

PROPOSAL 8-43R2 (2009)

SCOPE: Revise Table 15.4-2 and Sec. 15.6.2 of ASCE 7-05

PROPOSAL FOR CHANGE:

Revise Table 15.4-2 and Section 15.6.2 to Part 1 of the 2009 Provisions:

Cast-in-place concrete silos, stacks, and chimneys having walls continuous to the foundation	15.6.2	3	1.75	3	NL	NL	NL	NL	NL
All other reinforced masonry structures not similar to buildings	14.4.1	3	2	2.5	NL	NL	NL	50	50
All other nonreinforced masonry structures not similar to buildings	14.4.1	1.25	2	1.5	NL	NL	50	50	50
Concrete chimneys and stacks	<u>15.6.2</u>	<u>2</u>	<u>1.5</u>	<u>1.5</u>	<u>NL</u>	<u>NL</u>	<u>NL</u>	<u>NL</u>	<u>NL</u>
All other steel and reinforced concrete distributed mass cantilever structures not covered herein including stacks, chimneys, silos, and skirt-supported vertical vessels that are not similar to buildings	15.6.2 15.7.10 and 15.7.10.5 a and b.	3	2	2.5	NL	NL	NL	NL	NL

15.6.2 Stacks and Chimneys. Stacks and chimneys are permitted to be either lined or unlined, and shall be constructed from concrete, steel, or masonry. Steel stacks, concrete stacks, steel chimneys, concrete chimneys, and liners shall be designed to resist seismic lateral forces determined from a substantiated analysis using reference documents. Interaction of the stack or chimney with the liners shall be considered. A minimum separation shall be provided between the liner and chimney equal to Cd times the calculated differential lateral drift.

For concrete chimneys in SDC D, E, and F, splices for vertical rebar shall be staggered such that no more than 50% of the bars are spliced at any elevation. Design and detailing of cross-sections in the regions of breachings/openings, where the loss of cross-sectional area is greater than 10%, shall be performed one of the following ways:

- a. For vertical force, shear force, and bending moment demands along the vertical direction, design the affected cross-section using the overstrength factor of 1.5. The region of such overstrength shall extend above and below (except if the opening is at the base) the opening(s) by a distance equal to half of the width of the largest opening in the affected region. Appropriate reinforcement development lengths shall be provided beyond the required region of overstrength. The jamb regions around each opening shall be detailed using the column tie requirements in Section 7.10.5 of ACI 318. Such detailing shall extend for a jamb width of a minimum of two times the wall thickness and for a height of the opening height plus twice the wall thickness above and below the opening, but no less than the development length of the longitudinal bars. The percentage of longitudinal reinforcement in jamb regions shall meet the requirements of Section 10.9 of ACI 318 for compression members.
- b. Provided that the cross-sectional moment of inertia in the opening region is at least 70% of the same above and below it, the reduced cross-section shall be subject to the following requirements:

- 1 i. All detailing requirements listed in Item a. above for the overstrength option shall be
2 followed, in addition to the ones listed below.
3 ii. Hoop ties in jamb regions shall be detailed as columns of intermediate moment frames
4 using the requirements in Section 21.3.5 of ACI 318. The dimensions for jamb region
5 shall be the same as that required in Item a. above for the overstrength option.
6 iii. No construction joints within the opening region plus two times the wall thickness above
7 and below the opening.
8 iv. Ratio of outer diameter to wall thickness shall not exceed 20 within the opening region.

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11 **Revise Commentary Section C15.6.2 to Part 2 of the 2009 Provisions:**

12 **C15.6.2 Stacks and Chimneys.** The design of stacks and chimneys to resist natural hazards generally is
13 governed by wind design considerations. The exceptions to this general rule involve locations with high
14 seismicity, stacks and chimneys with large elevated masses, and stacks and chimneys with unusual
15 geometries. It is prudent to evaluate the effect of seismic loads in all but those areas with the lowest
16 seismicity. Although not specifically required, it is recommended that the special seismic details required
17 elsewhere in the standard be considered for application to stacks and chimneys.

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19 Concrete chimneys have low ductility, and their seismic behavior is especially critical in the opening
20 regions due to inherent reduction in strength and loss of confinement for vertical reinforcement in the
21 jamb regions around the openings. Spectacular earthquake-induced chimney failures have occurred in
22 recent history (in Turkey in 1999) and have been attributed to strength/detailing problems (Kilic and
23 Sozen 2003). Therefore, the R value of 3 traditionally used in ASCE 7 for concrete stacks and chimneys
24 was reduced to 2 and detailing requirements for breach openings were added in the 2009 Provisions.

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26 Guyed steel stacks and chimneys are generally lightweight. As a result, the design loads due to natural
27 hazards generally are governed by wind. On occasion, large flares or other elevated masses located near
28 the top may require in-depth seismic analysis. Although it does not specifically address seismic loading,
29 Chapter 6 of Troitsky (1982) provides a methodology appropriate for resolution of the seismic forces
30 defined in the standard.

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32 **Add the following reference to the end of the Chapter 15 commentary:**

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34 Kilic, S., and Sozen, M. (2003). "Evaluation of Effect of August 17, 1999, Marmara Earthquake on Two
35 Tall Reinforced Concrete Chimneys," ACI Structural Journal, Vol. 100, No. 3.

36 **REASON FOR PROPOSAL:**

37 Concrete chimneys have low ductility, and their seismic behavior is especially critical in the
38 opening regions due to inherent reduction in strength and loss of confinement for vertical
39 reinforcement in the jamb regions around the openings. Spectacular earthquake-induced
40 chimney failures have occurred in recent history (in Turkey in 1999) and have been attributed to
41 strength/detailing problems (Kilic and Sozen 2003). Therefore, the R value of 3 currently used
42 in ASCE 7 is reduced to 2 and detailing requirements for breach openings are added.