Table 5.21a—Uplift Loads (SI)

Uplift Load Case	Net Uplift Formula, U (N)	Allowable Anchor Bolt or Anchor Strap Stress (MPa)	Allowable Shell Stress at Anchor Attachment (MPa)	
Design Pressure	$[(P_i - 0.08t_h) \times D^2 \times 785] - W_1$	$^5/_{12} \times F_y$	$^2/_3\ F_{ty}$	14
Test Pressure	$[(P_t - 0.08t_h) \times D^2 \times 785] - W_1$	$^5/_9 \times F_y$	$^5/_6\ F_{ty}$	
Failure Pressure[a]	$[(1.5 \times P_f - 0.08t_h) \times D^2 \times 785] - W_3$	F_y	F_{ty}	
Wind Load	$P_{WR} \times D^2 \times 785 + [4 \times M_{WH}/D] - W_2$	$0.8 \times F_y$	$^5/_6\ F_{ty}$	
Seismic Load	$[4 \times M_{rw}/D] - W_2\ (1 - 0.4A_V)$	$0.8 \times F_y$	$^5/_6\ F_{ty}$	
Design Pressure[b] + Wind	$[(F_p\ P_i + P_{WR} - 0.08t_h) \times D^2 \times 785] + [4\ M_{WH}/D] - W_1$	$^5/_9 \times F_y$	$^5/_6\ F_{ty}$	14
Design Pressure[b] + Seismic	$[(F_p\ P_i - 0.08t_h) \times D^2 \times 785] + [4\ M_{rw}/D] - W_1\ (1 - 0.4A_V)$	$0.8 \times F_y$	$^5/_6\ F_{ty}$	14
Frangibility Pressure[c]	$[(3 \times P_f - 0.08t_h) \times D^2 \times 785] - W_3$	F_y	F_{ty}	

where

A_v is the vertical earthquake acceleration coefficient, in % g;

D is the tank diameter, in meters;

F_p is the pressure combination factor;

F_{ty} is the minimum yield strength of the bottom shell course, in MPa;

F_y is the minimum yield strength of the anchor bolt or strap; bolts are limited to specified material minimum yield strength or 380 MPa, whichever is less, in MPa; anchor strap material minimum yield strength shall not exceed the minimum yield strength of the shell; 14

H is the tank height, in meters;

M_{WH} equals $P_{WS} \times D \times H^2/_2$, in N-m;

M_{rw} is the seismic moment, in N-m (see Annex E);

P_i is the design pressure, in kPa (see Annex F); 14

P_f is the failure pressure, in kPa (see Annex F);

P_t is the test pressure, in kPa (see Annex F);

P_{WR} is the wind uplift pressure on roof, in kPa;

P_{WS} is the wind pressure on shell, in N/m^2;

t_h is the roof plate thickness (the corroded thickness when used with W_1 and nominal thickness when used with W_3), in millimeters;

W_1 is the dead load of shell minus any corrosion allowance and any dead load other than roof plate acting on the shell minus any corrosion allowance, in N;

W_2 is the dead load of shell minus any corrosion allowance and any dead load including roof plate acting on the shell minus any corrosion allowance, in N;

W_3 is the dead load of the shell using nominal thicknesses and any dead load other than roof plate acting on the shell using nominal thicknesses, in N.

[a] Failure pressure applies to tanks falling under F.1.3 only. The failure pressure shall be calculated using nominal thicknesses.

[b] Refer to 5.2.2 concerning the pressure combination factor applied to the design pressure.

[c] Frangibility pressure applies only to tanks designed to 5.10.2.6 d. The frangibility pressure shall be calculated using nominal thicknesses.

Table 5.21b—Uplift Loads (USC)

Uplift Load Case	Net Uplift Formula, U (lbf)	Allowable Anchor Bolt or Anchor Strap Stress (lbf/in.^{2})	Allowable Shell Stress at Anchor Attachment (lbf/in.^{2})
Design Pressure	$[(P_i - 8t_h) \times D^2 \times 4.08] - W_1$	$^5/_{12} \times F_y$	$^2/_3 F_{ty}$
Test Pressure	$[(P_t - 8t_h) \times D^2 \times 4.08] - W_1$	$^5/_9 \times F_y$	$^5/_6 F_{ty}$
Failure Pressure[a]	$[(1.5 \times P_f - 8t_h) \times D^2 \times 4.08] - W_3$	F_y	F_{ty}
Wind Load	$P_{WR} \times D^2 \times 4.08 + [4 \times M_{WH}/D] - W_2$	$0.8 \times F_y$	$^5/_6 F_{ty}$
Seismic Load	$[4 \times M_{rw}/D] - W_2 (1 - 0.4A_V)$	$0.8 \times F_y$	$^5/_6 F_{ty}$
Design Pressure[b] + Wind	$[(F_p P_i + P_{WR} - 8t_h) \times D^2 \times 4.08] + [4 M_{WH}/D] - W_1$	$^5/_9 \times F_y$	$^5/_6 F_{ty}$
Design Pressure[b] + Seismic	$[(F_p P_i - 8t_h) \times D^2 \times 4.08] + [4 M_{rw}/D] - W_1 (1 - 0.4A_V)$	$0.8 \times F_y$	$^5/_6 F_{ty}$
Frangibility Pressure[c]	$[(3 \times P_f - 8t_h) \times D^2 \times 4.08] - W_3$	F_y	F_{ty}

where

A_v is the vertical earthquake acceleration coefficient, in % g;

D is the tank diameter, in feet;

F_p is the pressure combination factor;

F_{ty} is the minimum yield strength of the bottom shell course, in psi;

F_y is the minimum yield strength of the anchor bolt or strap; bolts are limited to specified material minimum yield strength or 55,000 psi, whichever is less, in psi; anchor strap material minimum yield strength shall not exceed the minimum yield strength of the shell;

H is the tank height, in feet;

M_{WH} equals $P_{WS} \times D \times H^2/_2$, in ft-lbs;

M_{rw} is the seismic moment, in ft-lbs (see Annex E);

P_i is the design pressure, in inches of water column (see Annex F);

P_f is the failure pressure, in inches of water column (see Annex F);

P_t is the test pressure, in inches of water column (see Annex F);

P_{WR} is the wind uplift pressure on roof, in inches of water column;

P_{WS} is the wind pressure on shell, in lbs/ft^2;

t_h is the roof plate thickness (the corroded thickness when used with W_1 and nominal thickness when used with W_3), in inches;

W_1 is the dead load of shell minus any corrosion allowance and any dead load other than roof plate acting on the shell minus any corrosion allowance, in lbf;

W_2 is the dead load of shell minus any corrosion allowance and any dead load including roof plate acting on the shell minus any corrosion allowance, in lbf;

W_3 is the dead load of the shell using nominal thicknesses and any dead load other than roof plate acting on the shell using nominal thicknesses, in lbf.

[a] Failure pressure applies to tanks falling under F.1.3 only. The failure pressure shall be calculated using nominal thicknesses.

[b] Refer to 5.2.2 concerning the pressure combination factor applied to the design pressure.

[c] Frangibility pressure applies only to tanks designed to 5.10.2.6 d. The frangibility pressure shall be calculated using nominal thicknesses.