15.6.4 Special Hydraulic Structures

Special hydraulic structures are structures that are contained inside liquid-containing structures. These structures are exposed to liquids on both wall surfaces at the same head elevation under normal operating conditions. Special hydraulic structures are subjected to out-of-plane forces only during an earthquake where the structure is subjected to differential hydrodynamic fluid forces. Examples of special hydraulic structures include separation walls, baffle walls, weirs, and other similar structures.

15.6.4.1 Design Basis

Special hydraulic structures shall be designed for out-of-phase movement of the fluid. Unbalanced forces from the motion of the liquid must be applied simultaneously "in front of" and "behind" these elements.

Structures subject to hydrodynamic pressures induced by earthquakes shall be designed for rigid body and sloshing liquid forces and their own inertia force. The height of sloshing shall be determined and compared to the freeboard height of the structure. Interior elements, such as baffles or roof supports, also shall be designed for the effects of unbalanced forces and sloshing.

15.6.5 Secondary Containment Systems

Secondary containment systems, such as impoundment dikes and walls, shall meet the requirements of the applicable standards for tanks and vessels and the authority having jurisdiction.

Secondary containment systems shall be designed to withstand the effects of the maximum considered earthquake ground motion where empty and two-thirds of the maximum considered earthquake ground motion where full including all hydrodynamic forces as determined in accordance with the procedures of Section 11.4. Where determined by the risk assessment required by Section 1.5.2 or by the authority having jurisdiction that the site may be subject to aftershocks of the same magnitude as the maximum considered motion, secondary containment systems shall be designed to withstand the effects of the maximum considered earthquake ground motion where full including all hydrodynamic forces as determined in accordance with the procedures of Section 11.4.

15.6.5.1 Freeboard

Sloshing of the liquid within the secondary containment area shall be considered in determining the height of the impound. Where the primary containment has not been designed with a reduction in the structure category (i.e., no reduction in importance factor I_e) as permitted by Section 1.5.3, no freeboard provision is required. Where the primary containment has been designed for a reduced structure category (i.e., importance factor I_e reduced) as permitted by Section 1.5.3, a minimum freeboard, δ_s, shall be provided where

$$\delta_s = 0.42DS_{ac} \qquad (15.6\text{-}1)$$

where S_{ac} is the spectral acceleration of the convective component and is determined according to the procedures of Section 15.7.6.1 using 0.5 percent damping. For circular impoundment dikes, D shall be taken as the diameter of the impoundment dike. For rectangular impoundment dikes, D shall be taken as the plan dimension of the impoundment dike, L, for the direction under consideration.

15.6.6 Telecommunication Towers

Self-supporting and guyed telecommunication towers shall be designed to resist seismic lateral forces determined from a substantiated analysis using reference documents.

15.7 TANKS AND VESSELS

15.7.1 General

This section applies to all tanks, vessels, bins, and silos, and similar containers storing liquids, gases, and granular solids supported at the base (hereafter referred to generically as "tanks and vessels"). Tanks and vessels covered herein include reinforced concrete, prestressed concrete, steel, aluminum, and fiber-reinforced plastic materials. Tanks supported on elevated levels in buildings shall be designed in accordance with Section 15.3.

15.7.2 Design Basis

Tanks and vessels storing liquids, gases, and granular solids shall be designed in accordance with this standard and shall be designed to meet the requirements of the applicable reference documents listed in Chapter 23. Resistance to seismic forces shall be determined from a substantiated analysis based on the applicable reference documents listed in Chapter 23.

a. Damping for the convective (sloshing) force component shall be taken as 0.5 percent.
b. Impulsive and convective components shall be combined by the direct sum or the square root of