Table 15.7-1 Minimum Design Displacements for Piping Attachments

Condition	Displacements (in.)
Mechanically Anchored Tanks and Vessels	
Upward vertical displacement relative to support or foundation	1 (25.4 mm)
Downward vertical displacement relative to support or foundation	0.5 (12.7 mm)
Range of horizontal displacement (radial and tangential) relative to support or foundation	0.5 (12.7 mm)
Self-Anchored Tanks or Vessels (at grade)	
Upward vertical displacement relative to support or foundation	
If designed in accordance with a reference document as modified by this standard	
Anchorage ratio less than or equal to 0.785 (indicates no uplift)	1 (25.4 mm)
Anchorage ratio greater than 0.785 (indicates uplift)	4 (101.1 mm)
If designed for seismic loads in accordance with this standard but not covered by a reference document	
For tanks and vessels with a diameter less than 40 ft	8 (202.2 mm)
For tanks and vessels with a diameter equal to or greater than 40 ft	12 (0.305 m)
Downward vertical displacement relative to support or foundation	
For tanks with a ringwall/mat foundation	0.5 (12.7 mm)
For tanks with a berm foundation	1 (25.4 mm)
Range of horizontal displacement (radial and tangential) relative to support or foundation	2 (50.8mm)

they are designed for seismic displacements and defined operating pressure.

Unless otherwise calculated, the minimum displacements in Table 15.7-1 shall be assumed. For attachment points located above the support or foundation elevation, the displacements in Table 15.7-1 shall be increased to account for drift of the tank or vessel relative to the base of support. The piping system and tank connection shall also be designed to tolerate C_d times the displacements given in Table 15.7-1 without rupture, although permanent deformations and inelastic behavior in the piping supports and tank shell is permitted. For attachment points located above the support or foundation elevation, the displacements in Table 15.7-1 shall be increased to account for drift of the tank or vessel. The values given in Table 15.7-1 do not include the influence of relative movements of the foundation and piping anchorage points due to foundation movements (e.g., settlement, seismic displacements). The effects of the foundation movements shall be included in the piping system design including the determination of the mechanical loading on the tank or vessel, and the total displacement capacity of the mechanical devices intended to add flexibility.

The anchorage ratio, J, for self-anchored tanks shall comply with the criteria shown in Table 15.7-2 and is defined as

$$J = \frac{M_{rw}}{D^2\left(w_t + w_a\right)} \qquad (15.7\text{-}2)$$

Table 15.7-2 Anchorage Ratio

J Anchorage Ratio	Criteria
$J < 0.785$	No uplift under the design seismic overturning moment. The tank is self-anchored.
$0.785 < J < 1.54$	Tank is uplifting, but the tank is stable for the design load providing the shell compression requirements are satisfied. The tank is self-anchored.
$J > 1.54$	Tank is not stable and shall be mechanically anchored for the design load.

where

$$w_t = \frac{W_s}{\pi D} + w_r \qquad (15.7\text{-}3)$$

w_r = roof load acting on the shell in pounds per foot (N/m) of shell circumference. Only permanent roof loads shall be included. Roof live load shall not be included

w_a = maximum weight of the tank contents that may be used to resist the shell overturning moment in pounds per foot (N/m) of shell circumference. Usually consists of an annulus of liquid limited by the bending strength of the tank bottom or annular plate