For $T_i > T_L$

$$S_{ai} = \frac{S_{D1} T_L}{T_i^2} \quad (15.7\text{-}9)$$

NOTES:

a. Where a reference document is used in which the spectral acceleration for the tank shell, and the impulsive component of the liquid is independent of T_i, then $S_{ai} = S_{DS}$.
b. Equations 15.7-8 and 15.7-9 shall not be less than the minimum values required in Section 15.4.1 Item 2 multiplied by R/I_e.
c. For tanks in Risk Category IV, the value of the importance factor, I_e, used for freeboard determination only shall be taken as 1.0.
d. For tanks in Risk Categories I, II, and III, the value of T_L used for freeboard determination is permitted to be set equal to 4 s. The value of the importance factor, I_e, used for freeboard determination for tanks in Risk Categories I, II, and III shall be the value determined from Table 1.5-1.
e. Impulsive and convective seismic forces for tanks are permitted to be combined using the square root of the sum of the squares (SRSS) method in lieu of the direct sum method shown in Section 15.7.6 and its related subsections.

S_{ac} = the spectral acceleration of the sloshing liquid (convective component) based on the sloshing period T_c and 0.5 percent damping

For $T_c \leq T_L$:

$$S_{ac} = \frac{1.5 S_{D1}}{T_c} \leq 1.5 S_{DS} \quad (15.7\text{-}10)$$

For $T_c > T_L$:

$$S_{ac} = \frac{1.5 S_{D1} T_L}{T_c^2} \quad (15.7\text{-}11)$$

EXCEPTION: For $T_c > 4$ s, S_{ac} is permitted be determined by a site-specific study using one or more of the following methods: (i) the procedures found in Chapter 21, provided such procedures, which rely on ground-motion attenuation equations for computing response spectra, cover the natural period band containing T_c, (ii) ground-motion simulation methods employing seismological models of fault rupture and wave propagation, and (iii) analysis of representative strong-motion accelerogram data with reliable long-period content extending to periods greater than T_c. Site-specific values of S_{ac} shall be based on one standard deviation determinations. However, in no case shall the value of S_{ac} be taken as less than the value determined in accordance with Eq. 15.7-11 using 50% of the mapped value of T_L from Chapter 22.

The 80 percent limit on S_a required by Sections 21.3 and 21.4 shall not apply to the determination of site-specific values of S_{ac}, which satisfy the requirements of this exception. In determining the value of S_{ac}, the value of T_L shall not be less than 4 s where

$$T_c = 2\pi \sqrt{\frac{D}{3.68 g \tanh\left(\frac{3.68H}{D}\right)}} \quad (15.7\text{-}12)$$

and where

D = the tank diameter in ft (m), H = liquid height in ft (m), and g = acceleration due to gravity in consistent units

W_i = impulsive weight (impulsive component of liquid, roof and equipment, shell, bottom, and internal elements)

W_c = the portion of the liquid weight sloshing

15.7.6.1.1 Distribution of Hydrodynamic and Inertia Forces Unless otherwise required by the appropriate reference document listed in Chapter 23, the method given in ACI 350.3 is permitted to be used to determine the vertical and horizontal distribution of the hydrodynamic and inertia forces on the walls of circular and rectangular tanks.

15.7.6.1.2 Sloshing Sloshing of the stored liquid shall be taken into account in the seismic design of tanks and vessels in accordance with the following requirements:

a. The height of the sloshing wave, δ_s, shall be computed using Eq. 15.7-13 as follows:

$$\delta_s = 0.42 D_i I_e S_{ac} \quad (15.7\text{-}13)$$

For cylindrical tanks, D_i shall be the inside diameter of the tank; for rectangular tanks, the term D_i shall be replaced by the longitudinal plan dimension of the tank, L, for the direction under consideration.

b. The effects of sloshing shall be accommodated by means of one of the following:
   1. A minimum freeboard in accordance with Table 15.7-3.
   2. A roof and supporting structure designed to contain the sloshing liquid in accordance with subsection 3 below.
   3. For open-top tanks or vessels only, an overflow spillway around the tank or vessel perimeter.