

1 **PROPOSAL 2-3 (2009) Revision 4**

2  
3  
4 **SCOPE: Part 3 of the 2009 Provisions**

5  
6  
7  
8 **PROPOSAL FOR CHANGE:**

9  
10 **Replace Appendix to Chapter 5 which currently resides in Part 3 with the following {{note:**  
11 **material that is unchanged from the existing Appendix is not shown as new}}**

12  
13 **~~A5.1 GENERAL~~**

14 **~~A5.1.1 Scope.~~** This appendix provides guidelines for the use of the nonlinear static procedure for the  
15 analysis and design of structures.

16 **~~X. Nonlinear Static Procedure~~**

17 **~~X.1.A5.1.2 Definitions~~**

18 **~~Base:~~** See Sec. 4.1.3.

19 **~~Base shear:~~** See Sec. 4.1.3.

20 **~~Building:~~** See Sec. 4.1.3.

21 **~~Capacity curve:~~** A plot of the total applied lateral force,  $V_j$ , versus the lateral displacement of the control  
22 point,  $\delta_j$ , as determined in a nonlinear static analysis.

23 **~~Component:~~** See Sec. 1.1.4.

24 **~~Control point:~~** A point used to index the lateral displacement of the structure in a nonlinear static  
25 analysis, determined according to Sec. 5.2.1.

26 **~~Dead load:~~** See Sec. 4.1.3.

27 **~~Design earthquake ground motion:~~** See Sec. 1.1.4.

28 **~~Diaphragm:~~** See Sec. 4.1.3.

29 **~~Effective Yield Displacement:~~** The displacement of the control point at the intersection of the first and  
30 second branches of a bilinear curve that is fitted to the capacity curve according to Sec. A5.2.3.

31 **~~Effective Yield Strength:~~** The total applied lateral force at the intersection of the first and second  
32 branches of a bilinear curve that is fitted to the capacity curve according to Sec. A5.2.3.

33 **~~Live load:~~** See Sec. 4.1.3.

34 **~~Registered design professional:~~** See Sec. 2.1.3.

35 **~~Seismic force resisting system:~~** See Sec. 1.1.4.

36 **~~Story:~~** See Sec. 4.1.3.

37 **~~Structure:~~** See Sec. 1.1.4.

38 **~~Target displacement:~~** An estimate of the maximum expected displacement of the control point **node**  
39 **calculated for the design earthquake ground motion, determined according to Section 3.3.3.3.2 of**  
40 **ASCE/SEI 41 Supplement 1 using  $S_a$  defined as a risk-adjusted MCE spectral response acceleration**  
41 **according to the Provisions at the effective period.**

**X.2A5.1.3 Notation**

$C_d$  — See Sec. 4.1.4.

$C_s$  — See Sec. 5.1.3

$C_u$  — A modification factor to relate the displacement of the control point to the displacement of a representative single degree of freedom system, as determined by Eq. A5.2.3.

$C_I$  — A modification factor to account for the influence of inelastic behavior on the response of the system, as determined by Eq. A5.2.4.

$g$  — acceleration of gravity.

$j$  — The increment of lateral loading.

$Q_{Ei}$  — See Sec. 4.1.4.

$Q_{Ei}$  — individual member force in  $i$ -<sup>th</sup> member, determined according to Sec. 12.15.8A5.2.9.1

$R$  — See Sec. 4.1.4.

$R_d$  — The system ductility factor strength ratio as determined by Eq. X-1A5.2.5.

$R_{max}$  — The maximum strength ratio, defined by Equation 3-16 of ASCE/SEI 41 Supplement 1.

$T_I$  — The fundamental period of the structure in the direction under consideration 5.2.3.

$T_e$  — The effective fundamental period of the structure in the direction under consideration as determined according to Sec. A5.2.3.

$T_S$  — See Sec. 3.1.4.

$V_{Lj}$  — The total applied lateral force at load increment  $j$ .

$V_I$  — The total applied lateral force at the first increment of lateral load.

$V_y$  — The effective yield strength determined from a bilinear curve fitted to the capacity curve according to Sec. A5.2.3.

$W$  — See Sec. 1.1.5.

$w_i$  — See Sec. 4.1.4.

$\Delta$  — The design story drift as determined in Sec. A5.2.6.

$\gamma_i$  — The deformations for member  $i$ .

$\delta_{Lj}$  — The displacement of the control point at load increment  $j$ .

$\delta_I$  — The target displacement of the control point, determined according to Sec. A5.2.5.

$\delta_I$  — The displacement of the control point at the first increment of lateral load.

$\delta_y$  — The effective yield displacement of the control point determined from a bilinear curve fitted to the capacity curve according to Sec. A5.2.3.

$\phi_i$  — The amplitude of the shape vector at Level  $i$ , determined according to Sec. A5.2.4.

$\Omega_0$  — See Sec. 11.3 4.1.4.

**A5.2 NONLINEAR STATIC PROCEDURE**

**X.3. Applicability.** Where the nonlinear static procedure is used to design structures, the requirements of this section shall apply. Regular structures less than 40 feet in height in Occupancy Categories I and II may be designed using the Nonlinear Static Procedure following the requirements of this chapter.

**X.4. Seismic force-resisting system.** The seismic force-resisting system shall conform to one of the types indicated in Table 12.2-1, and shall be in accordance with the seismic design category and height limitations indicated in this table. The appropriate response modification coefficient,  $R$ , and system overstrength factor,  $\Omega_0$ , indicated in Table 12.2-1 shall be used, subject to the following.

**X.5.A5.2.1 Modeling and analysis.** Modeling and analysis shall conform to Sec. 3.3.3 of *ASCE/SEI 41 Supplement 1*, except that (i)  $S_a$  shall be defined as a risk-adjusted MCE spectral response acceleration according to the Provisions at the effective period, and (ii) the analysis shall be done for seismic actions occurring simultaneously with the effects of dead load in combination with not less than 25 percent of the required design live loads, reduced as permitted for the area of a single floor. A mathematical model of the structure shall be constructed to represent the spatial distribution of mass and stiffness of the structural system considering the effects of component nonlinearity for deformation levels that exceed the proportional limit. P-Delta effects shall be included in the analysis model, and dead and live loads acting on the entire structure shall be represented in the model.

For regular structures with independent orthogonal seismic force resisting systems, independent two-dimensional models shall be permitted to be used to represent each system. For structures having plan irregularities Types 4 and 5 as defined in Table 4.3-2 or structures without independent orthogonal systems, a three-dimensional model incorporating a minimum of three degrees of freedom for each level of the structure, consisting of translation in two orthogonal plan directions and torsional rotation about the vertical axis, shall be used. Where the diaphragms are not rigid compared to the vertical elements of the seismic force resisting system, the model should include representation of the diaphragm flexibility.

Unless analysis indicates that a component remains elastic, a nonlinear force deformation model shall be used to represent the stiffness of the component before onset of yield, the yield strength, and the stiffness properties of the component after yield at various levels of deformation. The properties of nonlinear component models shall be consistent with principles of mechanics or laboratory data. Properties representing component behavior before yield shall be consistent with the provisions of Sec. 5.3.1. Strengths of elements shall not exceed expected values considering material overstrength and strain hardening. The properties of elements and components after yielding shall account for strength and stiffness degradation due to softening, buckling, or fracture as indicated by principles of mechanics or test data. The model for columns should reflect the influence of axial load where axial loads exceed 15 percent of the compression strength. The structure shall be assumed to have a fixed base or, alternatively, it shall be permitted to use realistic assumptions with regard to the stiffness and load-carrying characteristics of the foundations, consistent with site specific soil data and rational principles of engineering mechanics.

A control point shall be selected for each model. For structures without penthouses, the control point shall be at the center of mass of the highest level of the structure. For structures with penthouses, the control point shall be at the center of mass of the level at the base of the penthouse

**A5.2.2 Analysis.** The structure shall be analyzed for seismic actions occurring simultaneously with the effects of dead load in combination with not less than 25 percent of the required design live loads, reduced as permitted for the area of a single floor. The lateral forces shall be applied at the center of mass of each level and shall be proportional to the distribution obtained from a modal analysis for the fundamental mode of response in the direction under consideration. The lateral loads shall be increased incrementally in a monotonic manner.

At the  $j$ -th increment of lateral loading, the total lateral force applied to the model shall be characterized by the term  $V_j$ . The incremental increases in applied lateral force should be in steps that are sufficiently small to permit significant changes in individual component behavior (such as yielding, buckling or failure) to be detected. The first increment in lateral loading shall result in linear elastic behavior. At each analysis step, the total applied lateral force,  $V_j$ , the lateral displacement of the control point,  $\delta_j$ , and the forces and deformations in each component shall be recorded. The analysis shall be continued until the

displacement of the control point is at least 150% of the target displacement determined in accordance with Sec. A5.2.5. The structure shall be designed so that the total applied lateral force does not decrease in any analysis increment for control point displacements less than or equal to 125% of the target displacement.

**A5.2.3 Effective yield strength and effective period.** A bilinear curve shall be fitted to the capacity curve, such that the first segment of the bilinear curve crosses the capacity curve at 60% of the effective yield strength, the second segment crosses the capacity curve at the target displacement, and the area under the bilinear curve equals the area under the capacity curve, between the origin and the target displacement. The effective yield strength,  $V_y$ , corresponds to the total applied lateral force at the intersection of the two line segments. The effective yield displacement,  $\delta_y$ , corresponds to the control point displacement at the intersection of the two line segments.

The effective fundamental period,  $T_e$ , shall be determined using Eq. A5.2-1 as follows:

$$T_e = T_1 \sqrt{\frac{V_1 / \delta_1}{V_y / \delta_y}} \quad (\text{A5.2-1})$$

where  $V_1$ ,  $\delta_1$ , and  $T_1$  are determined for the first increment of lateral load.

**A5.2.4 Shape vector.** The shape vector shall be equal to the first mode shape of the structure in the direction under consideration, determined by a modal analysis of the structure at the first increment of lateral load, and normalized to have unit amplitude at the level of the control point. It shall be permitted to substitute the deflected shape of the structure at the step at which the control point displacement is equal to the effective yield displacement in place of the mode shape, for determination of the shape vector.

**A5.2.5 Target displacement.** The target displacement of the control point,  $\delta_T$ , shall be determined using Equation A5.2-2 as follows:

$$\delta_T = C_0 C_1 S_a \left( \frac{T_e}{2\pi} \right)^2 g \quad \delta_T = C_0 C_1 C_2 S_a \left( \frac{T_e}{2\pi} \right)^2 g \quad (\text{A5.2-2})$$

where the spectral acceleration,  $S_a$ , is determined from either Sec. 3.3.4 or Sec. 3.4.4 at the effective fundamental period,  $T_e$ ;  $g$  is the acceleration of gravity, and the coefficients  $C_0$  and  $C_1$  are determined as follows.

The coefficient  $C_0$  shall be calculated using Equation A5.2-3 as:

$$C_0 = \frac{\sum_{i=1}^n w_i \phi_i}{\sum_{i=1}^n w_i \phi_i^2} \quad (\text{A5.2-3})$$

where:

—  $w_i$  = the portion of the seismic weight,  $W$ , at Level  $i$ , and

—  $\phi_i$  = the amplitude of the shape vector at Level  $i$ .

Where the effective fundamental period of the structure in the direction under consideration,  $T_e$ , is greater than  $T_s$ , as defined in Sec. 3.3.4 or Sec. 3.4.4, the coefficient  $C_1$  shall be taken as 1.0. Otherwise, the value of the coefficient  $C_1$  shall be calculated using Eq. A5.2-4 as follows:

$$C_1 = \frac{1}{R_d} \left( 1 + \frac{(R_d - 1)T_s}{T_e} \right)$$

(A5.2.4)

where

**X.6 Maximum strength ratio.** The system strength ratio,  $R_d$ , is given by Eq. X-1 as follows:

$$R_d = \frac{S_a}{V_y / W} C_m \tag{X-1}$$

where  $C_m$ ,  $V_y$ , and  $W$  are as defined in Section 3.3.3.3.2 of *ASCE/SEI 41 Supplement 1*, and  $S_a$  is defined as a risk-adjusted MCE spectral response acceleration according to the *Provisions* at the effective period. Use of the Nonlinear Static Procedure is not permitted where  $R_d$  exceeds  $R_{max}$ .

~~**A5.2.8 Distribution of design seismic forces.** The lateral forces used for design of the members shall be applied at the center of mass of each level and shall be proportional to the distribution obtained from a modal analysis for the fundamental mode of response in the direction under consideration.~~

~~**X.7A5.2.6 Story drift.** The design story drift,  $\Delta$ , taken as the value obtained for each story at the step at which the target displacement is reached, shall not exceed the drift limit specified in Sec. 12.12.14.5.1 multiplied by  $0.85R/C_d$ .~~

~~**X.8A5.2.7 Member strength.** In addition to satisfying the requirements of Section 12.15.9 this Appendix, member strengths also shall satisfy the requirements of Sec. 2.34.2.2 using  $E = 0$ , except that Section 4.2.2.2Section 12.4.3.2 shall apply where these *Provisions* specifically require the consideration the effect of structural overstrength on the design seismic force must be considered. Where these *Provisions* require the consideration the effect of structural overstrength is considered, according to Sec. 4.2.2.2, the value of the individual member forces,  $Q_{Ei}$  obtained from the analysis at the target displacement shall be taken in place of the quantity  $\Omega_0 Q_E$ .~~

~~**X.9A5.2.9 Detailed evaluation.** Detailed evaluation satisfying Sec. X.9.1 A5.2.9.1 and Sec. X.9.2A5.2.9.2 need not be satisfied if is required if  $R_d$  exceeds  $R/\Omega_0$ , the effective yield strength exceeds the product of the system overstrength factor as given in Table 4.3-1 and the seismic base shear determined in Sec. 5.2.1, modified to use the effective fundamental period  $T_e$  in place of  $T$  for the determination of  $C_s$ .~~

~~**X.9.1A5.2.9.1 Required member force and deformation.** For each nonlinear static analysis, the design response parameters, including the individual member forces,  $Q_{Ei}$ , and member deformations,  $\gamma_i$ , shall be taken as the values obtained from the analysis at the step at which the target displacement is reached.~~

~~**X.9.2A5.2.9.2 Member capacity.** The adequacy of individual members and their connections to withstand the member forces,  $Q_{Ei}$ , and member deformations,  $\gamma_i$ , shall be evaluated based on laboratory test data for similar components. The effects of gravity and other loads on member deformation capacity shall be considered in these evaluations. The deformation of a member supporting gravity loads shall not exceed (i) two-thirds of the deformation that results in loss of ability to support gravity loads, and (ii) two-thirds of the deformation at which the member strength has deteriorated to less than the 70 percent of the peak strength of the component model. The deformation of a member not required for gravity load support shall not exceed two-thirds of the value at which member strength has deteriorated to less than 70% of the peak strength of the component model. Alternatively, it shall be permissible to deem member deformation to be acceptable if the deformation does not exceed the value determined using the~~

1 acceptance criteria for nonlinear procedures given in the *Prestandard and Commentary for the Seismic*  
2 *Rehabilitation of Buildings* (FEMA 356) provided in ASCE/SEI 41 Supplement 1 for the Life Safety  
3 performance level.

4 Member forces shall be deemed acceptable if not in excess of expected capacities.

5 **X.10.A5.2.10 Design review.** A review of the design of the seismic force resisting system and the  
6 supporting structural analyses shall be performed by an ~~An~~ independent team having experience in  
7 seismic analysis methods and the theory and application of nonlinear seismic analysis and structural  
8 behavior under earthquake loading, composed of at least two members including at least one registered  
9 design professional, ~~composed of at least two members, consisting of registered design professionals in~~  
10 ~~the appropriate disciplines and others, with experience in seismic analysis methods and the theory and~~  
11 ~~application of nonlinear seismic analysis and structural behavior under earthquake loading, shall perform~~  
12 ~~a review of the design of the seismic force resisting system and the supporting structural analyses.~~ The  
13 design review shall include (i) review of any site-specific seismic criteria employed in the analysis  
14 including the development of site-specific spectra, and (ii) review of the determination of the target  
15 displacement and effective yield strength of the structure.

16 For those structures with where  $R_d$  exceeds  $R/\Omega_0$  ~~the effective yield strength is less than the product of the~~  
17 ~~system overstrength factor as given in Table 4.3-1 and the seismic base shear determined in Sec. 5.2.1,~~  
18 ~~modified to use the effective fundamental period  $T_e$  in place of  $T$  for the determination of  $C_s$ ,~~ the design  
19 review shall further include, but need not be limited to, the following:

20 1. Review of acceptance criteria used to demonstrate the adequacy of structural elements and systems to  
21 withstand the calculated force and deformation demands, together with that laboratory and other data used  
22 to substantiate such criteria. Review of the acceptance criteria for nonlinear procedures given in  
23 ASCE/SEI 41 Supplement 1 ~~the *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*~~  
24 ~~(FEMA 356)~~ shall be at the discretion of the design review team.

25 2. Review of the final design of the entire structural system and all supporting analyses.

26 The design review team shall issue a report that identifies, within the scope of the review, significant  
27 concerns and any departures from general conformance with the *Provisions*.

28

## Appendix to Chapter 5

### NONLINEAR STATIC PROCEDURE

#### COMMENTARY

**PREFACE:** This chapter appendix addresses nonlinear static analysis, a seismic analysis procedure also sometimes known as pushover analysis, for review and comment and for adoption into a subsequent edition of the *Provisions*.

Although nonlinear static analysis has only recently been included in design provisions for new building construction, the procedure itself is not new and has been used for many years in both research and design applications. For example, nonlinear static analysis has been used for many years as a standard methodology in the design of the offshore platform structures for hydrodynamic effects and has been adopted recently in several standard methodologies for the seismic evaluation and rehabilitation of building structures, including the *Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings* (FEMA-350, 2000a), *Seismic Rehabilitation of Existing Buildings* (ASCE/SEI 41-06, 2007), *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* (FEMA 356, 2000b) and *Seismic Evaluation and Retrofit of Concrete Buildings* (ATC 40, 1996).

Nonlinear static analysis forms the basis for earthquake loss estimation procedures contained in the earthquake module of the multihazard software application HAZUS-MH MR2 (NIBS, 2006) and its Advanced Engineering Building Module (NIBS, 2002). ~~HAZUS (NIBS, 1999), FEMA's nationally applicable earthquake loss estimation model.~~ A critical review and improvement of nonlinear static analysis methods was recently completed by the Applied Technology Council (FEMA-440, 2005).

Although it does not explicitly appear in the *Provisions*, the nonlinear static analysis methodology also forms the basis for the equivalent lateral force procedures contained in the provisions for base-isolated structures and structures with dampers.

One of the controversies surrounding the introduction of this methodology into the *Provisions* relates to the determination of the limit deformation (sometimes called a target displacement). Several methodologies for estimating the amount of deformation induced in a structure by earthquake-induced ground shaking have been proposed and are included in various adoptions of the procedure. The approach presented in this appendix is based on statistical correlations of the displacements predicted by linear and nonlinear dynamic analyses of structures recommended by the ATC-55 Project (FEMA-440, 2005), ~~which is similar to that contained in FEMA 356.~~

A second controversy relates to the limited availability of consensus-based acceptance criteria to be used to determine the adequacy of a design once the forces and deformations produced by design earthquake ground shaking are estimated. It should be noted that this limitation applies equally to the nonlinear response history approach, which already has been adopted into building codes.

A third controversy relates to the effects of higher modes (or multi-degree-of-freedom effects, for structures responding nonlinearly) on response quantities. Because the ATC-55 Project found significant disparities between response quantities determined by nonlinear static analysis and those determined by nonlinear dynamic analysis for all but low-rise structures, use of the nonlinear static procedure for the design of members is limited to structures 40 ft or less in height. The nonlinear static procedure may be used to ensure that structures designed according to the Equivalent Lateral Force procedure achieve strengths comparable to code expectations. Interstory drifts are compared with tabulated allowable story drifts to maintain consistency with past practice, although it is recognized that larger interstory drifts should be anticipated due to higher mode or multi-degree-of-freedom effects.

1 Nonlinear static analysis provides a simplified method of directly evaluating nonlinear response of  
2 structures to strong earthquake ground shaking that can be an attractive alternative to the more  
3 complex procedures of nonlinear response history analysis. It may be useful for characterizing system  
4 strength and stiffness, and for establishing that the structure develops a desirable inelastic mechanism.  
5 It is hoped that exposure of this approach through inclusion in this appendix will allow the necessary  
6 consensus to be developed to permit later integration into the *Provisions* as such.

7 Users of this appendix also should consult the *Commentary* for guidance. Please direct all feedback  
8 on this appendix and its commentary to the BSSC.

## 10 REFERENCES

11 [ASCE/SEI 41-06 \(2007\), \*Seismic Rehabilitation of Existing Buildings\*, ASCE Standard No. ASCE/SEI](#)  
12 [41-06, Supplement 1, American Society of Civil Engineers, Reston, Virginia.](#)

13  
14  
15 ATC 40 (SSC, 1996) *Seismic Evaluation and Retrofit of Concrete Buildings*, SSC Report No. 96-01,  
16 Seismic Safety Commission, State of California, Sacramento, California. Developed by the Applied  
17 Technology Council, Redwood City, California.

18  
19 [FEMA \(2006\), \*HAZUS-MH MR2\* . "Multi-hazard Loss Estimation Methodology, Earthquake Model,](#)  
20 [Technical Manual." Federal Emergency Management Agency, National Institute of Building Sciences,](#)  
21 [Washington, D.C.](#)

22  
23 FEMA 350 (FEMA, 2000a), *Recommended Seismic Design Criteria for New Steel Moment-Frame*  
24 *Buildings*, Federal Emergency Management Agency, Washington, D.C.

25  
26 FEMA 356 (FEMA, 2000b), *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*,  
27 Federal Emergency Management Agency, Washington, D.C.

28  
29 [FEMA 440 \(2005\), \*Improvement of Nonlinear Static Seismic Analysis Procedures\*, Report No. FEMA-](#)  
30 [440, Federal Emergency Management Agency, Washington, D.C.](#)

31  
32 [HAZUS \(NIBS, 1999\), \*HAZUS99 Technical Manual\*, National Institute of Building Science, Washington,](#)  
33 [D.C. Developed by the Federal Emergency Management Agency through agreements with the National](#)  
34 [Institute of Building Sciences.](#)

35  
36 [NIBS \(2002\), \*Earthquake Loss Estimation Methodology, HAZUS99-SR2, Advanced Engineering Building\*](#)  
37 [Module, Technical and User's Manual](#), prepared by National Institute of Building Sciences (NIBS) for  
38 [the Federal Emergency Management Agency, Washington, D.C.](#)

39  
40 [NIBS \(2006\). \*Multi-hazard Loss Estimation Methodology: Earthquake Model, HAZUS-MH MR2\*](#)  
41 [Technical Manual](#), prepared by the National Institute of Building Sciences (NIBS) for the Federal  
42 [Emergency Management Agency, Washington, D.C.](#)

## 45 REASON FOR PROPOSAL:

46  
47 This proposal revises the NSP to allow its use in design of regular buildings less than 40 ft. in height. Its  
48 placement in Part 3 of the Provisions reflects this limitation. The principal value of this approach, as  
49 currently presented, is for the design of buildings that are controlled by drift limits. Such buildings can be

1 designed to have sufficient stiffness without using the Equivalent Lateral Force Procedure, and will have  
2 sufficient strength that detailed member evaluations would not be required ( $R_d < R/\Omega_0$ ). In the future, the  
3 40-ft. limitation may be relaxed if, for example, the NSP is used in conjunction with a nonlinear dynamic  
4 analysis.

5  
6 Because requirements for the nonlinear static procedure are now specified in ASCE 41, it is simpler to  
7 refer to that document than to write applicable requirements into the Provisions. Modifications to the  
8 ASCE requirements are introduced here to maintain consistency with the nonlinear static procedure  
9 presented in the 2003 Provisions.

10  
11 The 40 ft limit in this proposal was selected based on the accuracy of response quantities determined for a  
12 3-story moment-frame structure; no height limit was identified in the ATC-55 project. Although higher  
13 modes will have a similar influence on ELF quantities, the higher base shear strengths and story shears of  
14 the ELF procedure will tend to result in smaller member ductility demands. Thus, precision in the NSP  
15 estimates is especially important where system strengths are lower than in the ELF approach, for which  
16 member deformation demands are evaluated in detail.

17  
18 The proposal simplifies the language used to establish whether lateral strength is nominally less than that  
19 required by the Equivalent Lateral Force procedure. This is now stated succinctly as  $R_d > R/\Omega_0$ .

20  
21 Section references were harmonized with ASCE 7-05 section numbers. If approved, the chapter number  
22 assigned to this material in Part 3 will have to be substituted where “X” appears in the proposal.