

## Agenda Item 625-1011

### Title: Remove 100V Plus 40H Seismic Combination for Base Shear Check

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Revision: 0

Handled By: Eric Gnade  
CB&I, A McDermott Company  
14105 S. Route 59  
Plainfield, IL 60544-8984  
Telephone: 815-439-6476  
Email: [Eric.Gnade@McDermott.com](mailto:Eric.Gnade@McDermott.com)

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- Purpose:** Make API 625 requirements for sliding resistance consistent with other industry standards and codes.
- Source:** Alex Cooperman (CB&I) pointing out the inconsistency with other standards and codes.
- Impact:** Seismic design checks for global stability consistent with other industry standards and codes. Regions with high vertical seismic will meet sliding resistance checks more easily.
- Rationale:** API 625 6.6.9 Resistance to Base Shear – Sliding currently requires that 100% vertical plus 40% horizontal in addition to 100% horizontal plus 40% vertical.

Starting with ASCE 7-16, the code has clarified in 15.1.4.1 for Nonbuilding Structures sensitive to vertical ground motions that only  $100\%H_x+30\%H_z+30\%V$  and  $30\%H_x+100\%H_z+30\%V$  are required for global stability (i.e. overturning and sliding).

*15.1.4.1 Direction of Loading Criteria for Nonbuilding Structures Sensitive to Vertical Ground Motions* The following orthogonal load combinations of horizontal and vertical seismic load effects shall be applied to hanging structures and structures incorporating horizontal cantilevers.

*15.1.4.1.1 Strength* The directions of application of seismic forces used in the strength design of structure elements shall be those that produce the most critical load effects. This requirement is deemed satisfied if the structure elements are designed to the more stringent demands of the following load directions:

1. 100% of the forces for one horizontal direction plus 30% of the forces for the perpendicular horizontal direction plus 30% of the forces for the vertical direction. The combination requiring the maximum component strength shall be used.
2. 100% of the forces for the vertical direction plus 30% of the forces for a horizontal direction plus 30% of the forces for the perpendicular horizontal direction. The combination requiring the maximum component strength shall be used.

*15.1.4.1.2 Overturning and Stability* The directions of application of seismic forces used in the evaluation of overturning stability and **sliding** of the structure shall be those that produce

the most critical load effects. This requirement is deemed satisfied if the structures and their foundations are evaluated for overturning stability and **sliding** using the following load directions:

1. 100% of the forces for one horizontal direction plus 30% of the forces for the perpendicular horizontal direction plus 30% of the forces for the vertical direction. The combination requiring the maximum component strength shall be used.

A similar approach will be published in ACI 376. The following text has passed ACI 376 committee ballot but has not published yet.

8.1.3.4.8 The impulsive, convective, and all other significant modal responses shall be combined by the square root of sum of squares (SRSS) method. The total horizontal and vertical responses of the tank structure shall be combined as follows:

- (a) For global stability, 100 percent horizontal with 40 percent vertical.
- (b) For ultimate limit state (ULS) and service limit state (SLS) design of components, both 100 percent horizontal with 40 percent vertical and 40 percent horizontal with 100 percent vertical.

Components in (b) include the tank base slab, wall, roof, and accessories such as platforms and piping.

The horizontal response shall be the maximum directional response rather than the geometric mean response.

## **Proposed Changes**

### **6.6.9 Resistance to Base Shear - Sliding**

The rules in API 620, Annex L shall be applied to determine sliding resistance. In high seismic regions a more extensive analysis may be applied, provided it includes evaluation of the response of the shell, the fluid, and foundation (in the case of a slab) to the fluctuation of liquid pressures in the tank. When applying this approach, the ~~horizontal and vertical~~ seismic response shall be applied based on the component combination of 100 % ~~horizontal~~ and 40 % ~~vertical~~. ~~The case for the 100 % vertical plus 40 % horizontal load case shall be evaluated in addition to the 100 % horizontal plus 40 % vertical load case defined by API 620, Annex L. Alternately, a time history analysis approach may be applied incorporating both horizontal and vertical motions simultaneously.~~ When performing a time history analysis, both horizontal and vertical motions shall be applied simultaneously.