EXPRESS TERMS
OF PROPOSED BUILDING STANDARDS
OF THE DIVISION OF THE STATE ARCHITECT - STRUCTURAL SAFETY

REGARDING THE 2001 CALIFORNIA BUILDING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 2

Adopt entire Division VI-R provisions applicable to state-owned buildings, except as modified below:

LEGEND FOR EXPRESS TERMS

1. Italicized text indicates the Division VI-R provisions applicable to state-owned buildings proposed for adoption by DSA-SS.
2. Provisions not adopted by DSA/SS are prefaced with "*[Not Adopted by DSA/SS]* ".
3. Additions and amendments to the Division VI-R provisions applicable to existing state-owned buildings are shown "*underlined and in italics*".

CHAPTER 16A, DIVISION VI-R

Division VI-R - EARTHQUAKE EVALUATION AND DESIGN FOR RETROFIT OF [FOR BSC, DSA] EXISTING STATE-OWNED BUILDINGS [FOR OSHPD] EXISTING HOSPITAL BUILDINGS [FOR DSA/SS] EARTHQUAKE EVALUATION AND DESIGN FOR REHABILITATION OF EXISTING BUILDINGS FOR USE AS A PUBLIC SCHOOL BUILDING

SECTION 1640A - GENERAL

1640A.1 Purpose. *All modifications, alterations, and/or repairs to existing structures or portions thereof shall, at a minimum, be designed and constructed to resist the effects of seismic ground motions as provided in this division. When applicable, the structural system shall be evaluated by the design professional of record and, if not meeting or exceeding the minimum seismic design purpose of this division, shall be retrofitted in compliance with these requirements.*

[For DSA/SS] *For rehabilitation of any existing buildings, the structural system shall be evaluated by the design professional in responsible charge of design and, if not meeting or exceeding the minimum seismic design purpose of this division, shall be designed and retrofitted in compliance with these requirements. Elements of structures, nonstructural components and equipment shall be evaluated and retrofitted to the seismic requirements of this division.*

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 OSHPD 1& 4] 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.

[For DSA/SS] *For rehabilitation of existing buildings for use as school buildings, the performance objective of this division is to provide for Protection of Life and Property as defined in Section 1641A.*

1640A.2 Applicability. *For all state-owned structures, including all buildings owned by the University of California and California State University: The requirements of this division apply wherever the structure is to be retrofitted, repaired, or modified and 1) total construction cost, not including cost of furnishings, fixtures and equipment, or normal maintenance, for the building exceeds 25 percent of the construction cost for the replacement of the existing building; or 2) changes in occupancy category; or 3) changes to structural elements reduce the lateral load capacity by more than 5 percent at any story; or 4) structural elements need repair where the damage has reduced the lateral load capacity by more than 10 percent at any story; or 5) changes in live or dead load increase the story shear by more than 5 percent. The changes in Item 1 are cumulative for past alterations to the building that occurred after adoption of this division and did not require the application of this division.*

[For DSA/SS] *The requirements of this division apply to the rehabilitation of existing buildings for public school use as required per Section 4-307, Article 1, Group 1, Chapter 4, Part 1, Title 24.*

1640A.2.1 [For OSHPD 1 & 4] *The requirements of this division apply to 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: 1) there is change in occupancy; or 2) changes to structural elements that reduce the lateral load capacity by more than 5% at any story; or 3) repair of structural elements where the damage has reduced the lateral load capacity by more than 10% at any story; or 4) changes in live or dead load that increase the story shear by more than 5%; or 5) where required by Section 1638A or Chapter 6, Part 1, Title 24, Building Standards Administrative Code. The changes in Items 2), 3), and 4) are cumulative for past alterations to the building.*

1640A.2.2 [Not adopted by DSA/SS] 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 and the peer reviewer(s), when Method B of Section 1648A is used, concur, 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.2.3 [For OSHPD 1] 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.*

1640A.2.4 [For DSA/SS] Required evaluation and retrofit. *Where evaluation per Section 1643A indicates the building or an element of the building does not meet the performance objective of this division, the retrofit shall be designed to meet the provisions of the same methodology used in the evaluation per Sections 1640A.3, 1640A.6 or 1640A.7. Retrofit to existing construction shall comply with the detailing requirements for new construction of Part 2, Title 24, currently effective edition.*

1640A.3 [Not adopted by DSA/SS] *The modification to any existing building may be prepared in accordance with the requirements for a new building, Chapter 16A, Division VI, Part 2, Title 24, California Code of Regulations, 2001 edition.*

1640A.3.1 [For DSA/SS] *The rehabilitation of any existing building may be evaluated and designed in accordance with the requirements for a new public school building in accordance with Part 2, Title 24, currently effective edition. Evaluation and design, material testing, condition assessment and determination of equivalency with code standards for non-conforming construction shall be approved in accordance with the procedures defined in Section 1640.A.8. Equivalency with code standards for non-conforming construction shall be determined by rational analysis or testing.*

1640A.4 *The requirements of the UBC Appendix Chapter 16, Sections 1654-1665, are to apply to the use of seismic isolation for the repair, modification or retrofit of an existing structure. When seismic isolation or passive energy dissipation is used, the project must have project peer review as prescribed in Section 1649A.*

> ***EXCEPTION:*** *For hospital buildings [DSA/SS: and public school buildings] the requirements of Appendix Chapter 16A, Section 1654A through 1665A apply in lieu of those of the UBC for repair, modification or retrofit to existing hospital buildings.*

1640A.5 [Not adopted by DSA/SS] *Any construction required by this division shall include structural observation by the licensed structural engineer, civil engineer or architect of record who is responsible for the structural design in accordance with Section 1643A.12.*

1640A.5.1 [For DSA/SS] *Construction testing, inspection and observation requirements shall be as set forth in Section 4-333(a), Article 5, Group 1, Chapter 4, Part 1, Title 24, Building Standards Administrative Code, Chapter 17A, and the testing and inspection requirements of Chapters 18A through 23A, Part 2, Title 24.*

1640A.6 *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.*

[For DSA/SS] *The rehabilitation of any existing building may be evaluated and designed in accordance with the requirements for Method B of this division provided the methodologies for evaluation and design, and for determination of acceptance criteria for existing construction are approved in accordance with the procedures defined in Section 1640.A.8. Procedures for material testing and condition assessment shall also be approved in accordance with Section 1640.A.8. When Method B is used, the owner shall retain an independent peer review consultant to provide expertise and recommendations appropriate to the design, analysis and performance issues associated with the project in accordance with Sections 1640A.8.3 and 1648A.2.*

1640A.6.1 *The structural system allowances of Chapter 34 do not apply to any building to which Division VI-R applies.*

1640A.7 [For DSA/SS] *The rehabilitation of any existing building, unless otherwise limited per Section 1643A.7, may be evaluated and designed in accordance with the requirements for Method A of this division. Methodologies for evaluation and design, and determination of β-factors or alternate β-factors per Section 1645A.2.2 shall be approved in accordance with the procedures defined in Section 1640.A.8. Procedures for material testing and condition assessment shall also be approved in accordance with Section 1640.A.8.*

1640A.8 [For DSA/SS] Procedures for DSA Approval of the Evaluation and Retrofit Design. *During the schematic phase of the project, the owner or the design professional in responsible charge of design shall perform initial data collection and assessment of the building (Section 1640A.8.1) and prepare and sign an Evaluation and Design Criteria Report (Section 1640A.8.2). The report shall propose the methodologies for evaluation and design, and determination of acceptance criteria for nonconforming construction; and shall propose the material testing and condition assessment requirements for the rehabilitation. Two copies of the report shall be submitted to the DSA for review and approval prior to proceeding with design development of the rehabilitation. The DSA shall review the report to determine that each item per Section 1640A.8.2 has been satisfactorily addressed. If DSA determines that one or more items are not satisfactorily addressed or DSA does not concur with any of the proposals, the report shall be returned to the design professional for correction. Upon concurrence that all items have been satisfactorily addressed by the proposals in the report, DSA shall approve, sign and return a copy of the signed report to the owner.*

The approved Evaluation and Design Criteria Report establishes: 1) the criteria for the evaluation and design to be used by the project design professionals, and 2) the material testing and condition assessment requirements.

If changes to the approved criteria are determined to be necessary during design development and completion of construction documents, the project design professional shall submit an amendment to the Evaluation and Design Criteria Report to the DSA for approval. When Method B is used, the peer reviewer shall review the amendment and provide a written report to the owner and DSA in accordance with Section 1649A.

Upon completion of the design, the plans and specifications shall be submitted to the DSA for approval per the provisions of Part 1,Title 24.

1640A.8.1. **Initial data collection and assessment.** Initial data collection and assessment shall include:

1. Site visit(s) of structure.

2. Data collection of existing site conditions and building construction in accordance with Section 1643A.2.

3. Review of original plans, specifications and associated construction documents, including material test reports, geohazard and geotechnical reports. Where original building plans and specifications are not available, "as-built" plans shall be prepared that accurately depict the existing vertical and lateral structural systems, exterior elements (cladding) and non-structural systems. Where geohazard and geotechnical reports are not available, these reports may be required by the DSA for existing sites in accordance with Section 4-317(e), Article 1, Group 1, Part 1, Title 24.

4. Preliminary analysis of the lateral force resisting system that provides the basis for the proposed evaluation and design method.

1640A.8.2. Evaluation and Design Criteria Report. *The Evaluation and Design Criteria Report shall be signed by the design professional in responsible charge of the design and the project structural engineer and shall:*

1. Describe the building(s) configuration and type of construction.

2. Identify the building gravity and lateral load resisting systems, and non-structural systems that may affect the stiffness or strength of the lateral system during a seismic event.

3. Describe the project site and identify any potential hazards from adjacent or adjoining structures or site conditions.

4. Identify potential geological hazards.

5. Describe the physical condition and known material properties of existing gravity and lateral load resisting elements or components and of exterior elements of the structure based on the data collection processes of 1650A.

6. Based on data collection and review of original construction documents and preliminary analysis, identify potential deficiencies in the gravity and lateral load resisting systems.

7. Propose the methodology for evaluation and design of the structure. Include methodology to establish modeling parameters to be used in the analysis and to establish Beta-factors or acceptance criteria for non-code-compliant construction.

8. Provide the justification for the proposed methodology. Include any preliminary calculations.

9. Propose the program for additional data collection, condition assessment and testing requirements to complete the analysis. Identify locations for the proposed material assessment and tests.

Submit with the Evaluation and Design Criteria Report:

1. Approved or "as-built" building plans, specifications and associated construction documents that accurately depict the existing construction.

2. Available material test reports, geohazard and geotechnical reports from the existing construction.

1640A.8.3. Requirements for Method B.

1. Upon selection of Method B, the design professional(s) in responsible charge of the design and the independent peer reviewer(s) shall meet with the DSA prior to development of the Evaluation and Design Criteria Report, to: define the scope of the structural rehabilitation, determine appropriate evaluation and design methodologies, determine initial data collection requirements, and determine the scope of the peer review process for the project.

2. During the schematic phase, upon review of the Evaluation and Design Criteria Report, the peer reviewer shall provide a written report to the owner and DSA in accordance with Section 1649A.

3. During the design development phase of the project, upon completion of the analysis, the peer reviewer shall review the analysis results and provide a written progress report in accordance with Section 1649A. The design professional(s) shall provide responses and corrective actions in accordance with Section 1649A.6.

> *EXCEPTION: When the DSA determines that the project scope does not require a report during the design development phase, this requirement may be waived by the DSA.*

4. Upon completion of the construction documents prior to submittal of the application to the DSA, the peer reviewer shall review the plans, specifications and any final analysis results and provide a written report to the owner and DSA in accordance with Section 1649A. The design professional(s) shall provide responses and corrective actions in accordance with Section 1649A.6.

5. During construction of the rehabilitation and when determined necessary by the design professional or the DSA, the peer reviewer shall review proposed changes to the approved plans and specifications and provide a written report to the owner and DSA in accordance with Section 1649A.

***1640A.9 [For DSA/SS]** Where only a portion(s) of a structure is to be rehabilitated, the school portion of the structure shall:*

1. Be seismically separated from the unrehabilitated portion in accordance with Section 1646A.2.11.1, or the entire structure shall be rehabilitated in accordance with this division. For structures in which the unrehabilitated portion is above or below the school portion, the entire structure shall be rehabilitated in accordance with this division.

2. Be retrofitted as necessary to protect the occupants from falling hazards of the unrehabilitated portion of the building, and;

3. Be retrofitted as necessary to protect required exitways being blocked by collapse or falling hazards of the unrehabilitated portion.

SECTION 1641A - DEFINITIONS

***1641A.1** For the purposes of this division, 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 *is one that has exhibited surface displacement within Holocene time (about 11,000 years) as determined by the California Division of Mines and Geology under the Alquist-Priolo Special Studies Zones Act or other authoritative source, Federal, State or Local Governmental Agency.*

CODE-COMPLYING ELEMENT [Not adopted by DSA/SS] *is an element that complies with the Seismic Zones 3 and 4 detailing requirements for elements that are part of the selected lateral-force-resisting system as given in the 1976 or later editions of the UBC [For OSHPD 1, 4, Title 17 and Title 24]. Refer to Section 1645A for specific elements and materials.*

[For DSA/SS] CODE-COMPLYING ELEMENT *is an element that complies with the Seismic Zones 3 and 4 detailing requirements for "ductile" elements that are part of the lateral-force-resisting system for a β equal to 1.0 as defined in Section 1645A for specific elements and materials.*

CODE-COMPLYING SYSTEM [Not adopted by DSA/SS] *is a system that complies with the Seismic Zones 3 and 4 requirements for lateral-force-resisting systems and materials as given in the 1976 or later editions of Title 17 and Title 24.*

[For DSA/SS] CODE-COMPLYING SYSTEM *is a system that complies with the Seismic Zones 3 and 4 requirements for lateral-force-resisting systems and materials consisting of code-complying elements.*

DESIGN *is the procedure that includes both the evaluation and retrofit design of an existing element and the design of a new element.*

DESIGN BASIS EARTHQUAKE *is the earthquake ground motion having a 5 percent damped acceleration response spectrum as represented by R/1 times the Base Shear V given by Formulas (44A-1) and (44A-2). [For OSHPD 1,4 is the earthquake ground motion defined in Section 1648A.2.2.1.]*

DISTANCE FROM AN ACTIVE EARTHQUAKE FAULT *is measured from the nearest point of the building to the closest edge of an Alquist-Priolo Special Study zone [For DSA/SS: Alquist-Priolo Earthquake Fault Zone] for an active fault, if such a map exists, or to the closest mapped splay of the fault.*

DUCTILE ELEMENT *is an element capable of sustaining large cyclic deformations beyond the attainment of its nominal strength without any significant loss in capacity. Refer to Section 1645A for specific elements and materials.*

ELEMENT *is a part of an architectural, electrical, mechanical or structural system.*

ENFORCEMENT AGENT *is that individual within the agency or organization charged with responsibility for agency or organization compliance with the requirements of Division VI-R.*

ESSENTIALLY COMPLYING STRUCTURAL SYSTEM or ELEMENT [Not adopted by DSA/SS] *is a lateral-force-resisting system or element that may deviate from but can provide comparable elastic and inelastic cyclic load-deformation behavior as a system or element that complies to the 1976 or later editions of the Uniform Building Code provisions for systems or elements resisting seismic*

forces. Refer to Section 1645A for specific elements and materials.

***[For DSA/SS] ESSENTIALLY COMPLYING STRUCTURAL SYSTEM or ELEMENT** is a lateral-force-resisting system or element that may deviate from but can provide comparable elastic and inelastic cyclic load-deformation behavior as a code-complying system or code-complying element.*

***ESSENTIAL LIFE SAFETY** is the retrofit or repair of a structure to a goal of essential life-safety as a level of expected structural performance taken to mean that occupants will be able to exit the structure safely following an earthquake. It does not mean that they will be uninjured or not be in need of medical attention. A structure is presumed to achieve this level of performance where, although significant damage to the structure may have occurred, some margin against either total or partial structural collapse remains, even though damage may not be economical to repair; major structural elements have not become dislodged or fallen so as to pose a life-safety threat; and, nonstructural systems or elements, which are heavy enough to cause severe injuries either within or outside the building, have not become dislodged so as to pose a life-safety threat.*

***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 clean-up, inspection and limited structural and nonstructural repairs may be required.*

***INELASTIC DEMAND RATIO (IDR)** is the ratio of the total load demand on an element to the nominal strength capacity of an element, where load demand is the combination of gravity loads and the unreduced (by R~~W~~) elastic response force due to the specified earthquake ground motion.*

***LATERAL LOAD CAPACITY** is the capacity as determined either by Method A or Method B of the subject element. A [For DSA/SS: The capacity of a] system is the sum of all element capacities acting individually reduced by the β-factor for the element and meeting the requirements of Section 1646A.2.4. All forms of loading are to consider both displacements in orthogonal directions and torsion.*

***LIMITED-DUCTILE ELEMENT [Not adopted by DSA/SS]** is an element that is capable of sustaining moderate cyclic deformations beyond the attainment of nominal strength without significant loss in strength. The deformation capability is less than that of a ductile element, and these elements do not meet the ductile element criteria of the 1976 or later versions of the UBC. Refer to Section 1645A for specific elements and materials.*

***[For DSA/SS] LIMITED-DUCTILE ELEMENT** is an element that is capable of sustaining moderate cyclic deformations beyond the attainment of nominal strength without significant loss in strength. The deformation capability is less than that of a "ductile" element, and these elements do not meet the "ductile" element criteria for a β-factor equal to 1.0 per Section 1645A for specific elements and materials.*

***METHOD A** refers to the procedures contained in Sections 1645A-1647A.*

METHOD B *refers to the procedures contained in Section 1648A.*

NOMINAL STRENGTH *is the peak capacity of an element using specified material and assembly properties of the applicable materials chapters of Title 24. Examples are the flexural strength of a reinforced concrete beam M_n when the maximum concrete strain is at 0.003, or the plastic flexural capacity of a steel beam $Mp = ZF_y$ when all fibers in the section are at yield stress F_y and Z is the plastic section modulus. It is also the accepted peak strength from test results.*

NONDUCTILE ELEMENT *is an element having a mode of failure that results in an abrupt loss of resistance when the element is deformed beyond the deformation corresponding to the development of its nominal strength. Nonductile elements cannot reliably sustain any significant deformation beyond that attained at their nominal strength.*

PEER REVIEW *refers to the procedures contained in Section 1649A.*

PROBABLE STRENGTH *is the level of strength of an element likely in as-built or existing materials. For example, in reinforced concrete, it is common that actual steel yield is larger than the specified design value, and therefore probable strength is taken as equal to 1.25 times the nominal strength in flexure.*

[For DSA/SS] PROTECTION OF LIFE AND PROPERTY *is the rehabilitation of a structure to a goal of protection of life and property as a level of expected structural and nonstructural performance taken to mean: a) the building has substantial margin against either total or partial collapse of the gravity and lateral structural systems allowing occupants to exit safely; b) structural and nonstructural elements either within or outside the building have not fallen or been dislodged so as to pose a life-safety threat. It is expected that the structure may experience some repairable damage.*

[For DSA/SS] REHABILITATION *is the evaluation and retrofit of an existing nonconforming building or a school building conforming to earlier code requirements to bring the building, or portion thereof, into conformance with the safety standards of the currently effective regulations, Parts 2, 3, 4, 5, 6, 7, 8, 9 and 12, Title 24, C. C. R.*

REPAIR *as used in this division 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.*

[For DSA/SS] RETROFIT *as used in this division means all design and construction work undertaken to construct any new or to repair or strengthen any existing structural or nonstructural elements required by the evaluation and design of the building.*

USABLE STRENGTH or FACTORED STRENGTH *is the product of under strength [For DSA/SS: strength-reduction] factor Φ times the nominal strength in the appropriate material.*

SECTION 1642A - SYMBOLS AND NOTATIONS

1642A.1 *The following symbols and notations apply to this division in addition to those of Section 1628A:*

[For DSA/SS] *C_n represents the nominal strength of a material for a given state of stress.*

ΦC_n = Usable strength or capacity of an element as determined in the materials chapters where Φ is the strength reduction factor.

C_w = Allowable or working stress resistance of an element.

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

H = The seismic coefficient defined in Section 1643A.8.

IDR = Inelastic Demand Ratio.

IDRL = Limit value of the IDR that an element can develop without failure.

β = Seismic Load Penalty Factor representing the limited inelastic deformation capability of nonductile and limited-ductile elements with respect to that of ductile elements in a given mode of failure (attainment of nominal strength).

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

Δ_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.

Δ_M = Maximum Inelastic Response Displacement, which is the total drift or total story drift given by $0.7R\Delta_s$.

SECTION 1643A - CRITERIA SELECTION

1643A.1 [Not adopted for DSA/SS] Basis for Evaluation and Design. *This section determines what technical approach is to be used for the seismic evaluation and design for existing buildings. For those buildings or portions of buildings for which Section 1640A.2 requires action, the procedures and limitations for the evaluation of existing buildings and design of retrofit systems and/or repair thereof shall be implemented in accordance with this section. One of three alternative approaches must be used: the first, Method A (Sections 1644A-1647A), is prescriptive and comparable to the Division VI provisions for new structures; the second, Method B (Section 1648A), for complex or potentially hazardous situations is performance based and depends on the independent review of a peer reviewer (Section 1649A); the third is the use of one of the applicable Uniform Code for Building Conservation (UCBC) special procedures given in Section 1643A.1.1.*

[For DSA/SS] Basis for Evaluation and Design. *This section determines which technical approach may be used for the seismic evaluation and design for existing buildings. For those buildings or portions of buildings for which Section 1640A.2 requires retrofit, the procedures and limitations for the evaluation of existing buildings and design of retrofit systems and/or repair thereof shall be implemented in accordance with this section. One of three alternative approaches must be used: the first, Method A (Sections 1644A-1647A), as defined in Section 1640A.7, is prescriptive*

and comparable to the Part 2, Title 24, provisions for new buildings; the second, Method B (Section 1648A), as defined in Section 1640A.6, for complex or potentially hazardous situations is performance based and depends on the independent review of a peer reviewer (Section 1649A); the third is the use of Part 2, Title 24, as defined in Section 1640A.3.

1643A.1.1 [Not adopted by DSA/SS] Special procedures. *Where there are special prescriptive procedures for the repair and/or retrofit of existing buildings as a part of these regulations, the UCBC, or accepted practice by the enforcement agent, these procedures may be used in lieu of the requirements of Chapter 34. The following special prescriptive procedures may be used for their respective types of construction to meet the requirements of this division.*

1. The UCBC for Seismic Strengthening Provisions for Unreinforced Masonry Bearing Wall Buildings (Appendix Chapter 1).

2. The UCBC for Cripple Walls and Anchor Bolts (Appendix Chapter 6).

3. The UCBC for Flexible Diaphragm Rigid Wall Buildings (Appendix Chapter 5).

4. The SAC Interim Guidelines for the Evaluation, Repair, Modification, and Design of Welded Steel Moment Frame Structures, FEMA 267, August 1995. The ground motion specifications of this division shall be used when the SAC procedures are applied.

1643A.1.1.1 *The UCBC for Seismic Strengthening Provisions for Unreinforced Masonry Bearing Wall Buildings (Appendix Chapter 1).*

> ***[For OSHPD 1] EXCEPTION:*** *For hospital buildings, the use of unreinforced masonry wall elements is not allowed.*

1643A.1.1.2 *The UCBC for Cripple Walls and Anchor Bolts (Appendix Chapter 6). [For OSHPD 1] Where the requirements of these regulations for new construction are more restrictive, they shall govern. Section A604.4.2 of the UCBC is not adopted.*

EXCEPTION: *Single-story wood light frame hospital buildings as defined in Section 2.2.3,Article 2, Chapter 6, Part 1, Title 24, which fail the check of Section 5.6.4, Article 5, Chapter 6, Part 1, Title 24, may be upgraded to SPC 2 by seismically retrofitting this deficiency in accordance with the provisions of the UCBC for Cripple Walls and Anchor Bolts (Appendix Chapter 6).]*

1643A.1.1.3 *The UCBC for Flexible Diaphragm Rigid Wall Buildings. [For OSHPD1]:Where the requirements of these regulations for new construction are more restrictive, they shall govern.*

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. The ground motion specifications of this division shall be used when the SAC procedures are applied.*

1643A.2 Existing Conditions. *The existing condition and properties of the entire structure must be determined and documented by thorough inspection, review of all available related construction documents, and performance of necessary testing and investigations [For DSA/SS: in accordance*

with data collection provisions of Section 1650A]. Where samples from the existing structure are taken or in situ tests are performed, they shall be selected and interpreted in a statistically appropriate manner to ensure that the properties determined and used in the evaluation or design are representative of the conditions and structural circumstances likely to be encountered in the structure as a whole.

The entire load path of the lateral-force-resisting system shall be determined, documented and evaluated. The load path includes all the horizontal and vertical elements participating in the structural response such as diaphragms, diaphragm chords, diaphragm drags, vertical lateral-force-resisting system (walls, frames, braces, etc.), foundations and the connection between the elements of the load path.

***1643A.3 Site Geology and Soil Characteristics.** Soil profile shall be assigned in accordance with the requirements of Section 1629A.3 [For DSA/SS: where Method A or Part 2, Title 24, are used].*

***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 1629A.2. [For 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.*

***1643A.5 Configuration Requirements.** Each structure shall be designated structurally regular or irregular in accordance with the requirements of Section 1629A.5.*

***1643A.6 Selection of the Design Method**. The requirements of Method B (Section 1648A) [For DSA/SS: and Part 2, Title 24,] may be used for any existing building.*

***1643A.7** The requirements of Method A (Sections 1644A-1647A) may be used except under the following conditions, where Method B [for OSHPD 1 & 4] or Special Procedures as defined in Section 1643A.1.1.*

***[For DSA/SS]** The requirements of Method A (Sections 1644A-1647A) may be used except under the following conditions, where Method B or Part 2, Title 24, shall be used.*

***1643A.7.1** When the building contains prestressed or posttensioned structural elements (beams, columns, walls or slabs) or contains precast structural elements (beams, columns, walls or flooring systems).*

***1643A.7.2** When the building is classified as irregular in vertical or horizontal plan by application of Table 16A-L or 16A-M, unless the irregularity is demonstrated not to affect the seismic performance of the building.*

> ***EXCEPTION:** If the retrofit design removes the configurational attributes that caused the building to be classified as irregular, then Section 1643A.7.2 does not apply and Method A may be used.*

***1643A.7.3 [Not adopted by DSA/SS]** For any building that has an importance factor I greater than 1.00 (Table 16A-K).*

> ***EXCEPTIONS:** 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.

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

1643A.7.4 *For any building using undefined or hybrid structural systems. [For DSA/SS] Method B shall be used for these structural systems.*

1643A.7.5 *When passive or active energy absorption systems are used in the retrofit or repair, either as part of the existing structure or as part of the modifications. [For DSA/SS] Method B shall be used for these structural systems.*

1643A.7.6 [Not adopted by DSA/SS] *When the height of the structure exceeds 240 feet (73 152 mm).*

1643A.7.6.1 [For DSA/SS] *When the building exceeds three stories.*

EXCEPTION: 1. Any school building for which the structural system is retrofitted using Method B, Method A may be used for retrofit or repair of nonstructural components and systems.

1643A.7.7 [For DSA/SS] *When the building contains unreinforced masonry.*

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

1643A.8.1 [Not adopted by DSA/SS.] *When the Importance Factor, I, is equal to 1, then H is equal to:*

[For OSHPD 1] EXCEPTION: *For hospitals this value of H may be used where I is equal to 1.0 if the assigned performance category is SPC-2.*

1643A.8.1.1 *Three-quarters (0.75), when the seismic coefficients C_a and C_v are determined from Tables 16A-Q and 16A-R.*

1643A.8.1.2 *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-percent 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 second provides the value of 2.5 Ca g, and the spectrum at 1.0 second provides the value of C_v g, where g is the gravity constant.*

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

2. The results of a community-wide probabilistic seismic analysis (Section 1643A.8.1.2) may be used when the responsible enforcement agency has accepted a probabilistic seismic hazard study for the jurisdiction to determine the value required by Section 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 1649A.

1643A.8.2 [Not adopted by DSA/SS.] *Otherwise, the H value is equal to unity (1.0), and the seismic coefficients C_a and C_v may be determined either from Tables 16A-Q and 16A-R or from a 5 percent damped acceleration response spectrum with a 10-percent probability of exceedance in 50 years determined from a probabilistic seismic hazard analysis for the specific site.*

EXCEPTIONS: *1. Exception 1 of Section 1643A.8.1.2 applies.*

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 the seismic coefficients C_a and C_v are determined from a 5 percent damped response spectrum with 10-percent probability of exceedance in 100 years determined from a probabilistic analysis for the specific site.

1643A.8.3 [For DSA/SS] *The Seismic Hazard Factor, H, is equal to 1.2.*

1643A.9 Capacity Requirements*. All elements of the lateral-force-resisting system must have the capacity to resist the seismic demand. Any element not having this capacity shall have its capacity increased by modifying or supplementing its capacity so that it exceeds the demand, or the demand reduced to less than the existing capacity by making other modifications to the structural system. [For DSA/SS: Any element that has experienced damage or deterioration and no longer retains the capacity to resist the seismic demand and/or gravity load shall be retrofitted in accordance with Section 1643A.10.1.]*

EXCEPTIONS: *1. An elements usable strength capacity may be less than that required by the specified seismic load combinations if it can be demonstrated that the associated reduction in seismic performance of the element or its removal due to the failure does not result in a structural system in which there is a life-safety hazard due to the loss of support of gravity loads; a laterally unstable structure; or falling structural or nonstructural elements or parts thereof. If this exception is taken for an element, then it cannot be considered part of the primary lateral-load-resisting system.*

2. The load transferred from an adjoining element to a given element need not exceed the probable strength 1.25 C_n of the adjoining element, given that the assembly remains stable [For DSA/SS:, where Method A or Part 2, Title 24, are used]. For elements where the resistance is expressed in terms of the allowable or working stress method, the usable strength ΦC_n may be determined using an allowable stress increase of 1.70, or may be established by acceptable published factors for a given material or element, or by the use of appropriate available test data and the applicable principles of mechanics.

3. [Not adopted by DSA/SS] This requirement does not apply to a mechanical penthouse when its floor area is less than one third of that of the immediately lower floor.

1643A.10 New Elements. [Not adopted by DSA] *All new elements shall either be "code-complying or ductile" or "limited-ductile," and shall be selected and designed to have compatible force-deformation performance with existing elements and nonstructural components.*

EXCEPTION: *The use of nonductile elements is allowed if the particular material provides the only means of ensuring compatible performance without detrimental interaction effects on the existing element material. Code-complying or essentially code-complying details shall be used where possible.*

1643A.10.1 [For DSA/SS] New or Retrofitted Elements. *Any new or retrofitted structural or nonstructural element(s) shall comply with the detailing requirements for new construction of Part 2, Title 24, currently effective edition, and shall meet the capacity requirements of Section 1643A.9.*

EXCEPTION: *1. Where approved by the DSA, other nationally recognized standards or guidelines may be used in lieu of Part 2, Title 24, provisions.*

2. Where approved by the DSA, the use of nonductile or limited ductile elements may be allowed if the particular material provides the only means of ensuring compatible performance without detrimental interaction effects on the existing element material.

1643A.11 Deformation Compatibility. *The compatibility of the deformation characteristics of all elements activated in the response shall be considered, as well as the configuration of the structural and nonstructural systems; the continuity, or lack thereof, of load paths; the redundancy, if any, of these load paths; and the physical condition of the materials and elements. [For DSA/SS: The gravity load resisting members and exterior elements shall be evaluated and retrofitted to resist gravity loads combined with seismic induced drift associated with the design ground motion.]*

1643A.12 [Not adopted for DSA/SS] Structural Observation.

1643A.12.1 ~~[For DSA/SS]~~ *Structural observation as used in this division 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 shall 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 this division. High-rise construction requires an interim progress report each month in addition to observation reports for the significant construction stages.*

The owner shall directly employ the engineer or architect, or their designee, responsible for the structural design to perform structural observation.

After each visit, the structural observer shall report in writing on the general conformity of the work to the approved plans and note any observed deficiencies to the owners representative, project inspector, contractor and the enforcement agency. The structural observer shall notify the enforcement agency 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 agency shall be notified for any necessary action.

At the conclusion of construction, the structural observer shall submit to the enforcement agency and the owner a final written statement that the required site visits have been made, that the work, to the best of the structural observers knowledge and belief, is or is not in general conformity to the approved plans and that the observed structural deficiencies have been resolved and/or listing those that, to the best of the structural observers knowledge and belief, have not been satisfactorily corrected.

1643A.12.1.1 *The requirement for structural observation shall be noted and prominently displayed on the front sheet of the approved plans and incorporated into the general notes on the approved plans.*

1643A.12.1.2 Preconstruction meeting. *A preconstruction meeting is mandatory for all projects which require structural observation. The meeting shall include, but is not limited to, the design engineer or architect, structural observer, general constructor, affected subcontractors, the project inspector and a representative of the enforcement agency (designated alternates may attend if approved by the structural observer). The structural observer will schedule and coordinate this meeting.*

The purpose of the meeting is to identify and clarify all essential structural elements and connections that affect the lateral and vertical load systems and to review scheduling of the required observations for the project's structural system retrofit.

1643A.12.2 [For OSHPD] 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.*

1643A.13 Temporary Actions. *When compatible with the building use, and the time phasing for both use and the retrofit program, temporary shoring or other structural support may be considered. Temporary bracing, shoring and prevention of falling hazards can offer an affordable means of qualifying for the exception in Section 1644A.4.1.1 that allows inadequate capability in some existing elements as long as life safety can be provided.*

1643A.14 [For DSA/SS] Unreinforced Masonry. *Unreinforced masonry shall not be used to resist in-plane or out-of-plane seismic forces or superimposed gravity loads.*

> *EXCEPTION: Masonry may be used to resist gravity loads when justified by rational analysis and approved by the DSA.*

1643A.15 [For DSA/SS] Wood Frame Buildings. *Horizontal diaphragms and vertical shear walls shall consist of either diagonal lumber sheathing or structural panel sheathing. Braced horizontal diaphragms may be acceptable when approved by DSA. Straight lumber sheathing may be used in combination with diagonal or structural panel sheathing as diaphragms or shear walls. Let-in bracing, plaster (stucco), gypsum wallboard and particleboard sheathing shall not be allowed to resist seismic forces.*

SECTION 1644A - METHOD A

1644A.1 General. *Structures shall be designed for seismic forces coming from any horizontal direction. The design seismic forces may be assumed to act nonconcurrently in the direction of each principal axis of the structure, except as required by Section 1646A.1.4. Seismic dead load, W, is the total dead load and applicable portions of other loads listed below.*

1644A.1.1 *In storage and warehouse occupancies, a minimum of 25 percent of the floor live load shall be applicable.*

1644A.1.2 *Where a partition load is required in the floor design, a load of not less than 10 pounds per square foot (psf) (0.48 kN/m2) shall be included.*

1644A.1.3 *Design snow loads of 30 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 agency.*

1644A.1.4 *Total weight of permanent equipment shall be included.*

1644A.2 *Determine the most applicable complying or essentially complying structural system as described in Section 1629A.6. All elements that are capable of providing significant resistance to the actions of lateral forces shall be included in the system.*

> ***EXCEPTION:*** *Elements made of noncomplying materials and/or details, and nonstructural components may be omitted from the system provided that their rigidity, capacity and load-deformation behavior are established for use in the investigation of the effects of these elements on the structural system as required by Sections 1646A.2.4 and 1646A.2.4.1.*

1644A.2.1 *Classify each element included in the assigned structural system and foundation as being either "ductile," "limited-ductile," or "nonductile" according to its relative compliance with required provisions and/or its ability to deform beyond the nominal strength level without an abrupt or significant loss of resistance.*

All elements shall be considered nonductile if they do not comply or do not essentially comply with the requirements for ductile elements. The limited-ductile classification must be established by related empirical data and analysis, or by meeting the requirements given in Section 1645A.

Section 1645A provides a listing of code dates and extra provisions that apply for given elements and materials to qualify for the "code-complying or ductile" classification. Section 1645A also provides the procedures and criteria that apply for the "limited-ductile" and "nonductile" classification.

The stiffness and nominal strength or capacity C_n of each element shall be determined for each possible mode of failure of the element.

1644A.2.2 *Evaluate the uplift and/or sliding resistance of joints and connections at all levels including the diaphragm-to-wall or frame connection and collectors, and including the foundation soil-structure interface along with the soil compressive resistance to seismic forces; the contribution of existing piles and caissons shall be considered where they occur.*

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

1644A.3 General. *Structural systems shall be classified with the requirements of Section 1629A.6 as one of the types listed in Table 16A-N and defined in this section. The system selected for an existing building to be most appropriate for a given existing building may contain noncomplying elements and/or elements that essentially comply to the required provisions and details for that*

system provided that all the noncomplying and essentially complying elements have been properly classified as "nonductile", "limited-ductile," or "ductile" and the corresponding β values are applied to their seismic load.

1644A.3.1 *The system R-value shall be taken as 4.5 for all existing structural systems except for the following conditions. [For DSA/SS: For systems in which the R-value in Table 16A-N is lower than 4.5, the lower R-value shall be used.]*

1644A.3.1.1 *R may be taken as 5.5 if the system constructed meets the requirements for a Building Frame System as defined in Section 1629A.6.3. [For DSA/SS: For systems in which the R-value in Table 16A-N is lower than 5.5, the lower R-value shall be used.]*

1644A.3.1.2 *For structural systems designed to meet all of the seismic provisions 1976 or later editions of the UBC, R may be taken as appropriate R value given in Table 16A-N for the corresponding basic structural system.*

1644A.4 Static Force Procedures.

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

$$V = \frac{H C_v I W}{RT} \qquad (44A\text{-}1)$$

The total design base shear need not exceed the following:

$$V = \frac{2.5 H C_a I W}{R} \qquad (44A\text{-}2)$$

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

$$V = 0.11 H Ca I W \qquad (44A\text{-}3)$$

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

$$V = \frac{0.8 H Z N_v I W}{R} \qquad (44A\text{-}4)$$

1644A.4.1.1 Strength basis for evaluation and design. *Elements subject to seismic load E due to the specified base shear V shall have the usable strength capacity ΦC_n to resist the following load combinations:*

1. For the case where the actions D, L and E are all in the same sense,

$$\Phi Cn = 1.05D + 0.25L + \beta E \qquad (44A\text{-}5)$$

where the live load L is the realistic live load, but shall not be less than the design load specified for the occupancy.

2. For the case where the action E is opposite to the sense of D,

$$\Phi Cn = \beta E - 0.9D \qquad (44A\text{-}6)$$

In the load combinations (44A-5) and (44A-6), the seismic load penalty factor β represents the limited inelastic deformation capability of nonductile and limited-ductile elements for an associated mode of failure. Values of β for specific types of elements and modes of failure are given in Section 1645A.

EXCEPTION: *See Exceptions 1 and 2 in Section 1643A.9.*

1644A.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 1612A.3.2 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:*

3. For the case where the actions D, L, and E are all in the same sense,

$$C_w = D + L + \frac{\beta E}{1.4} \qquad (44A\text{-}7)$$

4. For the case where the action E is opposite to the sense of D,

$$C_w = \frac{\beta E}{1.4} - 0.9D \qquad (44A\text{-}8)$$

EXCEPTION: *Section 1644A.4.1.2 may not be used for reinforced concrete.*

1644A.4.2 Structure period. *The value of T shall be determined in the same manner as for a new building contained in Section 1630A.2.2.*

1644A.5 Combinations of Structural Systems. General. *Where combinations of structural systems are incorporated into the same structure, the same requirements shall be satisfied as for a new building of Section 1630A.4 shall be satisfied.*

1644A.6 Vertical Distribution of Force. *The total force shall be distributed over the height of the structure in conformance with the requirements of Section 1630A.5 for new buildings.*

1644A.7 Horizontal Distribution of Shear. *The design story shear shall be distributed over the height of the structure in conformance with the requirements of Section 1630A.6 for new buildings.*

1644A.8 Horizontal Torsional Moments. *Provisions shall be made for the increased shears resulting from horizontal torsion where diaphragms are not flexible. The most severe load combination for each element shall be considered for design in conformance with the requirements of Section 1630A.7 for new buildings.*

1644A.9 Overturning.

1644A.9.1 General. *Every structure shall be designed to resist the overturning effects caused by earthquake forces specified in Section 1630A.5. At any level, the overturning moments to be resisted shall be determined using those seismic forces (F_t and F_x) that 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 1630A.6. Overturning effects on every element, wherever possible, shall be carried down directly in a linear path to the foundation. See load combinations in Sections 1644A.4.1.1 and 1644A.4.1.2 for combining gravity and seismic forces.*

1644A.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 16A-L or plan irregularity Type 4 in Table 16A-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:*

$$\Phi C_n = D + 0.8L + \Omega_o \beta E \qquad (44A\text{-}9)$$

$$\Phi C_n = \Omega_o \beta E - 0.9D \qquad (44A\text{-}10)$$

$\Omega_o \beta E$ in Formulas (44A-9) and (44A-10) need not exceed RE.

1644A.9.2.1 *The axial forces in such columns need not exceed the resultant of the probable strengths of the other elements of the structure that transfer such loads to the column.*

1644A.9.2.2 *Such columns shall be capable of carrying the above-described axial forces without exceeding the usable axial load capacity (ΦC_n) of the column. 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.*

EXCEPTION: *See Exceptions 1 and 2 in Section 1643A.9.*

1644A.9.2.3 Columns.

1644A.9.2.3.1 ~~[For DSA/SS]~~ *Such columns shall either resist the above-described axial forces without exceeding the usable axial capacity (ΦC_n), or shall meet the following detailing and member limitations:*

1. Chapter 19, Section 1921.4, for concrete, and Chapter 22, Section 2210, 2211.4 and 2211.5, for steel in structures in Seismic Zones 3 and 4, except for welded steel moment connections where the current SAC Guidelines for columns apply.

2. Chapter 19, Section 1921.8, for concrete, and Chapter 22A, Divisions I and IX, special provisions for developing plastic hinges at ultimate loading, for steel in structures in Seismic Zone 2.

1644A.9.2.3.2 [For OSHPD 1&4] *In order to qualify for a β value equal to 1.0, such columns shall meet the following detailing and member limitations:*

1. Chapter 19A, Section 1921A.4, for concrete, and Chapter 22A, Section 2210A, 2211.4 and NO TAG, for steel in structures in Seismic Zones 3 and 4, except for welded steel moment connections where the SAC Interim Guidelines for the Evaluation, Repair, Modification, and Design of Welded Steel Moment Frame Structures, FEMA 267, August, 1995, provisions for columns apply.

1644A.9.2.3.3 [For DSA/SS] *In order to qualify for a β value equal to 1.0, such columns shall meet the following detailing and member limitations:*

1. Chapter 19A, Section 1921A.4, for concrete, and Chapter 22A, Section 2210A, 2211.4, for steel in structures in Seismic Zones 3 and 4, except for welded steel moment connections where the current SAC Guidelines for the evaluation, repair, modification, and design of welded steel moment frame buildings, FEMA 350, 351, 352, July 2000, provisions for columns apply.

1644A.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 ΦC_n for each mode of failure. For this case, the β factor shall correspond to the properties of the girder.*

1644A.9.3 At foundation. *See Section 1809A.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 1809A.2 and Table 18A-I-A, and other load combinations need not apply:*

$$D + L + \frac{E}{1.4} \qquad (44A\text{-}11)$$

$$\frac{E}{1.4} - 0.9D \qquad (44A\text{-}12)$$

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 and axial loads on the sections of the foundation structure are to be factored by the appropriate β value and shall be resisted by the corresponding usable strength ΦC_n of the section. If piles or caissons are required for overturning moment tension resistance due to the load combination (44A-12), then the minimum tensile load-carrying resistance ΦC_n shall be E/14.

1644A.10 Drift and Story Drift Limitations. *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, $\Delta_{~m}$ $\underline{M}$, 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, Δ_s, shall be determined in accordance with Section 1644A.10.1. To determine $\Delta_{~m}$ $\underline{M}$, these drifts shall be amplified in accordance with Section 1644A.10.2.*

1644A.10.1 Determination of Δ_s. *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*

Δ_s, shall be determined at all critical locations in the structure. Calculated drift shall include translational and torsional deflections.

1644A.10.2 Determination of $\Delta_{\cancel{m}M}$. *The Maximum Inelastic Response Displacement, $\Delta_{\cancel{m}M}$, shall be computed as follows:*

$$\Delta_{\cancel{m}M} = 0.7\, R\, \Delta_s \qquad (44A\text{-}13)$$

1644A.10.3 Story drift defined. *Story drift is the displacement of one level relative to the level above or below using the Maximum Inelastic Displacement, $\Delta_{\cancel{m}M}$, at each level.*

1644A.10.4 Story drift limits. *Calculated story drift using $\Delta_{\cancel{m}M}$ 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: [Not adopted by DSA/SS]*** *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 OSHPD1&4] for buildings in seismic performance categories SPC-1 and SPC-2, and life safety and continued operation in SPC-3 through SPC-5 buildings.*

1644A.11 PΔ Effects. *The resulting member forces and moments and the story drifts induced by PΔ 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 Δ_s. PΔ 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 unfactored total dead, floor live load and snow load above the story times the seismic drift Δ_s 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, PΔ need not be considered where the story drift ratio does not exceed 0.02/R$_{\cancel{W}}$.*

1644A.12 Vertical Component. *The following requirements apply in Seismic Zones 3 and 4 only. Horizontal cantilever components shall have the usable strength capacity ΦC_n 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 1643A.~~9~~8 according to the occupancy and conditions of the building.*

1644A.13 Lateral Force on Elements of Structures, Nonstructural Components and Equipment Supported by Structures. *Elements of structures and their attachments, permanent nonstructural components and their attachments, and the attachments for permanent equipment supported by a structure shall be designed to resist the total design seismic forces prescribed in Section 1644A.13.1. Attachments for floor or roof-mounted, but not suspended, equipment weighing less than 400 pounds (181 kg), and furniture need not be designed.*

Attachments shall include anchorages and required bracing. Friction resulting from gravity loads shall not be considered to provide resistance to seismic forces.

When the failure of the lateral-force-resisting anchorage, bracing or connection of nonrigid

equipment would cause a life hazard, such elements shall be designed to resist the seismic forces prescribed in Section 1644A.13.1.

When allowable design stresses and other acceptance criteria are not contained in or referenced by this code, such criteria shall be obtained from approved national standards.

1644A.13.1 Design for total lateral force.

1644A.13.1.1 [Not adopted for DSA/SS] ~~[For DSA/SS]~~ *The total design lateral seismic force, F_p, shall be determined from the following formula:*

$$F_p = 4.0\ H\ Ca\ I_p\ W_p \qquad (44A\text{-}14)$$

Alternatively, Fp may be calculated using the following formula:

$$F_p = a_p\ H\ Ca / R_p\ (1+3\ h_x / h_r)\ W_p \qquad (44A\text{-}15)$$

Except that: F_g shall not be less than 0.7 H Ca Ip W_p and need not be more than 4 H Ca I_g W_g (44A-16)

WHERE:

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

h_r = the structure roof elevation with respect to grade.

a_p = 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. ~~[For~~ DSA/SS~~]~~ The β factor may be taken as 1.0 for anchorages requiring R_p equal to 1.0, 1.5 or 3.0.

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.

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 1643A.8.2 may be applied for the term HI_p in Formula 44-11.*

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+1 evaluate the force coefficients Fa/W_a 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.

1644A.13.1.2 [For OSHPD 1&4] *Critical nonstructural components and systems, as defined in Table 11.1, Chapter 6, 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 for new buildings, Section 1632A. All other elements of structures, nonstructural components and equipment supported by structures shall comply with provisions of Section 1645A.7 and this section.*

[For OSHPD] *The total design lateral force, F_p, shall be determined from the following formula:*

$$F_p = \beta\ H\ C_a\ I_p\ W_p \qquad (44A\text{-}14)$$

Alternatively, F_p may be calculated using the following formula:

$$F_p = \beta\ \frac{a_p\ H\ C_a}{R_p}\left(1+3\frac{h_x}{h_r}\right)w_p \qquad (44A\text{-}15)$$

Except that: F_p shall not be less than $0.7\ \beta\ H\ C_a\ I_p\ W_p$ and need not be more than $4\ \beta\ H\ C_a\ I_p\ W_p$. *(44A-16)*

Where:

β is the value for the connection, not the element to which it is attached. The values of β 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-0, 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.

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, exception 2 of Section 1643A.8.2 may be applied for the term HI_p in formula 44A-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.

1644A.13.1.2.1 [For DSA/SS] *Nonstructural components and systems shall meet the requirements for new buildings, Section 1632A, or comply with provisions of Section 1645A.8 and this section.*

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

$$F_p = \beta\, H\, C_a\, I_p\, W_p \qquad \text{(44A-14)}$$

Alternatively, Fp may be calculated using the following formula:

$$F_p = \beta\, \frac{a_p\, H\, C_a\, I_p}{R_p} \left(1 + 3\frac{h_x}{h_r}\right) w_p \qquad \text{(44A-15)}$$

Except that: F_p shall not be less than 0.7 β H C_a I_p W_p and need not be more than 4 β H C_a I_p W_p. *(44A-16)*

Where:

β is the value for the connection, not the element to which it is attached. The values of β 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-0, 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.

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.

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 1645A - PROCEDURES FOR THE CLASSIFICATION OF ELEMENTS INTO THE DUCTILE, LIMITED-DUCTILE AND NONDUCTILE CATEGORIES

1645A.1 General. *All elements will be classified as either being "ductile," "limited-ductile," or "nonductile". The purpose of this section is to provide the procedures and guidelines necessary for this classification and assignment of β values. The general requirements for all materials are listed below and will be followed by the specific requirements for each material. [For DSA/SS: Information from data collection (Sections 1643A.2 and 1650A) shall be used to establish the β-values.]*

1645A.1.1 Ductile category. *A ductile element is one that complies with the definition of ductile. Code-complying elements shall be classified as ductile, except as noted in Section 1644A.9.2.3. Otherwise, a rational analysis, as described in the nonductile category below, may be used to justify the use of the ductile classification.*

1645A.1.2 Nonductile category. *Any element that does not comply with the code-compliant definition shall be classified as nonductile; except for the case where it either complies with the specific provisions of Section 1645A required for the limited-ductile category, or a rational analysis based on the principles of mechanics, related research and test results can demonstrate that it has the cyclic inelastic deformation behavior required for the limited-ductile or ductile categories.*

1645A.1.3 Limited-ductile category. *An element that does not qualify as ductile, but does comply or essentially complies with the specific material limited-ductile provisions of Section 1645A,may be classified as limited-ductile. Otherwise, a rational analysis as described in the nonductile category above may be used to justify the use of the limited-ductile classification.*

1645A.2 *For each element and loading condition, a β value is assigned that represents the expected load-deflection behavior of the element during the full earthquake loading of the element, including repeated, reversing loads. β values that are significantly different from those given in Section 1645A must receive the acceptance of the enforcement agency when they are used in the analysis and design.*

[For DSA/SS] *For each element and loading condition, a β value is assigned that represents the expected load-deflection behavior of the element during the full earthquake loading of the element, including repeated, reversing loads. β values that are different from those given in Section 1645A must receive the acceptance of the DSA when they are used in the analysis and design.*

1645A.2.1 *Sections 1645A.3 through 1645A.6.2 provide reference values for selected elements and loading conditions; these β values are to be used as guidance for the assignment of values for conditions and elements not listed by comparison of expected performance to that expected for listed elements.*

1645A.2.2 *Alternative β values to those listed may be used where experimental results, coupled with rational analysis, lead to the conclusion that a different β value better represents the behavior of a given element and its conditions. Such interpretation and analysis shall be subject to the review and approval of the enforcement agency and shall consider the following items:*

1. The effects of cyclic load reversals representative of seismic loading beyond the strength level of the element, considering the specific nature of the loading used in the test, especially whether essentially static or dynamic.

2. The size or scale effect of the test data, along with the compatibility of the test specimen details with those of the existing element.

3. The sample size of the test program and range of related test variables necessary to reasonably define behavior.

1645A.3 Reinforced Concrete. *Reinforced concrete is considered to be any combination of concrete with steel reinforcing that can develop the compressive and tensile properties of the respective materials. The procedures and provisions for the classification of ductile, limited-ductile and nonductile elements are given in Sections 1645A.3.1 through 1645A.3.1.4. The corresponding β values are given in Table 16A-R-1.*

1645A.3.1 Reinforced concrete frame elements.

1645A.3.1.1 [Not adopted by DSA/SS] *Any frame element in conformance with the requirements of 1976 UBC Section 2626 or later editions (Sections 1921A.1 through 1921A.5 for Seismic Zones 3 and 4) may be classified as ductile and the β value taken as 1.0.*

EXCEPTIONS: *1. Hooked bar development length shall comply with Section 1921A.5.4 to qualify the bar anchorage as ductile.*

2. For a column to be classified as ductile, no more than one-third of the columns in a story level of its frame-line may have the weak column-strong beam condition; otherwise, each column in the story level frame-line shall be classified as no more than limited ductile.

1645A.3.1.1.1 [For DSA/SS] *Any frame element in conformance with the requirements of 1985 UBC Section 2625 or later editions may be classified as ductile and the β value taken as 1.0.*

EXCEPTIONS: *1. For a column to be classified as ductile, no more than one-third of the columns in a story level of its frame-line may have the weak column-strong beam condition; otherwise, each column in the story level frame-line shall be classified as no more than limited ductile.*

1645A.3.1.2 *Any frame element in essential conformance with the requirements of Section 1921A.8 [For DSA/SS: UBC Section 1921.8] or equivalent requirements of earlier editions, shall be classified as limited ductile and assigned a β value equal to or greater than that given in Table 16A-R-1.*

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

1645A.3.1.4 *Any element not meeting the requirements of Section 1645A.3.1.1, 1645A.3.1.2 or 1645A.3.1.3 shall be classified as nonductile, with corresponding β value equal to or greater than that given in Table 16A-R-1, except where Section 1645A.2 allows use of another value. The Section 1645A.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).

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 1646A.1.3.2)

6. Negative moment hook pullout.

7. Stirrups for both shear resistance and concrete confinement.

8. Noncontinuous longitudinal steel leaving sections with weakness in flexural and shear resistance (Section 1921.8.4.1).

9. Joint shear reinforcing and confinement.

10. Weak column-strong beam condition (Sections 1645A.3.1.1, Exception 2, and 1921A.4.2.2).

11. Slab punching shear.

12. Short or captive column.

13. The shear capacity of columns.

1645A.3.2 Shear walls and diaphragms.

1645A.3.2.1 [Not adopted by DSA/SS] *Any shear wall or diaphragm in conformance with the requirements of the 1976 UBC Section 2626 or later editions (Section 1921.6) may be classified as ductile and the β value taken as 1.0.*

> ***EXCEPTION:*** *A shear wall shall essentially meets the boundary zone requirements of Section 1921.6.6 to be classified as ductile.*

1645A.3.2.1.1 [For DSA/SS] *Any shear wall or diaphragm in conformance with the requirements of the 1985 UBC Section 2625 or later editions may be classified as ductile and the β value taken as 1.0.*

> ***EXCEPTION:*** *A shear wall that essentially meets the boundary zone requirements of Section 1921.6.6 may be classified as ductile.*

1645A.3.2.2 *Any shear wall or diaphragm in conformance with 1976 UBC Section 2614 may be classified as a limited-ductile element and assigned a β value equal to or greater than that given in Table 16A-R-1.*

1645A.3.2.3 *Any wall element not meeting the requirements of Section 1645A.3.2.1 or 1645A.3.2.2 shall be classified as nonductile, with corresponding β value equal to or greater than that given in Table 16A-R-1, except where Section 1645A.2 allows use of another value. The Section 1645A.2.2 analysis shall consider at a minimum:*

1. Dowel and reinforcing bar lap splice length, cover and ties.

2. Boundary element or boundary zone confinement ties.

3. Horizontal shear steel and its anchorage in boundary element or boundary zone.

4. Location and characteristics of construction joints.

5. Relative stiffness and friction resistance of soil-footing interface to determine if the effects of foundation rotation and/or horizontal slip need to be included in the analytical model (Section 1646A.1.3.4)

6. Diaphragm drag or collector elements and connection of diaphragm to wall or braced frame (Sections 1646A.1.3.3 and 1646A.1.3.4).

7. Spandrel capacity to resist flexure and vertical shear.

8. Pile-to-footing connection resistance to tension due to overturning moment (Section 1644A.9.3).

1645A.3.2.4 *Any diaphragm element not meeting the requirements of Section 1645A.3.2.1 or 1645A.3.2.2 shall be classified as nonductile, with corresponding β value equal to or greater than that given in Table 16A-R-1, except where Section 1645A.2 allows use of another value. The Section 1645A.2.2 analysis shall consider at a minimum:*

1. Thickness of slab and positioning of reinforcing.

2. Shear connection to walls.

3. Shear reinforcing.

4. Reinforcing around openings.

5. Chord element.

6. Drag or collector elements.

1645A.4 Masonry.

1645A.4.1 Ductile or code-complying. *Any element in essential conformance with the seismic requirements of Chapter 21A, Sections 2106A.1.12.4 [For DSA/SS:, 2107A.1.3] and 2108A.2.3.8, may be classified as ductile and the β value taken as 1.0.*

> ***EXCEPTION:*** *Any shear wall pier and spandrel element having height or clear span to depth ratios greater than 2 shall comply with Section 2108A.2.6 (wall frames) to be classified as ductile; otherwise, it shall be classified as a limited-ductile element with β =2.5 or greater.*

1645A.4.2 Limited-ductile. *Any masonry element in essential conformance with the 1994 UBC Sections 2106.1.12.3 (special provisions for Seismic Zone 2), and 2108.2.3.8 (seismic design provisions), shall be classified as limited ductile and assigned a β value equal to or greater than 2.5 for all modes of failure.*

1645A.4.3 Nonductile. *Systems and elements that do not comply with Section 1645A.4.1 or 1645A.4.2 shall be classified as nonductile, with a corresponding β value equal to or greater than 4.5 for all modes of failure, except where Section 1645A.2 allows use of another value. Section 1645A.2.2 analysis shall consider at a minimum:*

Wall elevation:

1. Horizontal and vertical reinforcing.

2. Reinforcing at edges of wall and openings.

3. Slenderness proportions of wall piers and spandrels.

4. Height-to-thickness ratio of wall.

5. Special reinforcing for slender piers.

6. Spandrels and openings.

7. Diaphragm connections.

8. Quality of dry-pack mortar joints and grouting of shear friction dowels at the horizontal joint between the top of masonry walls and adjoining reinforced concrete beams or slabs.

Grouting:

1. Grouting of cells, particularly those containing reinforcing steel.

2. Potential for incomplete grouting because of large or pairs of reinforcing bars in one cell or in bond beams.

3. Bond beams at required spacing and location.

4. Splice lengths for vertical and horizontal reinforcing.

5. Quality of construction joint at base of wall and vertical control joints.

Wall and diaphragm connections:

1. Wall joints and separations for pounding or hard-spot effects.

2. Wall-reinforcing ties at wall intersections and corners.

3. Wall-to-diaphragm connections.

***1645A.4.4 [Not adopted by DSA/SS]** 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 (UCBC). [For OSHPD 1] For hospital buildings, the use of unreinforced bearing wall masonry elements for seismic resistance is not allowed.*

***1645A.4.5 [Not adopted by DSA/SS]** 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. [For 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.*

***1645A.4.6 [Not adopted by DSA/SS] Inspections required.** Unless inspection reports from the original construction are available and acceptable, then appropriate destructive testing and inspections shall be performed, including core testing and removing masonry. For each wall that is part of the lateral-resisting system, at least one of each of the following tests shall be done:*

1. Core test to determine the strength of the masonry, the bond between the grout and the masonry units, and the placement and size of reinforcing steel in the walls.

2. At sections of the construction joints where masonry adjoins concrete at slab, concrete framing or foundations, determine the value of shear transfer.

1645A.5 Structural Steel.

1645A.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.*

[For DSA/SS] *The references in this section are to the following SAC Joint Venture recommendations and AISC provisions:*

1. FEMA 350, Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings (July 2000).

2. FEMA 351, Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel-Moment Frame Buildings (July 2000).

3. FEMA 352, Recommended Post Earthquake Evaluation and Repair Criteria for Welded Moment-Frame Construction for Seismic Applications (July 2000).

4. AISC Seismic Provisions for Structural Steel Buildings, April 1997 with Supplement 2.

1645A.5.1.1 [Not adopted by DSA/SS] *Any frame element in conformance with the requirements of Chapter 7 of the 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 β value taken as 1.0.*

1645A.5.1.1.1 [For DSA/SS] *Any frame, including its connections, in conformance with the requirements of Part 2, Title 24 for new school buildings may be classified as ductile and the β-value taken as 1.0.*

1645A.5.1.2 [Not adopted by DSA/SS] *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 FEMA 267 require inspection may be classified as limited-ductile and the β value taken as 1.5; or

2. Has been repaired and evaluated in conformance with the recommendations of Chapters 4 and 6 of FEMA 267 may be classified as limited-ductile and the β value taken as 1.5 or greater; or

3. Has been repaired in conformance with the requirements of Chapter 6 of FEMA 267 requirements for the repair may be classified as limited-ductile and the β value taken as 2.0 or greater [for OSHPD]; or

4. Has been inspected in accordance with the requirements of Chapters 3 and 4 of FEMA 267,

4.1 Connections that have been inspected but not repaired or modified may be classified as limited-ductile and the β value taken as 1.5 + 0.5 d_i, where d_i is the damage index for the inspected connections.

4.2 Connections that have not been inspected may be classified as limited-ductile and the β value taken as 1.5 + 0.5DA, where DA is the average damage index for the inspected connections.

4.3 Connections that have been modified in accordance with the recommendations of Chapters 4 and 6 of FEMA 267 may be classified as ductile and the β value taken as 1.0.

4.4 Connections that have been repaired in accordance with the recommendations of Chapters 4 and 6 of FEMA 267 may be classified as limited-ductile and the β value taken as 1.5; or

5. Has not been inspected in accordance with the requirements of Chapters 3 and 4 of FEMA 267, the connections of the structure may be classified as limited-ductile and the β value taken as 3.0 or higher.

1645A.5.1.2.1 [For DSA/SS] *For any frame element, including connections, 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 been inspected and evaluated in accordance with Chapter 4 of FEMA 352 and repaired or retrofitted in accordance with the recommendations of Chapter 6 of FEMA 352 may be classified as limited-ductile and the β-value taken as 1.5; or

2. Has been repaired or retrofitted in accordance with the recommendations of Chapter 6 of FEMA 352, but not inspected and evaluated in accordance with Chapter 4 of FEMA 352, may be classified as limited-ductile and the β-value taken as 2.0 or greater; or

3. Has been inspected in accordance with the requirements of Chapters 3 and 4 of FEMA 352:

3.1 Connections within a connection group in which all connections in the group have been inspected (Method 1, Level 1 Evaluation), but not repaired or retrofitted may be classified as limited-ductile and the β value for connections may be taken as 1.5 + 1.5 d_j, where d_j is the damage index for the connection group at floor "i". Damaged connections, $d_j \geq 1$ where d_j is the damage index for the j^{th} connection in the group, shall be repaired or retrofitted in accordance with Section 1643A.10.1.

3.2 For buildings that may have experienced potentially damaging ground motions, connections within a connection group in which inspections have been conducted on a sample of connections (Method 2, Level 1 Evaluation), but not repaired or retrofitted, may be classified as limited-ductile and the β value taken as 1.5 + 1.5d_{avg}, where d_{avg} is the average damage

index for the evaluated connections within the group at that floor. The use of this approach shall be approved by the DSA in the Evaluation and Design Criteria Report. When damage is found in any connection, $D_j \geq 1$, every connection shall be inspected. Damaged connections shall be retrofitted in accordance with Section 1643A.10.1.

4. Has not been evaluated, repaired nor retrofitted in accordance with the requirements of FEMA 351 or 352, the connections of the structure may be classified as limited-ductile and the β value taken as 3.0 or higher.

1645A.5.1.3 *Any bolted frame element in conformance with the requirements of the 1997 UBC for bolted connections may be classified as ductile and the β value taken as 1.0. Where the frame element at least meets the requirements of 1976 UBC but not the 1997 requirements, then the element may be classified as limited- ductile and the β value taken as 1.5 or higher.*

1645A.5.1.4 *Any structural element having moment capacity but not qualifying as ductile under any UBC code provisions since 1976 may be classified as limited-ductile and the β value taken as 3.0 or higher.*

1645A.5.1.5 *Any truss girder or knee brace frame element may be classified as limited-ductile and the β value taken as 2.0 or higher.*

1645A.5.1.6 *Elements of frames with lateral girder buckling and/ or noncompact column sections may be classified as limited-ductile and the β value taken as 2.0 or higher.*

1645A.5.2 Braced steel frame elements.

1645A.5.2.1 *Any braced frame element in conformance with the requirements of 1997 UBC for braced frames may be classified as ductile and the β value taken as 1.0.*

1645A.5.2.2 *Any braced frame element in conformance with the requirements of 1997 UBC, except that the b/t ratio exceeds the 1997 requirements for special braced frames may be classified as limited-ductile and the β value taken as 1.5 for a special and 2.5 for ordinary braced frames.*

1645A.5.2.3 *Any braced frame element where the connection gusset plate is subject to buckling may be classified as limited-ductile and the β value taken as 2.0 or greater.*

1645A.5.2.4 *Any braced frame element with tension-only bracing, with rods or angles, may be classified as limited-ductile and the β value taken as 3.0 or greater.*

1645A.6 Wood and Other Sheathing Materials.

1645A.6.1 *Wood elements and other sheathing materials that essentially comply with the 1976 UBC Chapter 25, Wood, and Chapter 47, Installation of Wall and Ceiling Coverings, or the equivalent sections of later editions may be classified as ductile and assigned a β value of 1 as given in Table 16A-R-2.*

EXCEPTION: [Not adopted by DSA/SS] *Let-in bracing, plaster (stucco), gypsum wallboard and*

particle board sheathing shall be classified as limited-ductile or nonductile and assigned a β value given in Table 16A-R-2.

1645A.6.2 *Any element not meeting the requirements of Section 1645A.6.1 shall be classified as nonductile, with a corresponding β value equal to or greater than that given in Table 16A-R-2, except where Section 1645A.2 allows use of another value. The Section 1645A.2.2 analysis shall consider at a minimum:*

1. Anchoring attachment of tile or other heavy roofing elements, and chimneys.

2. In-plane and out-of-plane bracing of roof framing and trusses.

3. Wall-to-diaphragm connection for framing perpendicular to wall.

3.1 Indirect shear path.

4. Wall-to-diaphragm connection for framing parallel to wall.

5. Shear transfer connection from shear panels or walls to framing and/or collector elements at top and bottom of shear walls.

6. Wall hold-down details between floors and a positive load path to foundation at base of wall.

7. Attachment of sheathing and stucco to transfer shear from wall to foundation.

8. Sill bolts to transfer from wall framing to foundation.

9. Scabs and blocking and connections needed to transfer shear through floor framing.

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

1645A.7.1 *The requirements of Section 1643A.9 applies to the following systems for the indicated nonstructural performance levels NPC-1 through NPC-5, as defined in Chapter 6, Part 1, Title 24, Building Standards Administrative Code:*

EXCEPTION: *All exterior nonbearing, nonshear wall panels or elements that are not considered as part of the structural system shall be assessed using the requirements of Section 1646A.2.4.2, not Section 1645A.7.*

1645A.7.1.1 *For the NPC-1 performance level the requirements of Section 1643A.9 for nonstructural elements and systems do not apply.*

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

1. Communications systems;

2. Emergency power systems;

3. Bulk medical gas systems;

4. Fire alarm systems; and

5. Emergency lighting equipment and signs in the means of egress.

1645A.7.1.3 *For the NPC-3 performance level the requirements of Section 1643A.9 must be met by the following systems in critical care areas, clinical laboratory, service spaces, pharmaceutical service spaces, radiological service spaces, and central and sterile supply areas:*

1. Those required by Section 1645A.7.1.2;

2. Nonstructural components, as listed in Title 24, Part 2, Table 16A-O; and

3. Equipment listed in Part 2, Title 24, California Code of Regulations, Table 16A-O "Equipment" including equipment in the physical plant that services these areas.

> ***EXCEPTIONS:*** *For Section 1645A.7.1.3, seismic restraints need not be provided for cable trays, conduit and HVAC ducting. Seismic restraints may be omitted from piping systems, provided that an approved method of preventing release of the contents of the piping system in the event of a break is provided.*
>
> *2. For Section 1645A.7.1.3, only elevator(s) selected to provide patient, surgical, obstetrical and ground floors during interruption of normal power need meet the structural requirements of Part 2, Title 24.*

4. Fire sprinkler systems must comply with the bracing and anchorage requirements of NFPA-13, 1994 edition, or subsequent applicable standards.

> ***EXCEPTION:*** *Acute care hospital facilities in both a rural area as defined by Section 70059.1, Division 5 of Title 22 and Seismic Zone 3 shall comply with the bracing and anchorage requirements of NFPA 13, 1994 edition or subsequent applicable standards as specified in Article 11, Chapter 6, Part 1, Title 24, Building Standards Administrative Code.*

1645A.7.1.4 *For the NPC-4 performance level the requirements of Section 1643A.9 must be met by the following systems:*

1. Those required by Section 1645A.7.1.3; and

2. All architectural, mechanical and electrical systems, components and equipment and hospital equipment bracing and anchorages.

1645A.7.1.5 *For the NPC-5 performance level, the requirements of Section 1643A.9 must be met by the following systems:*

1. Those required by Section 1645A.7.1.4;

2. On-site supplies of water and holding tanks for waste water, sufficient for 72 hours of emergency

operations, that are integrated into the building plumbing system, including any alternative hook-ups to allow the use of transportable water and sanitary waste water disposal; and

3. On-site emergency system as defined within Part 3, Title 24; this includes task lighting, selected outlets and ventilation systems, radiological service, and on-site fuel supply for 72 hours of acute care operation.

***1645A.7.2** The β values to be used in Section 1644A.13.1 and Formula 44A-11 for the connection and bracing of nonstructural elements, equipment and systems shall be determined as follows:*

***1645A.7.2.1 Ductile or Code Complying:** Any element constructed under a permit issued by OSHPD may be classified as ductile and the β value taken as 1.0.*

***1645A.7.2.2 Nonductile:** Any element whose construction was completed before 1973 shall be classified as nonductile and β taken as 4.0, except where Section 1645A.2 or 1646A.2.4.2 allow use of another value. The Section 1645A.2.2 analysis shall consider at a minimum:*

1. The anchorage of the element to the structural system.

2. The yielding and post yielding, buckling, and/or failure behavior of the connection and/or bracing system.

3. The attachment of supported equipment to the brace and bracing system and the ability to reliably develop yielding in the connection and/or brace.

4. Stability of the bracing system under both in-plane and out-of-plane displacements of the supported equipment.

***1645A.7.2.3 Limited-Ductile:** Systems and elements that do not comply with Section 1645A.7.2.1 or 1645A.7.2.2 shall be classified as limited-ductile, with corresponding β value equal to or greater than 2.5 for all modes of failure, except where Section 1645A.2 allows use of another value. The Section 1645A.2.2 analysis shall consider at a minimum the items 1 through 4 listed in Section 1645A.7.2.2.*

> ***EXCEPTION:** All drilled mechanical anchors subject to tension loads shall be classified as nonductile, except that they may be classified as ductile where tension testing, consistent with OSHPD, DSA or comparable procedures, has been completed for the anchors and the results of testing are evaluated as acceptable.*

1645A.8 [For DSA/SS] Nonstructural Components and Systems

***1645A.8.1** The requirements of Section 1643A.9 apply to the nonstructural components and systems for public schools:*

> ***EXCEPTION:** All exterior nonbearing, nonshear wall panels or elements that are not considered as part of the structural system shall be assessed using the requirements of Section 1646A.2.4.2, not Section 1645A.7.*

1645A.8.2 *The β values to be used in Section 1644A.13.1 and Formulas 44A-14, 44A-15 and 44A-16 for the connection and bracing of nonstructural elements, equipment and systems shall be determined as follows:*

1645A.8.2.1 Ductile or Code Complying: *Any element or connection satisfying the cyclical requirements to qualify as a "ductile element" per Section 1641A may be classified as ductile and the β-value taken as 1.0. Elements constructed to the requirements of prior editions of Part 2, Title 24, deemed to be equivalent to the current code may be classified as ductile and the β-value taken as 1.0 when approved by the DSA.*

1645A.8.2.2 Nonductile: *Any element or connection may be classified as nonductile and β taken as 4.0.*

1645A.8.2.3 Limited-Ductile: *Systems and elements that qualify use of another β value in accordance with Section 1645A.2 may be classified as limited-ductile. The Section 1645A.2.2 analysis shall consider at a minimum:*

1. The anchorage of the element to the structural system.

2. The yielding and post yielding, buckling, and/or failure behavior of the connection and/or bracing system.

3. The attachment of supported equipment to the brace and bracing system and the ability to reliably develop yielding in the connection and/or brace.

4. Stability of the bracing system under both in-plane and out-of-plane displacements of the supported equipment.

SECTION 1646A - DETAILED SYSTEMS DESIGN REQUIREMENTS

1646A.1 General. *All structural framing systems shall comply with the requirements of Section 1643A.9. The individual elements shall have the usable strength capacity ΦC_n or the allowable capacity C_w to resist the prescribed seismic load combinations. In addition, such framing systems and elements shall comply with the detailed system design requirements contained in Section 1646A.*

1646A.1.1 *All building components in Seismic Zones 3 and 4 shall be designed to resist the effects of the seismic forces prescribed herein and the effects of gravity loadings from dead, floor live and snow loads.*

1646A.1.2 *Consideration shall be given at each story level to the effects of uplift, reversed moment and/or sliding, caused by seismic loads, as prescribed in Sections 1646A.1.3 and 1646A.2.4.2.*

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

1646A.1.3.1 [Not adopted by DSA/SS] *Overturning moment tension resistance for elements and*

connections: If the tension action due to Ω_o E - 0.9 D > 0, then the usable tensile strength ΦC_n shall equal or exceed the greater of the tension due to Ω_o E-0.9 D or E/14 for semi-ductile and brittle elements; and E-0.9 D or E/14 for ductile elements.

1646A.1.3.1.1 [For DSA/SS] *Overturning moment tension resistance for elements and connections: If the tension action due to Ω_o E - 0.9 D > 0, then the usable tensile strength ΦC_n shall equal or exceed the greater of the tension due to Ω_o E-0.9 D or E/14 for limited ductile and nonductile elements; and E-0.9 D or E/14 for ductile elements.*

1646A.1.3.2 [Not adopted by DSA/SS] *Reversed moment opposite to that caused by gravity loads in beams, slabs and spandrels: If the flexural action due to Ω_o E - 0.9 D > 0, then the usable flexural strength ΦC_n shall equal or exceed the greater of the moment due to Ω_o E-0.9 D or E/14 for semi-ductile and brittle elements; and E-0.9 D or E/14 for ductile elements.*

1646A.1.3.2.1 [For DSA/SS] *Reversed moment opposite to that caused by gravity loads in beams, slabs and spandrels: If the flexural action due to Ω_o E - 0.9 D > 0, then the usable flexural strength ΦC_n shall equal or exceed the greater of the moment due to Ω_o E-0.9 D or E/14 for limited ductile and nonductile elements; and E-0.9 D or E/14 for ductile elements.*

1646A.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 ΦC_n equals or exceeds the shear on the joint due to E.*

1646A.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:

$$\Omega_o E \pm 0.9D \qquad (46A\text{-}1)$$

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

1646A.1.4 *In Seismic Zones 3 and 4, provision shall be made for the effects of earthquake forces acting in a direction other than the principal axes in each of the following circumstances:*

1. The structure has plan irregularity Type E as given in Table 16A-M.

[For DSA/SS] *The structure has plan structural irregularity Type 5, Non-parallel systems, as given in Table 16A-M.*

2. The structure has plan irregularity Type A as given in Table 16A-M for both major axes.

[For DSA/SS] *The structure has plan structural irregularity Type 1, Torsional irregularity, as given in Table 16A-M for both major axes.*

3. A column of a structure forms part of two or more intersecting lateral-force-resisting systems.

> ***EXCEPTION:*** *If the axial load in the column due to seismic forces acting in either direction is less than 20 percent of the column allowable axial load.*

The requirement that orthogonal effects be considered may be satisfied by designing such elements for 100 percent of the prescribed seismic forces in one direction plus 30 percent of the prescribed forces in the perpendicular direction. The combination requiring the greater component strength shall be used for design. Alternatively, the effects of the two orthogonal directions may be combined on a square root of the sum of the squares (SRSS) basis. When the SRSS method of combining directional effects is used, each term computed shall be assigned the sign that will result in the most conservative result.

1646A.2 Structural Framing Systems.

1646A.2.1 General. *Four types of general building framing systems defined in Section 1629A.6 are recognized in these provisions and shown in Table 16A-N. Each type is subdivided by the types of vertical elements used to resist lateral seismic forces. Special framing requirements are given in this section and in Chapters 19A through 23A.*

1646A.2.2 Detailing for combinations of systems. *For components common to different structural systems, the more restrictive detailing requirements shall be used.*

1646A.2.3 Connections. *Connections that resist seismic forces shall be designed and detailed on the drawings.*

1646A.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 times the displacements resulting from the required design lateral forces given in Section 1644A.4. A representation of cracked section stiffness properties for reinforced concrete and masonry elements [For DSA/SS:, as approved by the DSA in the Evaluation and Design Criteria Report,] 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.

1646A.2.4.1 Adjoining rigid elements. *Any framing elements, including those of the lateral-force-resisting system, may be enclosed by or adjoined by more rigid elements, which would tend to limit the frame from resisting lateral forces, where it can be shown that the action or failure of the more rigid elements will not impair the vertical and lateral-load-resisting ability of the frame. Where failure*

of the more rigid elements is indicated, then the life-safety consequences due to debris and other falling hazards shall be investigated and mitigated where appropriate.

1646A.2.4.2 Exterior elements. *Exterior nonbearing, nonshear wall panels or elements that are attached to or enclose the exterior of the structure shall be designed to resist the forces per Formula (44A-14) 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 factored displacements given in Section 1646A.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 that 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 Formula (44A-14) 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 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.

1646A.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. At 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 0.5 H C_a I 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 0.5 H C_a I times the dead plus live load.*

1646A.2.6 Collector elements. *Collector elements shall be provided that are capable of transferring the seismic forces originating in other portions of the building to the element providing the resistance to those forces. These elements shall be classified as "ductile," "limited-ductile," or "nonductile" and assigned the corresponding β factor for the seismic load. Unless an element can qualify for a β value given in Section 1645A, β shall be 1.00 for code-complying or ductile elements, and 4.00 for nonductile elements.*

1646A.2.7 Concrete frames. *In order to qualify for the "code- complying or ductile" classification and use of an R greater than 5.5, concrete frames that are part of the lateral-force-resisting system shall conform to the requirements of Division VI [For DSA/SS: of Part 2, Title 24] for special moment-*

resisting frames in Seismic Zones 3 and 4.

1646A.2.8 Anchorage of concrete or masonry walls. *Concrete or masonry walls shall be anchored to all floors and roofs that provide lateral support for the wall. The anchorage shall provide a positive direct connection between the wall and floor or roof construction capable of resisting the horizontal forces specified in Section 1611A or 1644A.13.1. Requirements for developing anchorage forces in diaphragms are given in Section 1646A.2.9. Diaphragm deformation shall be considered in the design of the supported walls.*

1646A.2.9 Diaphragms.

1646A.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 that 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 Δ_s due to F_{px} with $\beta = 1.00$ in Formula (46A-2).*

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

$$F_{px} = \beta \frac{F_t + \sum_{i=x}^{n} F_i}{\sum_{i=1}^{n} w_i} w_{px} \qquad \text{(46A-2)}$$

The force F_{px} determined from Formula (46A-2) need not exceed $1.0\ \beta\ H\ C_a\ I\ w_{px}$, but shall not be less than $0.5\ \beta\ HI\ w_{px}$. The β value to be used in the capacity analysis is the factor appropriate to the element and condition of loading.

The actions on an element due to the force F_{px} are the seismic load E. The value of β shall be 1.00 for code-complying or essentially complying elements and 4.00 for nonductile elements, unless the element qualifies for a lower value as given in Table 16A-R-1 or 16A-R-2.

1646A.2.9.3 *When the diaphragm is required to transfer lateral forces from the vertical-resisting elements above the diaphragm to other vertical-resisting elements below the diaphragm due to off set in the placement of the elements or to changes in stiffness in the vertical elements, these forces shall be added to those determined from Formula (46A-2).*

1646A.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 not to exceed 4.*

1646A.2.9.5 *Diaphragms supporting concrete or masonry walls shall have continuous ties or struts between diaphragm chords to distribute the anchorage forces specified in Section 1644A.13.1. Added chords may be used to form subdiaphragms to transmit the anchorage forces to the main crossties.*

1646A.2.9.6 *Where wood diaphragms are used to laterally support concrete or masonry walls, the anchorage shall conform to Section 1644A.13.1. Anchorage shall not be accomplished by use of*

toenails or nails subject to withdrawal, nor shall wood ledgers or framing be used in cross-grain bending or cross-grain tension, and the continuous ties required by Section 1646A.2.9.5 shall be in addition to the diaphragm sheathing.

***EXCEPTION:** The prohibited details may be used if an appropriate β factor is assigned to allow for nonductile behavior.*

***1646A.2.10 Framing below the base.** Elements of the lateral force-resisting system and all framing elements between the base and the foundation are subject to the same provisions as required for the superstructure. [For DSA/SS: Retrofit of any elements shall comply with the provisions for new buildings in accordance with Section 1633A.2.10.]*

***1646A.2.11 [Not adopted by DSA/SS] Building separations.** When the gap separating the building from adjacent structures is less than 0.7R times the displacement due to seismic forces of the building Δ_s, 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/5.5 times the displacements due to specified seismic forces.*

***1646A.2.11.1 [For DSA/SS] Building separations.** When the gap separating the building from adjacent structures, or other portions of the building, is less than Δ_{MT} as calculated per the provisions of Section 1633A.2.11, 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.*

SECTION 1647A - NONBUILDING STRUCTURES

***1647A.1 [Not adopted by DSA/SS] General**. Nonbuilding existing structures include all self-supporting structures other than buildings that carry gravity loads and resist the effects of earthquake. Nonbuilding existing structures shall be designed to resist the minimum lateral forces specified in this division. Design shall conform to the applicable provisions of Section 1634A for new structures except as modified by the provisions contained in this division.*

***1647A.1.1 [For DSA/SS] General.** For all rehabilitations of existing nonconforming non-building structures as defined in Article 1, Group 1, Chapter 4, Part 1, Title 24, the structural system shall be evaluated by the design professional in responsible charge of design and, if not meeting or exceeding the minimum seismic design purpose of this division, shall be retrofitted in compliance with these requirements.*

SECTION 1648A - METHOD B

***1648A.1 [Not Adopted by DSA/SS]** 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) [For 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 safety goals of this division, [For OSHPD 1: and the applicable structural seismic performance (SPC) and nonstructural performance (NPC) requirements] then a retrofit and/or repair design shall be prepared that yields a structure that meets the life-safety [For OSHPD 1: and operational] performance objectives of Section 1640A of this division 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 agency 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 the provisions of this division 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.*

***1648A.1.1 [For DSA/SS]** The existing or retrofitted structure shall be demonstrated to have the capability to sustain the deformation response due to the specified earthquake ground motions and yield a building of reliable stability when subjected to the prescribed design earthquake loads and conditions. When the evaluation indicates the structural elements of the building do not meet the objective of the safety goals of this division, then a retrofit and/or repair design shall be prepared that yields a structure that meets the protection of life and property for a seismic event based on ground shaking having a 10 percent probability of exceedance in 50 years and the maximum considered earthquake at the performance level for collapse prevention.*

***1648A.1.2 [For DSA/SS]** The evaluation and retrofit design provisions of FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings", November 2000, shall be used for evaluation and retrofit of the existing building; except that the ground motion characterization shall be in accordance with Section 1648A.2.2. Any of the methodologies contained in FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings", hereafter referred to as the "approach", may be used subject to the approval of the peer reviewer (Section 1649A) and the DSA in accordance with the procedures of Section 1640A.8 and the provisions of this division.*

For application of the procedures of FEMA 356 to structural elements, the acceptance criteria factor (e.g. m, ε, rotation) for the protection of life and property shall be at a performance level between the life safety (LS) and immediate occupancy (IO) performance levels and shall be interpolated as follows:

Acceptance criteria factor (e.g. m, ε, rotation) = LS - 0.33 (IO – LS),

where the factors for systems and components are defined in the material chapters of FEMA 356.

***EXCEPTION:** An alternative evaluation and retrofit methodology that will yield a structure of*

equal or greater reliability than a structure evaluated and retrofitted to FEMA 356 may be used subject to the approval of the peer reviewer(s) and the DSA in accordance with the procedures of Section 1640A.8.

1648A.2 [Not adopted by DSA/SS] *The approach, models, analysis procedures, assumptions on material and system behavior, and conclusions shall be peer reviewed in accordance with the requirements of Section 1649A and accepted by the peer reviewer(s) [OSHPD 1: and/or Enforcement Agent].*

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.

1648A.2a [For DSA/SS] *The approach, models, analysis procedures, assumptions on material and system behavior, and conclusions shall be peer reviewed in accordance with the requirements of Section 1649A and accepted by DSA.*

EXCEPTION: *When determined appropriate by DSA, DSA may perform the work of peer review.*

1648A.2b [For DSA/SS] *The following provisions apply to wood and light-gage metal frame buildings:*

1. The linear procedures of FEMA 356 may be used for evaluation and retrofit of wood and light-gage metal frame buildings. Non-linear procedures shall not apply.

2. Lateral force resisting diaphragms and shear wall systems shall be in accordance with Section 1643A.15.

1648A.2.1 [Not adopted by DSA/SS] *The approach used in the development of the design shall be acceptable to the peer reviewer. Approaches that are specifically tailored to the type of building, construction materials and specific building characteristics may be used, if they are acceptable to the independent peer reviewer. Section 1648A.3 provides several approaches that may be considered. The following conditions apply to whatever approach is selected.*

1648A.2.1a [For DSA/SS] *The following conditions apply to whatever approach is selected.*

1648A.2.1.1 *If load (e.g., R_w, β) factors, capacity reduction factors (e.g., Φ), or measures of inelastic deformation capability (e.g., IDR_L, μ, ε_L, rotation, θ_L) are used, the basis for their use and the specific values assigned shall be assessed and supported in a consistent manner.*

1648A.2.1.2 *Where dynamic time history analysis is used, at least three distinct representative records with simultaneous loadings in different directions, as appropriate, shall be used in the analysis. The maximum response parameter of interest shall be used for design.*

1648A.2.1.3 *When an elastic analysis approach is adopted, the stiffness characteristics for the*

elements of the elastic model should be representative of the inelastic behavior at the maximum response for the strength degrading materials and the nominal strength deformation for nondegrading materials. The following items are given for consideration:

1. For reinforced concrete frame elements and reinforced concrete and masonry shear wall elements, this stiffness may be taken as one-half of that of the gross section or that of the cracked section. A more appropriate value may be used if justified by analysis.

2. Steel framing and bracing elements are to have their elastic section stiffness.

3. Steel-framing elements encased in reinforced concrete are to have the composite section stiffness which may be taken as 1.3 times the concrete gross-section stiffness, and beam-column joints may be assumed to be rigid.

4. Framing elements shall have model lengths equal to the clear span length, or have a suitable rigid element representation of the joint configuration.

5. If framing element connections and/or supports are not fully rigid, then these shall be modeled as springs.

6. The representation of foundation flexibility shall be included when it results in more than a 25-percent reduction in the assumed full fixity of supported elements. This includes the effects of both rotational and horizontal deformations and sliding.

1648A.2.1.4 *Reliable capacities shall be used for all elements, consistent with the fundamental behavior of the element and/or system under reversing loads at the design level of earthquake loads.*

1648A.2.1.5 *The value of the earthquake loading of an element need not exceed the force action induced in the element when the inelastic structure is displaced due to the prescribed ground motions, and the elements are assigned their probable strength values.*

1648A.2.1.6 *All nonstructural elements that can affect life safety shall be shown to have acceptable behavior in the design loadings. For structural elements not considered as part of the lateral-load-resisting system, the requirements of Section 1644A.13 are sufficient to meet this requirement.*

1648A.2.2 *The ground motion characterization used for Method B shall be consistent with those required by Section 1643A.8.*

1648A.2.2.1 [For OSHPD 1] *The ground motion characterization used for Method B shall be based on ground shaking having a 10 percent probability of exceedance in 50 years for category SPC 2 at the essential life-safety performance level. For SPC 3 through SPC 5, the ground motion characterization used for Method B shall be based on ground shaking having a 10 percent probability of exceedance in 50 years at the immediate occupancy performance level and the maximum considered earthquake at the collapse prevention performance level.*

Ground shaking having a 10 percent 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 1648A.2.2.2 or the Site-Specific Procedure of Section 1648A.2.2.3.

In the General Procedure, ground shaking hazard is determined from the response spectrum acceleration contour maps. Maps showing 5-percent-damped response spectrum ordinates for short-period (0.2 second) and long-period (1 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 1648A.2.2.2 for developing design response spectra for either or both the 10 percent 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 1648A.2.2.2) 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 1648A.2.2.2.

> ***EXCEPTION:*** *Where S_s determined in accordance with Section 1648A.2.2.2, < 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.

1648A.2.2.1.1 [For DSA/SS] *The ground motion characterization used for Method B shall be based on ground shaking having a 10 percent probability of exceedance in 50 years at a performance level for the protection of life and property and the maximum considered earthquake at the performance level for collapse prevention.*

Ground shaking having a 10 percent 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 1648A.2.2.2.1 or the Site-Specific Procedure of Section 1648A.2.2.3.

In the General Procedure, ground shaking hazard is determined from the response spectrum acceleration contour maps. Maps showing 5-percent-damped response spectrum ordinates for short-period (0.2 second) and long-period (1 second) response distributed by FEMA for use with FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Existing Buildings" shall be used directly with the General Procedure of Section 1648A.2.2.2.1 for developing design response spectra for either or both the 10 percent 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 site is located within 10 kilometers of an active fault.

2. The building is located on Type E soils (as defined in Section 1648A.2.2.2.1) and the mapped maximum considered earthquake spectral response acceleration at short periods (S_s) exceeds 2.0g.

3. The building is located on Type F soils as defined in Section 1648A.2.2.2.1.

> ***EXCEPTION:*** *Where S_s determined in accordance with Section 1648A.2.2.2.1, < 0.20g. In these cases, a Type E soil profile may be assumed.*

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

1648A.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 1648A.2.2.3.

The mapped short-period response acceleration parameter, S_s, and mapped response acceleration parameter at a 1-second period, S_1, for 10 percent probability of exceedance in 50 years ground motion shall be obtained directly from the maps distributed by FEMA for use with the "NEHRP Guidelines for the Seismic Rehabilitation of Buildings" (FEMA 273). The mapped short-period response acceleration parameter, S_s, and mapped response acceleration parameter at a 1-second period, S_1, for the maximum considered earthquake shall also be obtained directly from the maps.

Parameters S_s and S_1 shall be obtained by interpolating between the values shown on the response acceleration contour lines on either side of the site, on the appropriate map, or by using the value shown on the map for the higher contour adjacent to the site.

The mapped short-period response acceleration parameter, S_s, and mapped response acceleration parameter at a 1-second period, S_1, for 10 percent probability of exceedance in 50 years ground shaking hazards shall be taken as the smaller of the following:

1. The values of the parameters S_s and S_1, respectively, determined for 10 percent probability of exceedance in 50 years ground motion.

2. Two-thirds of the values of the parameters S_s and S_1, respectively, determined from the

maximum considered earthquake ground motion map.

The design short-period spectral response acceleration parameter, S_{xs}, and the design spectral response acceleration parameter at 1 second, Sx1, shall be obtained, respectively, from Equations (48A-1) and (48A-2) as follows:

$$S_{xs} = F_a S_s \qquad (48A\text{-}1)$$

$$S_{x1} = F_v S_1 \qquad (48A\text{-}2)$$

where F_a and F_v are site coefficients determined respectively from Tables 16A-R-3 and 16A-R-4, based on the site class and the values of the response acceleration parameters S_s and S_1.

Site classes shall be defined as follows:

Class A: *Hard rock with measured shear wave velocity, $\bar{v}_s$ > 5,000 ft/sec (1524 m/s).*

Class B: *Rock with 2,500 ft/sec (762 m/s) < $\bar{v}_s$ < 5,000 ft/sec (1524 m/s).*

Class C: *Very dense soil and soft rock with 1,200 ft/sec (366 m/s) < $\bar{v}_s$ ≤2,500 ft/sec (762 m/s) or with either standard blow count $\bar{N}$ > 50 or undrained shear strength $\bar{s}_u$ > 2,000 pounds per square feet (psf) (96 kN/m2).*

Class D: *Stiff soil with 600 ft/sec (48 kN/m2) < $\bar{v}_s$ ≤1,200 ft/sec (366 m/s) or with 15 < $\bar{N}$ ≤ 50 or 1,000 psf (48 kN/m2) ≤ $\bar{s}_u$ < 2,000 psf (96 kN/m2).*

Class E: *Any profile with more than 10 feet (3048 mm) of soft clay defined as soil with plasticity index PI > 20, or water content w >40 percent, and $\bar{s}_u$ < 500 psf (24 kN/m2) or a soil profile with $\bar{v}_s$ < 600 ft/sec (183 m/s). If insufficient data available to classify a soil profile as Type A through D, a Type E profile shall be assumed.*

Class F: *Soils requiring site-specific evaluations:*

1. Soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils.

2. Peats and/or highly organic clays (H > 10 feet (3048 mm) of peat and/or highly organic clay, where H = thickness of soil).

3. Very high plasticity clays (H > 25 feet (7620 mm) with PI > 75 percent).

4. Very thick soft/medium stiff clays (H > 120 feet) [36 576 mm].

The parameters $\bar{v}_s$, $\bar{N}$ and $\bar{s}_u$ are, respectively, the average values of the shear wave velocity, Standard Penetration Test (SPT) blow count, and undrained shear strength of the upper 100 feet (30 480 mm) of soils at the site. These values shall be calculated from Equation (48B-3):

$$\bar{v}_s,\ \bar{N},\ \bar{s}_u = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}},\ \frac{d_i}{N_i},\ \frac{d_i}{s_{ui}}} \qquad (48B\text{-}3)$$

WHERE:

N_i = *SPT blow count in soil layer "i".*

n = Number of layers of similar soil materials for which data is available.

d_i = *Depth of layer "i".*

s_{ui} = *Undrained shear strength in layer "i".*

v_{si} = *Shear wave velocity of the soil in layer "i".*

and

$$\sum_{i=1}^{n} d_i = 100\ ft \qquad (48B\text{-}4)$$

Where reliable v_s *data are available for the site, such data shall be used to classify the site. If such data are not available, N data shall be used for cohesionless soil sites (sands, gravels), and* s_u *data for cohesive soil sites (clays). For rock in profile classes B and C, classification may be based either on measured or estimated values of* v_s*. Classification of a site as Class A rock shall be based on measurements of* v_s *either for material at the site itself, or for similar rock materials in the vicinity; otherwise, Class B rock shall be assumed. Class A or B profiles shall not be assumed to be present if there is more than 10 feet (3048 mm) of soil between the rock surface and the base of the building.*

A general, horizontal response spectrum shall be constructed by plotting the following two functions in the spectral acceleration vs. structural period domain, as shown in Figure 16A-R-1.Where a vertical response spectrum is required, it may be constructed by taking two-thirds of the spectral ordinates, at each period, obtained for the horizontal response spectrum.

$$S_a = (S_{xs} / B_s)\ (0.4 + 3\ T / T_o) \qquad (48A\text{-}5)$$

for $0 < T \leq 0.2\ To$

$$Sa = (S_{xi} / (B_1\ T)),\ for\ T > T_o \qquad (48A\text{-}6)$$

where To is given by the equation

$$T_o = (S_{xi}\ B_s) / (S_{xs}\ B_1) \qquad (48A\text{-}7)$$

where B_s and B_1 are taken from Table 16A-R-5.

A 5-percent damped response spectrum shall be used for the design of buildings and structural systems, with the following exceptions:

1. For structures without exterior cladding, an effective viscous damping ratio, β, of 2 percent shall be assumed.

2. For structures with wood diaphragms and a large number of interior partitions and cross walls that interconnect the diaphragm levels, an effective viscous damping ratio, β, of 10 percent may be assumed.

3. For structures rehabilitated using seismic isolation technology or enhanced energy dissipation technology, the equivalent effective viscous damping ratio, β, shall be determined in accordance with Section 1629A.10.2.

1648A.2.2.2.1 [For DSA/SS] 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 1648A.2.2.3.1.

The mapped short-period response acceleration parameter, S_s, and mapped response acceleration parameter at a 1-second period, S_1, for 10 percent probability of exceedance in 50 years ground motion shall be obtained directly from the maps distributed by FEMA for use with the FEMA 356,"Prestandard and Commentary for the Seismic Rehabilitation of Existing Buildings". The mapped short-period response acceleration parameter, S_s, and mapped response acceleration parameter at a 1-second period, S_1, for the maximum considered earthquake shall also be obtained directly from the maps.

Parameters S_s and S_1 shall be obtained by interpolating between the values shown on the response acceleration contour lines on either side of the site, on the appropriate map, or by using the value shown on the map for the higher contour adjacent to the site.

The mapped short-period response acceleration parameter, S_s, and mapped response acceleration parameter at a 1-second period, S_1, for 10 percent probability of exceedance in 50 years ground shaking hazards shall be taken as the smaller of the following:

1. The values of the parameters S_s and S_1, respectively, determined for 10 percent probability of exceedance in 50 years ground motion.

2. Two-thirds of the values of the parameters S_s and S_1, respectively, determined from the maximum considered earthquake ground motion map.

The design short-period spectral response acceleration parameter, S_{xs}, and the design spectral

response acceleration parameter at 1 second, S_{x1}, shall be obtained, respectively, from Equations (48A-1) and (48A-2) as follows:

$$S_{xs} = F_a S_s \qquad (48A\text{-}1)$$

$$S_{x1} = F_v S_1 \qquad (48A\text{-}2)$$

where F_a and F_v are site coefficients determined respectively from Tables 16A-R-3 and 16A-R-4, based on the site class and the values of the response acceleration parameters S_s and S_1.

Site classes shall be defined as follows:

Class A: *Hard rock with measured shear wave velocity, $\bar{v}_s$ > 5,000 ft/sec (1524 m/s).*

Class B: *Rock with 2,500 ft/sec (762 m/s) < $\bar{v}_s$ < 5,000 ft/sec (1524 m/s).*

Class C: *Very dense soil and soft rock with 1,200 ft/sec (366 m/s) < $\bar{v}_s \leq$ 2,500 ft/sec (762 m/s) or with either standard blow count $\bar{N}$ > 50 or undrained shear strength $\bar{s}_u$ > 2,000 pounds per square feet (psf) (96 kN/m2).*

Class D: *Stiff soil with 600 ft/sec (48 kN/m2) < $\bar{v}_s \leq$ 1,200 ft/sec (366 m/s) or with 15 < $\bar{N} \leq$ 50 or 1,000 psf (48 kN/m2) $\leq \bar{s}_u$ < 2,000 psf (96 kN/m2).*

Class E: *Any profile with more than 10 feet (3048 mm) of soft clay defined as soil with plasticity index PI > 20, or water content w > 40 percent, and $\bar{s}_u$ < 500 psf (24 kN/m2) or a soil profile with $\bar{v}_s$ < 600 ft/sec (183 m/s). If insufficient data are available to classify a soil profile as Type A through C, and there is no evidence of soft clay soils characteristic of Class E in the vicinity of the site, the default site class may be taken as Class D. If there is evidence of Class E soils in the vicinity of the site, and no other data supporting selection of Class A through D, the default site class shall be taken as Class E.*

Class F: *Soils requiring site-specific evaluations:*

1. Soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils.

2. Peats and/or highly organic clays (H > 10 feet (3048 mm) of peat and/or highly organic clay, where H = thickness of soil).

3. Very high plasticity clays (H > 25 feet (7620 mm) with PI > 75 percent).

4. Very thick soft/medium stiff clays (H > 120 feet) [36 576 mm].

The parameters $\bar{v}_s$, $\bar{N}$ and $\bar{s}_u$ are, respectively, the average values of the shear wave velocity, Standard Penetration Test (SPT) blow count, and undrained shear strength of the upper 100 feet (30 480 mm) of soils at the site. These values shall be calculated from Equation (48B-3):

$$\bar{v}_s,\ \bar{N},\ \bar{s}_u = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}},\ \frac{d_i}{N_i},\ \frac{d_i}{s_{ui}}} \qquad \text{(48B-3)}$$

WHERE:

N_i = SPT blow count in soil layer "i".

n = Number of layers of similar soil materials for which data is available.

d_i = Depth of layer "i".

s_{ui} = Undrained shear strength in layer "i".

v_{si} = Shear wave velocity of the soil in layer "i".

and

$$\sum_{i=1}^{n} d_i = 100\ ft \qquad \text{(48B-4)}$$

Where reliable v_s data are available for the site, such data shall be used to classify the site. If such data are not available, N data shall be used for cohesionless soil sites (sands, gravels), and s_u data for cohesive soil sites (clays). For rock in profile classes B and C, classification may be based either on measured or estimated values of v_s. Classification of a site as Class A rock shall be based on measurements of v_s either for material at the site itself, or for similar rock materials in the vicinity; otherwise, Class B rock shall be assumed. Class A or B profiles shall not be assumed to be present if there is more than 10 feet (3048 mm) of soil between the rock surface and the base of the building.

A general, horizontal response spectrum shall be constructed by plotting the following two functions in the spectral acceleration vs. structural period domain, as shown in Figure 1-1 of FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Existing Buildings". Where a vertical response spectrum is required, it may be constructed by taking two-thirds of the spectral ordinates, at each period, obtained for the horizontal response spectrum.

$$S_a = S_{xs}\left[\left(\frac{5}{B_s} - 2\right)\frac{T}{T_s} + 0.4\right] \qquad \text{(48A-5)}$$

for $0 < T < T_o$, and

$$S_a = \frac{S_{XS}}{B_S} \quad for \quad T < T_s\ , \ and \qquad \text{(48A-6)}$$

$$S_a = \frac{S_{X1}}{B_1 T} \quad for \quad T > T_s \qquad (48A\text{-}7)$$

where T_s and T_o are given by Equations 48A-8 and 48A-9 is given by the equation

$$T_s = \frac{S_{X1} B_S}{S_{XS} B_1} \qquad (48A\text{-}8)$$

$$T_o = 0.2\, T_s \qquad (48A\text{-}9)$$

where B_S and B_1 are taken from Table 16A-R-5.

Use of spectral response accelerations calculated using Equation 48A-5 in the extreme short period range ($T < T_o$) shall only be permitted in dynamic analysis procedures and only for modes other than the fundamental mode.

A 5-percent damped response spectrum shall be used for the design of buildings and structural systems, with the following exceptions:

1. For structures without exterior cladding, an effective viscous damping ratio, β, equal to 2 percent of critical damping shall be assumed.

2. For structures with wood diaphragms and a large number of interior partitions and cross walls that interconnect the diaphragm levels at a maximum spacing of 40 feet on center transverse to the direction of motion, an effective viscous damping ratio, β, of 10 percent of critical damping shall be permitted.

3. For structures rehabilitated using seismic isolation technology or enhanced energy dissipation technology, the equivalent effective viscous damping ratio, β, shall be determined in accordance with Section 1629A.10.2.

1648A.2.2.3 [For OSHPD 1] Site-specific procedure to determine the acceleration response spectra. *Where site-specific ground shaking characterization is used as the basis of the design, the characterization shall be developed in accordance with this section.*

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 percent. Additional spectra may be developed for other damping ratios appropriate to the indicated structural behavior, as discussed in Section 1648A.2.2.2. When the 5-percent damped site-specific spectrum has spectral amplitudes in the period range of the greatest significance to the structural response that are less than 70 percent of the spectral amplitudes of the General Response Spectrum, an independent peer review of the spectrum shall be made by an individual with expertise in the evaluation of ground motion in accordance with Section 1649A.

The maximum considered earthquake ground motion shall be taken as that motion represented by

an acceleration response spectrum having a 2 percent probability of exceedance within a 50-year period. The maximum considered earthquake spectral response acceleration at any period shall be taken from the 2 percent probability of exceedance within a 50 year period spectrum as limited by the following:

Where the spectral response ordinates at 0.2 second or 1 second for a 5 percent damped spectrum having a 2 percent probability of exceedance within a 50-year period exceed 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 percent 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 16A-R-2, where F_a and F_v are determined in accordance with Section 1648A.2.2.2, 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.

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_o, 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 second, except that it shall be taken as not less than 90 percent 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 percent of that which would be obtained directly from the spectrum. The value of T_o shall be determined in accordance with Equation (48A-8). Alternatively, the values obtained in accordance with Section 1648A.2.2.2 may be used for all of these parameters.

$$T_o = S_{x1} / S_{xs} \qquad (48A\text{-}8)$$

Time-history analysis shall be performed with no fewer than three data sets (two horizontal components or, if vertical motion is to be considered, two horizontal components and one vertical component) of appropriate ground motion time histories that shall be selected and scaled from no fewer than three recorded events. Appropriate time histories shall have magnitude, fault distances and source mechanisms that are consistent with those that control the design earthquake ground motion. Where three appropriate recorded ground-motion time-history data sets are not available, appropriate simulated time-history data sets may be used to make up the total number required. For each data set, the square root of the sum of the squares (SRSS) of the 5-percent damped site-specific spectrum of the scaled horizontal components shall be constructed. The data sets shall be scaled such that the average value of the SRSS spectra does not fall below 1.4 times the 5-percent damped spectrum for the design earthquake for periods between 0.2T second and 1.5T seconds (where T is the fundamental period of the building).

Where three time-history data sets are used in the analysis of the structure, the maximum value of each response parameter (e.g., force in a member, displacement at a specific level) shall be used to

determine design acceptability. Where seven or more time-history data sets are employed, the average value of each response parameter shall be used to determine design acceptability.

1648A.2.2.3.1 [For DSA/SS] Site-specific procedure to determine the acceleration response spectra. *Where site-specific ground shaking characterization is selected, or required by DSA, as the basis of the rehabilitation design, the characterization shall be developed in accordance with this section.*

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 percent of critical damping. Additional spectra may be developed for other damping ratios appropriate to the indicated structural behavior, as discussed in Section 1648A.2.2.2.1. The 5-percent damped site-specific spectral amplitudes in the period range of the greatest significance to the structural response shall not be less than 70 percent of the spectral amplitudes of the General Response Spectrum.

The maximum considered earthquake ground motion shall be taken as that motion represented by a 5% damped acceleration response spectrum having a 2 percent probability of exceedance within a 50 year period. The maximum considered earthquake spectral response acceleration, S_{aM}, at any period, T, shall be taken from that spectrum as limited by the following:

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 on the maximum considered earthquake ground motion, 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 but not less than the deterministic limit on the maximum considered earthquake ground motion.

The deterministic limit on the maximum considered earthquake ground motion shall be taken as the response spectrum determined in accordance with Figure 16A-R-2, where F_a and F_v are determined in accordance with Section 1648A2.2.2.1 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.

The deterministic maximum considered earthquake ground motion response spectrum shall be calculated as 150% of the median spectral response accelerations, S_{aM}, at all periods resulting from a characteristic earthquake on any known active fault within the region.

The site-specific response acceleration parameters for ground motion having a 10% probability of exceedance in 50 years shall be taken as the lesser of:

1. The values of the parameters, S_s and S_1, from mean probabilistic site-specific spectra at the 10%/50 year probability of exceedance, and

2. Two-thirds of the values of the parameters, S_s and S_1, determined for the maximum considered earthquake based on site-specific spectra.

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_s, they shall be obtained in accordance with this section. The value of the design spectral response acceleration at short-periods, S_{xs}, shall be taken as the response acceleration obtained from the site-specific spectrum at a period of 0.2 second, except that it shall be taken as not less than 90 percent 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 spectra such that at any period, the value of S_a obtained from the curve is not less than 90 percent of that which would be obtained directly from the spectra. The value of T_s shall be determined in accordance with Equation (48A-10). Alternatively, the values obtained in accordance with Section 1648A.2.2.2.1 may be used for all of these parameters.

$$T_s = S_{x1} / S_{xs} \qquad \text{(48A-10)}$$

Time-history analysis shall be performed with no fewer than three data sets (two horizontal components or, if vertical motion is to be considered, two horizontal components and one vertical component) of appropriate ground motion time histories that shall be selected and scaled from no fewer than three recorded events. Appropriate time histories shall have magnitude, fault distances and source mechanisms that are consistent with those that control the design earthquake ground motion. Where three appropriate recorded ground-motion time-history data sets are not available, appropriate simulated time-history data sets may be used to make up the total number required. For each data set, the square root of the sum of the squares (SRSS) of the 5-percent damped site-specific spectrum of the scaled horizontal components shall be constructed. The data sets shall be scaled such that the average value of the SRSS spectra does not fall below 1.4 times the 5-percent damped spectrum for the design earthquake for periods between 0.2T second and 1.5T seconds (where T is the fundamental period of the building).

Where three time-history data sets are used in the analysis of the structure, the maximum value of each response parameter (e.g., force in a member, displacement at a specific level) shall be used to determine design acceptability. Where seven or more time-history data sets are employed, the average value of each response parameter shall be used to determine design acceptability.

1648A.2.3 *Whatever evaluation or analysis method is used in meeting the requirements of Section 1648A, the designer shall, unless the exception of Section 1648A.1 applies, at a minimum.*

[For DSA/SS] *Whatever evaluation or analysis method is used in meeting the requirements of Section 1648A, the designer shall, at a minimum:*

1648A.2.3.1 *Identify all elements and systems (both vertical and horizontal) that are subject to the response loads and deformations due to the specified maximum expected earthquake ground shaking. Elements include beams, columns, joints, connections, walls, diaphragms, construction joints, precast element joints, exterior panel connections, bracing, diaphragms, collectors, diaphragm-to-wall or frame connection and foundations.*

1648A.2.3.2 *Identify the vertical elements (e.g., walls, frames, braced frames, in-filled frames, moment frames, etc.) that will participate in the lateral-load-resisting system.*

1648A.2.3.3 *Identify the horizontal or nearly horizontal elements that form the diaphragm systems that interconnect the vertical elements, along with the chords, drags or collector elements, and connections to the vertical systems, and the internal connections within the diaphragm (precast planks, metal decking, bracing systems, pour-strips for prestressed slabs, etc.).*

1648A.2.3.4 *Identify the foundation system supporting the lateral-load-resisting system, including all connections and the means of resisting the actions of overturning moment and sliding.*

1648A.2.3.5 *Assign the expected strength level to all elements for all of their possible modes of yielding or failure. For reinforced concrete, use nominal capacity. For structural steel, use either 1.7 times allowable stress capacity or the nominal capacity from LRFD. For all other materials, use either 1.7 times allowable stress capacity or estimated strength from tests and/or existing research results.*

1648A.2.3.6 *Assign the effective elastic stiffness for all elements for each type and directional sense of action (flexural, shear, torsion, axial) that the element shall resist. The effective stiffness should be the best estimate of the secant stiffness at the development of the element strength representing the onset of the constant yield threshold.*

1648A.2.3.7 *Assign the element deformation behavior beyond the development of the strength or constant yield threshold for each mode of failure or yielding. Identify elements having a sudden brittle or buckling mode of failure. The effects of reversed cycles of loading should be considered to evaluate the degree of strength degradation and/or the pinching of the shape of the hysterisis loop. The deformation behavior may be in the form of load-deformation curves, allowable inelastic demand ratio (IDR_L) values, or allowable ductility demand (μ_L) values, or maximum allowable strain values ε_L or allowable rotation values θ_L. The classification of the elements as "ductile," "limited-ductile," or "nonductile" may be a part of the element deformation behavior description.*

1648A.2.4 *Prior to implementation, the procedures, methods, material assumptions and acceptance/rejection criteria proposed by the engineer will be peer reviewed as provided in Section 1649A.*

1648A.2.5 *The conclusions and design decisions shall be reviewed and accepted by the peer reviewer(s).*

1648A.3 <u>[Not adopted by DSA/SS]</u> *Any method of analysis meeting the requirements of Sections 1648A.2 and 1648A.3 may be used, subject to acceptance by the peer reviewer(s). Among those that can be used are the following types of analysis and assessment provisions, if the specific characteristics of the structure warrant their use:*

1. Equivalent stiffness (or substitute structure) methods.

2. Inelastic demand ratio methods.

3. Pushover or capacity spectrum methods.

4. Inelastic time-history methods.

SECTION 1649A - PEER REVIEW REQUIREMENTS

1649A.1 General. *Independent peer review is an objective technical review by knowledgeable reviewer(s) experienced in the structural design, analysis and performance issues involved. The reviewer(s) shall examine the available information on the condition of the building, the basic engineering concepts employed and the recommendations for action. [For DSA/SS: DSA may require more than one peer reviewer, creating a peer review team, to provide expertise relating to specific aspects of construction and/or the evaluation and retrofit design. When a peer review team is required, the owner shall designate a chairperson to manage the peer review process and prepare any reports required in this section.]*

1649A.2 [Not adopted by DSA/SS] Timing of Independent Review. *The independent reviewer(s) shall be selected prior to initiation of substantial portions of the design and/or analysis work that is to be reviewed, and review shall start as soon as practical after Method B is adopted and sufficient information defining the project is available.*

1649A.2.1 [For DSA/SS] Timing of Independent Review. *The peer reviewer(s) shall be retained in a timely manner to provide services in accordance with the procedures specified in Section 1640A.8.3.*

1649A.3 Qualifications and Terms of Employment. *The reviewer shall be independent from the design and construction team.*

1649A.3.1 *The reviewer(s) shall have no other involvement in the project before, during or after the review, except in a review capacity.*

1649A.3.2 *The reviewer shall be selected and paid by the owner and shall have technical expertise in repair of buildings similar to the one being reviewed, as determined by the responsible enforcement agency.*

1649A.3.3 *The reviewer (or in the case of review teams, the chair) shall be a California-licensed structural engineer who is familiar with the technical issues and regulations governing the work to be reviewed.*

1649A.3.4 *The reviewer shall serve through completion of the project and shall not be terminated except for failure to perform the duties specified herein. Such termination shall be in writing with copies to the enforcement agency, owner, and the engineer of record. When a reviewer is terminated or resigns, a qualified replacement shall be appointed within 10 working days. [For DSA/SS: 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 correspondence to the design professional in responsible charge, the owner, and DSA within 10 working days of such termination.]*

1649A.4 [Not adopted by DSA/SS] Scope of Review. *Review activities shall include, where appropriate, available construction documents, observations of the condition of the structure, all inspection and testing 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, methods, materials and details.

1649A.4.1 [For DSA/SS] Scope of Review. *Review activities shall include, where appropriate, available new and original construction documents, observations of the condition of the structure, all new and original inspection and testing reports, including methods of sampling, and analyses prepared by the project structural engineer and consultants. Review shall consider the proposed design approach, retrofit or repair methods, materials and details for appropriateness to the performance objectives. Where required by DSA, changes observed during construction that affect the seismic-resisting system or the approved retrofit shall be reported to the peer reviewer by the design professional for review and recommendations.*

1649A.5 [Not adopted by DSA/SS] Reports. *The reviewer(s) shall prepare a written report to the owner and responsible enforcement agent that covers all aspects of the review performed, including conclusions reached by the reviewer. Reports shall be issued after the schematic phase, during design development, and at the completion of construction documents, but prior to their issuance for permit. Such reports should include, at the minimum, statements of the following.*

1. Scope of engineering design peer review with limitations defined.

2. The status of the project documents at each review stage.

3. Ability of selected materials and framing systems to meet performance criteria with given loads and configuration.

4. Degree of structural system redundancy and the deformation compatibility among structural and nonstructural elements.

5. Basic constructability of the retrofit or repair system.

6. Other recommendations that would be appropriate to the specific project.

7. Presentation of the conclusions of the reviewer identifying any areas that need further review, investigation and/or clarification.

8. Recommendations.

1649A.5.1 [For DSA/SS] Reports. *The reviewer(s) shall prepare a written report to the owner and responsible DSA that covers all aspects of the review performed, including conclusions reached by the reviewer, in accordance with Section 1640A.8.3. Such reports shall address the following.*

1. Scope of engineering design peer review performed during phase of work.

2. The status of the project documents and/or analyses at each review stage.

3. Ability of structural and nonstructural materials and framing systems to meet the performance objective.

4. Basic constructability of the retrofit or repair system.

5. Recommendations that would be appropriate to the specific project.

6. Presentation of the conclusions of the reviewer identifying any areas that need further review, investigation and/or clarification.

7. Compliance with the evaluation and retrofit report criteria per Section 1640A.8.

1649A.6 [Not adopted by DSA/SS] 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 agency 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 correspondence to the responsible enforcement agent, the owner, and the engineer of record within 10 working days of such termination.*

1649A.6.1 [For DSA/SS] Responses and Corrective Actions. *The project structural engineer shall review the report from the peer reviewer(s) and shall develop corrective actions and other responses as appropriate. During the design development and construction document phases, all reports, responses and corrective actions prepared pursuant to this section shall be submitted to the project design professional, the owner and DSA.*

1649A.7 [For DSA/SS] Resolution of Conflicts. *When the conclusions and recommendations of the peer reviewer conflict with the design professional's proposed design, the DSA shall make the final determination of the requirements for the design.*

1650A - [For DSA/SS] DATA COLLECTION

1650A.1 Data Collection*. Data collection shall be performed to determine the as-built conditions and material properties and assess the condition of the structural and non-structural components of the existing building. Knowledge of construction and material properties shall be determined for all components and connections of the lateral load resisting system and those components of the gravity load resisting system, exterior elements and the non-structural elements that may affect the strength and stiffness of the lateral system, and/or create falling hazards to the building occupants.*

Data collection shall be directed and observed by the project structural engineer or design professional in general responsible charge of the design.

1650A.2 Data collection requirements. *Data collection of the as-built conditions shall address the following:*

1. Information shall be obtained, to the extent possible, from original construction documents including design drawings, specifications, material test records and quality assurance reports

covering original construction and subsequent modifications to the structure. The information shall be verified, or when missing, determined, by visual and comprehensive condition assessment and by comprehensive material testing in accordance with Sections 1650A.2 and 1650A.3, respectively. Qualified test data from the original construction may be accepted, in part or in whole, by DSA to fulfill the requirements of the comprehensive material testing. Comprehensive condition assessment and material testing shall meet the "comprehensive" requirements of FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings", November 2000.

Exception: 1. Alternative recognized processes for condition assessment and/or material testing may be used when approved by DSA.

2. Welded steel moment frame connections of buildings that may have experienced potentially damaging ground motions shall be inspected in accordance with Chapters 3 and 4, FEMA 352, Recommended Post Earthquake Evaluation and Repair Criteria for Welded Moment-Frame Construction for Seismic Applications (July 2000). If any damage is observed, then each connection in the lateral force-resisting frame shall be inspected.

2. In absence of qualified material test records and quality assurance reports, material properties shall be determined by comprehensive materials testing. The coefficient of variation in material test results shall be less than 20%, unless accepted by the peer reviewer and the DSA.

3. Information on adjacent buildings may be obtained through field surveys and available as-built information.

4. Information on the existing foundations and site related items may be obtained from existing documents, geohazard and geotechnical reports, field surveys or a program of subsurface investigation. Where geohazard and geotechnical reports are not available, these reports may be required by the DSA for existing sites in accordance with Section 4-317(e), Article 1, Group 1, Part 1, Title 24.

5. Repaired or retrofitted elements shall be identified and the standards under which the work was constructed shall be determined by review of construction documents and visual or comprehensive condition assessment.

***1650A.3 Condition assessment.** Condition assessment is the determination of both physical configuration and physical condition of structural and nonstructural elements and components. Condition assessment shall be based on visual and comprehensive (destructive and non-destructive) examination.*

Visual assessment shall include direct visual inspection of assessable components and connections and indirect visual inspection where coverings or other obstructions exist. Direct visual inspection of accessible components and connections shall be performed to identify configurational issues, dimensions and degradation of material. Direct visual inspection may require removal of finish materials or fireproofing to obtain access. Indirect visual assessment may require the use of scoping equipment to inspect through an obstruction.

Comprehensive assessment may require destructive and non-destructive investigation processes or

removal of localized structural material to expose the component of the element under consideration. Destructive and/or non-destructive testing may be used to determine material components and any damage or deterioration of the element.

The minimum number of samples for condition assessment to be performed shall meet the "comprehensive" requirements of FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings" as specified in the respective material chapters.

EXCEPTION: 1. When damage or deterioration is observed, the DSA may require inspection of additional elements that may be similarly affected.

2. Deviation in the number of samples for condition assessment may be approved by DSA when it has been determined that adequate information regarding the condition of the element has been obtained.

3. Welded steel moment frame connections of buildings that may have experienced potentially damaging ground motions shall be inspected in accordance with Section 1650A.1, Item 1, Exception 2.

Condition assessment shall include:
1. Characterization of the site soil.

2. Examination of the physical condition of components that will receive seismic-induced forces or deformations to identify the presence of degradation due to environmental or loading effects.

3. Verification of the presence and configuration of structural elements and components and their connections; and the continuity of load paths between components, elements and systems.

4. Identification of conditions that may influence building performance including: a) the presence of neighboring party walls and buildings, b) the presence of nonstructural components, c) prior modifications or additions, d) the presence and attachment of veneer.

1650A.4 Material Testing. *Properties of materials and/or assemblies shall be determined and/or quantified by testing of specific components and/or mock-up assemblies.*

The minimum number of samples for any material tests to be performed shall meet the "comprehensive" requirements of FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings" as specified in the respective material chapters. The location and number of the material or assembly samples to be tested shall be indicated in the Evaluation and Design Criteria Report per Section 1640A.8.

EXCEPTION: Deviation in the number of samples for material testing may be approved by DSA when it has been determined by DSA that adequate information identifying the material properties has been obtained.