PROPOSAL 2-7 (2009)

SCOPE: Sec. 16.1.3.1 and 16.1.3.2 of 2009 *Provisions*

PROPOSAL FOR CHANGE:

Introduce new material to Part 1 to replace Sections 16.1.3.1 and 16.1.3.2 of ASCE-7 as indicated below:

16.1.3.1 Two-Dimensional Analysis. Where ~~2-D~~ two-dimensional analyses are performed, each ground motion shall consist of a horizontal ground motion acceleration history, selected from an actual recorded event. Appropriate ground motion ~~acceleration~~ histories shall be obtained from records of events having magnitudes, fault distances, and source mechanisms that are consistent with those that control the maximum considered earthquake. Where the required number of appropriate recorded ground motion records ~~are~~is not available, appropriate simulated ground motion records ~~shall~~ are permitted to be used to make up the total number required. The ground motions shall be scaled such that the average value of the 5-percent damped response spectra for the suite of motions is not less than the target design response spectrum for the site, determined in accordance with Sec. 11.4.5 or 11.4.7, for periods ranging from $0.2T$ to $1.5T$, where T is the natural period of the structure in the fundamental mode for the direction of response being analyzed.

> **EXCEPTION:** Site-specific scenario spectra are permitted to be used to define the target design response spectrum. Where site-specific scenario spectra are used, scenario events shall be defined using site-specific disaggregation of the uniform hazard spectral ordinate at each period of interest. Where disaggregation indicates that multiple scenario events contribute significantly to the hazard at a period of interest, scenario spectra representative of each event shall be used as target design spectra. Appropriate ground motion histories shall be obtained from records of events having magnitudes, fault distances, and source mechanisms that are consistent with each scenario event. Where the required number of appropriate recorded ground motion records is not available, appropriate simulated ground motion records are permitted to be used to make up the total number required. The ground motions shall be scaled for each period of interest such that the average value of the 5-percent damped response spectra of the suite of motions is not less than 1.1 times the scenario spectrum at the period of interest, for each scenario event. The periods of interest are those for which the scenario event causes significant structural response and shall be selected considering the structure's nonlinear behavior. Design review of the disaggregation results and the process used to develop the scenario spectra is required.

16.1.3.2 Three-Dimensional Analysis. Where ~~3-D~~ three-dimensional ~~analysis is~~ analyses are performed, ground motions shall consist of pairs of appropriate horizontal ground motion acceleration components that shall be selected and scaled from individual recorded events. Appropriate ground motions shall be selected from events having magnitudes, fault distances,

and source mechanisms that are consistent with those that control the maximum considered earthquake. Where the required number of recorded ground motion pairs ~~are~~is not available, appropriate simulated ground motion pairs ~~shall~~ are permitted to be used to make up the total number required. For each pair of horizontal ground motion components, a square root of the sum of squares (SRSS) spectrum shall be constructed by taking the SRSS of the 5-percent-damped response spectra for the scaled components (where an identical scale factor is applied to both components of a pair). Each pair of motions shall be scaled such that for each period between 0.2*T* and 1.5*T*, the ratio of the average of the SRSS spectra from all horizontal component pairs ~~does not fall below 1.3 times~~ and the corresponding ordinate of the target design response spectrum, determined in accordance with Section 11.4.5 or ~~21.2~~11.4.7 is not less than 1.2 and averages not less than 1.3.~~, by more than 10 percent~~.

> **EXCEPTION:** Site-specific scenario spectra are permitted to be used to define the target design response spectrum. Where site-specific scenario spectra are used, scenario events shall be defined using site-specific disaggregation of the uniform hazard spectral ordinate at each period of interest. Where disaggregation indicates that multiple scenario events contribute significantly to the hazard at a period of interest, scenario spectra representative of each event shall be used as target design spectra. Appropriate pairs of ground motion histories shall be obtained from records of events having magnitudes, fault distances, and source mechanisms that are consistent with each scenario event. Where the required number of appropriate recorded ground motion records is not available, appropriate simulated ground motion records are permitted to be used to make up the total number required. The ground motion pairs shall be scaled for each period of interest such that the average of the SRSS spectra from all horizontal component pairs is not less than 1.3 times the corresponding ordinate of the scenario spectrum at the period of interest, for each scenario event. The periods of interest are those for which the scenario event causes significant structural response. Design review of the disaggregation results and the process used to develop the scenario spectra is required.

REASON FOR PROPOSAL:

The existing text forces the scaling of ground motion records to the design spectrum, which is essentially a uniform hazard spectrum. This has been shown to be an unrealistic basis for ground motion scaling, because spectral shapes for recorded ground motions do not tend to be uniformly much larger than median estimates from attenuation relations, as is the case with uniform hazard spectra at high hazard levels (instead, the data show that individual recordings can be much higher than median spectra across relatively narrow period bands). The proposal allows scaling according to scenario spectra determined by disaggregation of the hazard at the site. This concept has been endorsed by attendees at the 2006 COSMOS meeting, where the issue was discussed at some length.

The proposal makes minor grammatical improvements, closes an existing loophole in 3D analysis by requiring the average scaled SRSS spectra to be not less than 1.3 times the target design spectrum, and simplifies phrasing of existing language for 3D analysis by replacing 10% less than 1.3 times the target design spectrum with 1.2 times the target

design spectrum. The 1.2 comes from (0.9)(1.3) = 1.17 ≈ 1.2. Thus, the existing approaches scale ground motions to not less than 1.0 and 1.2 times the target spectrum for 2D and 3D analyses, respectively, for any period within the defined range of periods.

Scaling for the scenario spectra is done at a specific period of interest, rather than over a range of periods, and hence, spectra for scenario ground motions should not be allowed to drop, in effect, to 90% of the target spectrum at the period of interest. Consequently, the corresponding minimum values for scenario spectra at any specific period of interest are 1/0.9 = 1.11 ≈ 1.1 and (1/0.9)(1.2) = 1.33 ≈ 1.3 [or (1/0.9)(1.17) = 1.3] for 2D and 3D scenario spectra, respectively.

TS 2 VOTE:

YES = 6 *Yes with Reservations = 2* *No = 0* *Not Voting = 1*

Constantineau: Yes with Reservations

The reservation being that the language needs improvement to clearly communicate the intent. An option is to clearly explain this using a graph describing the ratio and the "average" relative to the target design spectrum in the Commentary.

Charney: Yes with Reservations

My vote is yes with reservations. My only suggestion is that some kind of illustration be used to clarify the terminology and processes described in the exceptions. This illustration would be included in the Provisions or in the commentary.