA.2 allows use of another value. The Section 1645BA.2.2 analysis shall consider at a minimum:

1. Reinforcing bar lap splice length, cover, and ties.
2. Pile-to-footing connection resistance to tension due to overturning moment. (~~Section 1644A.9.3, Part 2, Title 24, California Code of Regulations, 1995 Edition~~).
3. Footing flexural and shear capacity.
4. Column ties for both shear resistance and concrete confinement.
5. Positive Moment tension bar pullout or slab flexural failure. (Section 1645BA.1.3.2)
6. Negative moment hook pullout.
7. Stirrups for both shear resistance and concrete confinement.
8. Non-continuous longitudinal steel leaving sections with weakness in flexural and shear resistance. (~~1994 UBC Section 1921.8.4.1~~)
9. Joint shear reinforcing and confinement.
10. Weak column-strong beam condition. (Section 1921A.4.2.2, ~~Part 2, Title 24, California Code of Regulations, 1995 Edition~~ and Section 1645A.3.2.1.1 Exception 2).
11. Slab punching shear.

12. Short or captive column.

13. The shear capacity of columns.

1645BA.3.2 Shear Walls and Diaphragms

1645A.3.2.1 Any shear wall or diaphragm in conformance with the requirements of the 1976 UBC Section 2626 or later editions (Section 19216A of the ~~1994 UBC~~) may be classified as ductile and the ϕ value taken as 1.0.

Exception: A shear wall that essentially meets the boundary zone requirements of the ~~1994 UBC~~ Section 1921.6.5 may be classified as ductile.

1645BA.3.2.2...

1645BA.3.2.3...

1645BA.3.2.4...

Table 16A-R-1 Table of ϕ Values for Reinforced Concrete Elements...

Table 16A-R-1 Table of ϕ Values for Reinforced Concrete Elements (continued)...

1645BA.4 Masonry

1645BA.4.1 Ductile or Code Complying: Any element in essential conformance with the seismic requirements of Chapter 21A, Sections 2106A.1.12.4 and 2108A.2.3.8, ~~Part 2, Title 24, California Code of Regulations, 1995 Edition~~, may be classified as ductile and the ϕ value taken as 1.0.

Exception: Any shear wall pier and spandrel element having height or clear span to depth ratios greater than two shall ~~either~~ comply with Section 2108A.2.6 (Wall Frames), ~~Part 2, Title 24, California Code of Regulations, 1995 Edition~~, to be classified as ductile; otherwise, it shall be classified as a limited-ductile element with $\phi = 2.5$ or greater.

1645BA.4.2 Limited-Ductile:...

1645BA.4.3 Non-Ductile:...

1645BA.4.4 Where an element is unreinforced masonry, then the seismic capacities shall be determined in the manner consistent with the testing requirements specified in the Uniform Code for Building Conservation. [OSHPD 1: For hospital buildings, the use of unreinforced bearing wall masonry elements for seismic resistance is not allowed.]

1645BA.4.5 For masonry buildings with wood diaphragms, the requirements for Flexible Diaphragm-Rigid Wall Buildings of Uniform Code for Building Conservation, Appendix Chapter 5, shall apply.

[OSHPD 1: For masonry hospital buildings with wood diaphragms the requirements of these regulations for new construction shall apply. The procedures for Flexible Diaphragm-Rigid Wall Buildings of the UCBC. Appendix Chapter 5 may be used, subject to the limitations of these regulations for new construction.]

1645BA.4.6 Inspections Required....

1645BA.5 Structural Steel

1645BA.5.1 Welded steel moment frame elements. The SAC references in this section are to the SAC Interim Guidelines for the Evaluation, Repair, Modification, and Design of Welded Steel Moment Frame Structures, FEMA 267, August, 1995, ~~or subsequent editions.~~

1645BA.5.1.1 Any frame element in conformance with the requirements of Chapter 7 of the ~~SAC Guideline~~ FEMA 267 requirements for new construction or which has had its connections repaired and modified in accordance with the recommendations of Chapter 6 may be classified as ductile and the \$ value taken as 1.0

1645BA.5.1.2 For any frame element in essential conformance with the requirements of 1976 UBC Section 2722 for Seismic Zones 3 and 4 or later editions of the UBC, where the structure:

1. Has not experienced potentially damaging ground motions in an earthquake that by the recommendations of Chapter 4 of ~~SAC Guideline~~ FEMA 267 require inspection may be classified as limited-ductile and the \$ value taken as 1.5; or,
2. Has been repaired and evaluated in conformance with the recommendations of Chapters 4 and 6 of the ~~SAC Guideline~~ FEMA 267 may be classified as limited-ductile and the \$ value taken as 1.5 or greater; or,
3. Has been repaired in conformance with the requirements of Chapter 6 of the ~~SAC Guideline~~ FEMA 267 requirements for

the repair may be classified as limited-ductile and the \$ value taken as 2.0 or greater; or,

4. *Has been inspected in accordance with the requirements of Chapters 3 and 4 of the ~~SAC Guideline~~ FEMA 267,*
 - a. *connections that have been inspected but not repaired or modified may be classified as limited-ductile and the \$ value taken as $1.5 + .5d_i$, where d_i is the damage index for the inspected connections;*
 - b. *connections that have not been inspected may be classified as limited-ductile and the \$ value taken as $1.5 + .5DA$, where DA is the average damage index for the inspected connections;*
 - c. *connections that have been modified in accordance with the recommendations for Chapters 4 and 6 of the ~~SAC Guideline~~ FEMA 267 may be classified as ductile and the \$ value taken as 1.0;*
 - d. *connections that have been repaired in accordance with the recommendations of Chapters 4 and 6 of ~~SAC Guideline~~ FEMA 267 may be classified as limited-ductile and the \$ value taken as 1.5; or,*
5. *Has not been inspected in accordance with the requirements of Chapters 3 and 4 of the ~~SAC Guideline~~ FEMA 267, the connections of the structure may be classified as limited ductile and the \$ value taken as 3.0 or higher.*

1645BA.5.1.3...

1645BA.5.1.4...

1645BA.5.1.5...

1645BA.5.1.6...

1645BA.5.2 Braced steel frame elements

1645BA.5.2.1 *Any braced frame element in conformance with the requirements of 19947 UBC for braced frames may be classified as ductile and the \$ value taken as 1.0.*

1645BA.5.2.2 Any braced frame element in conformance with the requirements of 19947 UBC, except that the b/t ratio exceeds the 1947 requirements for braced frames may be classified as limited-ductile and the ϕ value taken as 1.5 for a special and 2.5 for ordinary braced frames.

1645BA.5.2.3...

1645BA.5.2.4...

1645BA.6 Wood and Other Sheathing Materials

1645BA.6.1...

TABLE 16BA - R-2 Table of ϕ Values for Wood and Other Sheathing Materials...

1645BA.6.2...

1645BA.7 [OSHPD 1: Nonstructural Components and Systems Critical to Patient Care]

1645BA.7.1...

1645BA.7.1.1...

1645BA.7.1.2 For the NPC-2 performance level the requirements of Section 1643BA.9 must be met by the following systems:

1. communications systems;
2. emergency power systems;
3. bulk medical gas systems; and,
4. fire alarm systems.
5. Emergency lighting equipment and signs in the means of egress.

1645BA.7.1.3...

1645BA.7.1.4...

1645BA.7.1.5...

1645BA.7.2 The ϕ values to be used in Section 1644BA.13.1 and formulas 44A-4114, 44A-15, and 44A-16 for the connection and bracing of nonstructural elements, equipment and systems shall be determined as follows:

1645BA.7.2.1 Ductile of Code Complying:...

1645BA.7.2.2 Non-Ductile:...

1645BA.7.2.3 Limited-Ductile:...

Section 1646BA-Detailed Systems Design Requirements

1646BA.1 General...

1646BA.1.1

1646BA.1.2

1646BA.1.3 The following provisions apply for all levels of the superstructure and its connection to the foundation structure:

1646BA.1.3.1 Overturning moment tension resistance for elements and connections: if the tension action due to $\frac{3(R_w/8)E}{8} W_oE - 0.9DL > 0$, then the usable tensile strength ϕF_c shall equal or exceed the greater of the tension due to $\frac{3(R_w/8)E}{8} W_oE - 0.9DL$ or $E/4410$ for semi-ductile and brittle elements; and $4.4E - 0.9DL$ or $E/4410$ for ductile elements.

1646BA.1.3.2 Reversed Moment opposite to that caused by gravity loads in beams, slabs, and spandrels: if the flexural action due to $\frac{3(R_w/8)E}{8} W_oE - 0.9DL > 0$, then the usable flexural strength ϕF_c shall equal or exceed the greater of the moment due to $\frac{3(R_w/8)E}{8} W_oE - 0.9DL$ or $E/4410$ for semi-ductile and brittle elements; $4.4E - 0.9DL$ or $E/4410$ for ductile elements.

1646BA.1.3.3 Resistance to sliding or slip of horizontal joints and/or the in-plane joints between diaphragms and walls or frames shall be such that the usable horizontal shear strength ϕF_c equals or exceeds the shear on the joint due to $4.4E$.

1646BA.1.3.4 For the following conditions:

1. Foundations at the soil-structure interface;
2. Horizontal construction joints in shear walls; or,
3. Diaphragm collectors, joints or connections of diaphragms to shear walls or frames.

if the strength capacity to resist overturning and/or sliding is exceeded by the application of a load combination of

$$\frac{3R_w}{8} E \pm 0.9DL \quad W_oE - 0.9D \quad (46BA-1)$$

then the deformations to be used in the investigation required by Section 1646BA.2.4 shall be two times the displacement prescribed by Section 1646BA.2.4.

1646BA.1.4...

1646BA.2 Structural Framing Systems.

1646BA.2.1 General...

1646BA.2.2 Detailing for combinations of systems...

1646BA.2.3 Connections

1646BA.2.4 Deformation compatibility. All vertical load bearing elements not included as a part of the lateral force resisting system shall be investigated and shown to be adequate for vertical load carrying capacity when displaced $(0.7)R_w$ times the displacements Δ_s resulting from the required design lateral forces given in Section ~~1628B.4~~ 1644A.4. A representation of cracked section stiffness properties for reinforced concrete and masonry elements shall be used in the calculation of the displacements. The displacements shall include diaphragm deformation.

For designs using working stress methods, this capacity may be determined using an allowable stress increase of 1.7 or acceptable published factors for a given material or element. The effects of adjoining rigid and exterior elements shall be considered as follows:

1646BA.2.4.1 Adjoining rigid elements....

1646BA.2.4.2 Exterior elements. Exterior nonbearing, non-shear wall panels or elements that are attached to or enclose the exterior of the structure shall be designed to resist the forces per Formulas ~~(44BA-1114)~~ or (44A-15) and shall accommodate movements of the structure resulting from lateral forces or temperature changes. In order to qualify for the "code-complying or ductile" classification such elements shall be supported by means of cast-in-place concrete or by mechanical connections and fasteners in accordance with the following provisions:

1. Connections and panel joints shall allow for a relative movement between stories of not less than two times story drift caused by wind or the story drift corresponding to the $(0.7) R_w$ factored displacements given in Section 1646BA.2.4, $(0.015 h)$, or 0.5 inch (13 mm), whichever is greater.
2. Connections to permit movement in the plane of the panel for story drift shall be sliding connections using slotted or oversize holes, connections

which permit movement by bending of steel, or other connections providing equivalent sliding and ductility capacity.

3. Bodies of connections shall have sufficient ductility and rotation capacity so as to preclude fracture of the concrete or brittle failures at or near welds.
4. The body of the connection shall be designed for one and one-third times the force determined by Formulas (44BA-11) or (44A-15) where $R_p = 3.0$ and $a_p = 1.0$.
5. All fasteners in the connecting system such as bolts, inserts, welds and dowels shall be designed using $\phi = 4.00$ in Formula (44B-11) for four times the force determined by Formula (44A-14) or (44A-15) where $R_p = 3.0$ and $a_p = 1.0$.
6. Fasteners embedded in concrete shall be attached to, or hooked around, reinforcing steel or otherwise terminated so as to effectively transfer forces to the reinforcing steel.

1646BA.2.5 Ties and continuity. All parts of a structure shall be interconnected and the connections shall be capable of transmitting the seismic force induced by the parts being connected. As a minimum, any smaller portion of the building shall be tied to the remainder of the building with elements having at least a strength to resist $\frac{1}{3} 0.5H_{ca}$ times the weight of the smaller portion.

A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder or truss. This force shall not be less than $\frac{1}{5} 0.5H_{ca}$ times the dead plus live load.

1646BA.2.6 Collector elements....

1646BA.2.7 Concrete frames. In order to qualify for the "code-complying or ductile" classification and use of an R_w greater than 8.5 , concrete frames that are part of the lateral-force-resisting system shall conform to the requirements of Division III for special moment-resisting frames in seismic Zones 3 and 4.

1646BA.2.9 Diaphragms:

1646BA.2.9.1 The deflection in the plane of the diaphragm shall not exceed the permissible deflection of the attached elements. Permissible deflection shall be that deflection which will permit the attached element to maintain its structural

integrity under the individual loading and continue to support the prescribed loads. For the purpose of this evaluation the deflection of the diaphragm shall be $(0.7)R_w$ times the deflection \underline{D}_s due to F_{px} with $\$ = 1.00$ in Formula (46BA-2).

1646BA.2.9.2 Floor and roof diaphragms shall be designed to resist the forces determined in accordance with the following formula:

$$F_{px} = b \frac{F_t + \sum_{i=x}^n F_i}{\sum_{i=1}^n w_i} w_{px} \quad (46BA-2)$$

The force F_{px} determined from Formula (46BA-2) need not exceed $0.751.0 b H C_a$ $l w_{px}$ but shall not be less than $0.350.5 b H C_a$ $l w_{px}$. The $\$$ value to be used in the capacity analysis is the factor appropriate to the element and condition of loading.

~~The force F_{px} shall be resisted using elements designed on an allowable or working stress basis, and the one third increase in allowable stress as per Section 1603BA.5 may be used except where specifically prohibited. For strength design the usable strength NC_n shall equal or exceed the load due to $1.4 F_{px}$. The actions on an element due to the force F_{px} are the seismic load E . The value of $\$$ shall be 1.00 for code complying or essentially complying elements and 4.00 for non-ductile elements, unless the element qualifies for a lower value as given in Table 16BA-R-1 or 16BA -R-2.~~

1646BA.2.9.3...

1646BA.2.9.4 Design forces for flexible diaphragms and their connections providing lateral supports for walls or frames of masonry or concrete shall be calculated using an R_w not to exceed 64.

1646BA.2.9.5...

1646BA.2.9.6...

1646BA.2.10 Framing below the base...

1646BA.2.11 Building separations. When the gap separating the building from adjacent structures is less than $0.7R_w$ times the displacement due to seismic forces of the building, then the effects of pounding shall be investigated and the structure modified so that pounding or interaction does not pose a life-safety threat to the building.

Exception: Smaller separations may be permitted when justified by rational analyses based on maximum expected ground motions. Under this exception, as a minimum, building separations shall not be less than $(R_w/8)^{3/4}$ R/5.5 times the displacements due to specified seismic forces.

Section 1647BA Nonbuilding Structures

1647BA.1 General Nonbuilding existing structures include all self-supporting structures other than buildings which carry gravity loads and resist the effects of earthquake. Nonbuilding existing structures shall be designed to resist the minimum lateral forces specified in this dDivision-III-R. Design shall conform to the applicable provisions of Section 16324BA for new structures except as modified by the provisions contained in this dDivision-III-R.

Section 1648BA-Method B

The existing or retrofitted structure shall be demonstrated to have the capability to sustain the deformation response due to the specified earthquake ground motions. The engineer shall provide an evaluation of the response of the existing structure in its current configuration and condition to the ground motions specified. If the building's seismic performance is evaluated as satisfactory and the peer reviewer(s) [OSHPD 1: and the enforcement agent] concurs, then no further engineering work is required. When the evaluation indicates the building does not meet the objective of ~~the Division-III-R~~ safety goals of this division [OSHPD 1: and the applicable structural seismic performance (SPC) and nonstructural seismic performance (NPC) requirements,] then a retrofit and/or repair design shall be prepared that yields a structure that meets the life-safety [OSHPD 1: and operational] performance objectives of Section 1640BA this dDivision-III-R and reflects the appropriate consideration of existing conditions. Any approach to analysis and design may be used that yields a building of reliable stability in the prescribed design earthquake loads and conditions. The approach shall be rational, shall be consistent with the established principals of mechanics, and shall use the known performance characteristics of materials and assemblages under reversing loads typical of severe earthquake ground motions.

Exception: Further consideration of the structure's seismic performance can be waived by the Enforcement Agent if both the engineer-of-record and peer reviewer(s) [OSHPD 1: and/or Enforcement Agent] conclude that the structural system can be expected to perform at least as well as required by this dDivision's ~~III-R~~ provisions without completing an analysis of the structure's

conformance to these requirements. A detailed report shall be submitted to the responsible Enforcement Agent that presents the reasons and basis for this conclusion. This report shall be prepared by the engineer of record. The peer reviewer(s) [OSHPD 1: and/or Enforcement Agent] shall concur in this conclusion and affirm to it in writing.

1648BA.2 The approach, models, analysis procedures, assumptions on material and system behavior, and conclusions shall be peer reviewed in accordance with the requirements of Section 1649BA and accepted by the peer reviewer(s) [OSHPD 1: and Enforcement Agent] ~~as appropriate to the specific applications.~~

EXCEPTIONS: 1) The enforcement agency may perform the work of peer review when qualified staff is available within the jurisdiction.

2) The enforcement agency may modify or waive the requirements for peer review when appropriate.

1648BA.2.1...

1648BA.2.1.1...

1648BA.2.1.2...

1648BA.2.1.3...

1648BA.2.1.4...

1648BA.2.1.5...

1648BA.2.1.6...

1648BA.2.2...

1648BA.2.2.1 [For OSHPD 1] *The ground motion characterization...*

Ground shaking having a 10% probability of exceedance in 50 years need not exceed 2/3 of the maximum considered earthquake.

Ground shaking response spectra for use in Method B shall be determined in accordance with either the General Procedure of Section 1648BA.2.2.4~~2~~ or the Site-Specific Procedure of Section 1648BA.2.2.2~~3~~.

In the General Procedure, ground shaking hazard is determined from the response spectrum acceleration contour maps. Maps showing 5%-damped response spectrum ordinates for short-period (0.2 second) and long-period (1.0 second) response distributed by FEMA for use with the "NEHRP Guidelines for the Seismic Rehabilitation of Buildings" (FEMA 273) shall be used directly with the General Procedure of Section 1648B.2.2.4~~2~~ for developing design response

spectra for either or both the 10% probability of exceedance in 50 years and the maximum considered earthquake. In the Site-Specific Procedure, ground shaking hazard is determined using a specific study of the faults and seismic source zones that may affect the site, as well as evaluation of the regional and geologic conditions that affect the character of the site ground motion caused by events occurring on these faults and sources.

The General Procedure may be used for any building except as specified below. The Site-Specific Procedure may ~~also~~ be used for any building and shall be required where any of the following apply:

1. The building is category SPC-5;
2. The building site is located within 10 kilometers of an active fault;
3. The building is located on Type E soils (as defined in Section 1648B.2.2.42) and the mapped maximum considered earthquake spectral response acceleration at short periods (S_S) exceeds 2.0g;
4. The building is located on Type F soils as defined in Section 1648B.2.2.42.

Exception: Where S_S determined in accordance with Section 1648BA.2.2.42, $< 0.20g$. In these cases, a Type E soil profile may be assumed.

5. A time history response analysis of the building is performed as part of the design.

1648BA.2.2.2 [For OSHPD 1] General Procedure to Determine the Acceleration Response Spectra. The general procedures of this section shall be used to determine the acceleration response spectra. Deterministic estimates of earthquake hazard, in which an acceleration response spectrum is obtained for a specific magnitude earthquake occurring on a defined fault, shall be made using the Site-Specific Procedures of Section 1648BA.2.2.23. The mapped short-period response...

Table 16BA-R-3 Values of F_a as a Function of Site Class and Mapped Short-Period Spectral Response Acceleration S_S

Table 16BA-R-4 Values of F_v as a Function of Site Class and Mapped Spectral Response Acceleration at One- Second Period S_1

Table 16BA-R-5 Damping Coefficients B_S and B_1 as a Function of Effective Damping β

Figure 16BA-R-1 General Response Spectrum

1648BA.2.2.3 [For OSHPD 1] Site Specific Procedure to Determine the Acceleration Response Spectra

Where site-specific ground shaking...

Development of site-specific response spectra shall be based on the geologic, seismologic, and soil characteristics associated with the specific site. Response spectra shall be developed for an equivalent viscous damping ratio of 5%. Additional spectra may be developed for other damping ratios appropriate to the indicated structural behavior, as discussed in Section 1648BA.2.2.42. When the 5% damped...

The maximum considered earthquake

Where the spectral response ordinates at 0.2 second or 1 second for a 5% damped spectrum having a 2% probability of exceedance within a 50 year period exceeds the corresponding ordinates of the deterministic limit, the maximum considered earthquake ground motion spectrum shall be taken as the lesser of the probabilistic maximum considered earthquake ground motion or the deterministic maximum considered earthquake ground motion spectrum. The deterministic limit for the maximum considered earthquake ground motion response spectrum shall be calculated as 150% of the median spectral response accelerations at all periods resulting from a characteristic earthquake on any known active fault within the region and shall comply with the response spectrum determined in accordance with Figure 16BA-R-2, where F_a and F_v are determined in accordance with Section 1648BA.2.2.42 with the value of the mapped short period spectral response acceleration, S_S , taken as 1.5g and the value of the mapped spectral response acceleration at 1 second, S_1 , taken as 0.6g.

Figure 16BA -R-2 Deterministic limit on maximum considered earthquake response spectrum

When a site-specific response spectrum has been developed and other sections of these regulations require values for the spectral response parameters, S_{XS} , S_{X1} , or T_0 , they shall be obtained in accordance with this section. The value of the design spectral response acceleration at short S_{XS} , shall be taken as the response acceleration obtained from the site-specific spectrum at a period of 0.2 seconds, except that it shall be taken as not less than 90% of the peak response acceleration at any period. In order to obtain a value for the design spectral

response acceleration parameter S_{X1} , a curve of the form $S_a = S_{X1}/T$ shall be graphically overlaid on the site-specific spectrum such that at any period, the value of S_a obtained from the curve is not less than 90% of that which would be obtained directly from the spectrum. The value of T_0 shall be determined in accordance with Equation 48BA-8. Alternatively, the values obtained in accordance with Section 1648BA.2.2.42 may be used...

1648BA.2.3...

1648BA.2.3.1...

1648BA.2.3.2...

1648BA.2.3.3...

1648BA.2.3.4...

1648BA.2.3.5...

1648BA.2.3.6...

1648BA.2.3.7...

1648BA.2.4...

1648BA.2.5...

1648BA.3...

Section 1649BA-Peer Review Requirements

1649BA.1 General:...

1649BA.2. Timing of Independent Review:...

1649BA.3. Qualifications and Terms of Employment:...

1649BA.3.1...

1649BA.3.2...

1649BA.3.3...

1649BA.3.4...

1649BA.4. Scope of Review:...

1649BA.5. Reports:...

1649BA.5.1...

1649BA.5.2...

1649BA.5.3...

1649BA.5.4...

1649BA.5.5...

1649BA.5.6...

1649BA.5.7...

1649BA.5.8...

1649BA.6. Response and Corrective Actions:...

1649BA.7. Distribution of Reports...

1649BA.8. Design Professional of record:...

1649BA.9. Resolution of Differences:...