Table 5-21a—(SI) Uplift Loads

Uplift Load Case	Net Uplift Formula, U (N)	Allowable Anchor Bolt Stress (MPa)	Allowable Shell Stress at Anchor Attachment (MPa)
Design Pressure	$[(P - 0.08t_h) \times D^2 \times 785] - W_1$	105	140
Test Pressure	$[(P_t - 0.08t_h) \times D^2 \times 785] - W_1$	140	170
Failure Pressure[a]	$[(1.5 \times P_f - 0.08t_h) \times D^2 \times 785] - W_3$	F_y	F_{ty}
Wind Load	$P_{WR} \times D^2 \times 785 + [4 \times (M_w/D)] - W_2$	$0.8 \times F_y$	170
Seismic Load	$[4 \times (M_s/D)] - W_2 (1 - 0.4A_V)$	$0.8 \times F_y$	170
Design Pressure[b] + Wind	$[(0.4P + P_{WR} - 0.08t_h) \times D^2 \times 785] + [4(M_w/D)] - W_1$	140	170
Design Pressure[b] + Seismic	$[(0.4P - 0.08t_h) \times D^2 \times 785] + [4(M_s/D)] - W_1 (1 - 0.4A_V)$	$0.8 \times F_y$	170
Frangibility Pressure[c]	$[(3 \times P_f - 0.08t_h) \times D^2] - W_3$	F_y	F_{ty}

where

A_v = vertical earthquake acceleration coefficient, % g
D = tank diameter in (m)
F_{ty} = minimum yield strength of the bottom shell course (MPa)
F_y = minimum yield strength of the anchor bolt (MPa)
H = tank height in (m)
M_{WH} = $P_{WS} \times D \times H^2/2$ (N-m)
M_s = seismic moment in (N-m) (see Appendix E)
P = design pressure in (kPa) (see Appendix F)
P_f = failure pressure in (kPa) (see Appendix F)
P_t = test pressure in (kPa) (see Appendix F)
P_{WR} = wind uplift pressure on roof in (kPa)
P_{WS} = wind pressure on shell in (N/m^2)
t_h = roof plate thickness (mm)
W_1 = dead load of shell minus any corrosion allowance and any dead load other than roof plate acting on the shell minus any corrosion allowance (kN)
W_2 = dead load of shell minus any corrosion allowance and any dead load including roof plate acting on the shell minus any corrosion allowance (kN)
W_3 = dead load of the shell using as-built thicknesses and any dead load other than roof plate acting on the shell using as-built thicknesses (kN)

[a]Failure pressure applies to tanks falling under F.1.3 only. The failure pressure shall be calculated using as-built thicknesses.
[b]Refer to note R.2 in Appendix R for Purchaser guidance when specifying the 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 as-built thicknesses.

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M_{WH}
M_{rw}
M_{rw}
M_{WH}
M_{rw}
FRANGIBILITY PRESSURE[c] $[(3 \times P_f - 0.08t_h) \times D^2 \times 785] - W_3$

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Table 5-21b—(USC) Uplift Loads

Uplift Load Case	Net Uplift Formula, U (lbf)	Allowable Anchor Bolt Stress (lbf/in.^{2})	Allowable Anchor Bolt Stress at Anchor Attachment (lbf/in.^{2})
Design Pressure	$[(P - 8t_h) \times D^2 \times 4.08] - W_1$	15,000	20,000
Test Pressure	$[(P_t - 8t_h) \times D^2 \times 4.08] - W_1$	20,000	25,000
Failure Pressure[a]	$[(1.5 \times P_f - 8t_h) \times D^2 \times 4.08] - W_3$	F_y	F_{ty}
Wind Load	$P_{WR} \times D^2 \times 4.08 + [4 \times (M_s/D)] - W_2$	$0.8 \times F_y$	25,000
Seismic Load	$[4 \times (M_s/D)] - W_2 (1 - 0.4A_V)$	$0.8 \times F_y$	25,000
Design Pressure[b] + Wind	$[(0.4P + P_{WR} - 0.08t_h) \times D^2 \times 4.08] + [4 M_{WH}/D] - W_1$	20,000	25,000
Design Pressure[b] + Seismic	$[(0.4P - 0.08t_h) \times D^2 \times 4.08] + [4(M_s/D)] - W_1 (1 - 0.4A_V)$	$0.8 \times F_y$	25,000
Frangibility Pressure[c]	$[(3 \times P_f - 0.08t_h) \times D^2] - W_3$	F_y	F_{ty}

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where

A_v = vertical earthquake acceleration coefficient, % g
D = tank diameter in (ft)
F_{ty} = minimum yield strength of the bottom shell course (psi)
F_y = minimum yield strength of the anchor bolt (psi)
H = tank height in (ft)
M_{WH} = $P_{WS} \times D \times H^2/2$ (ft-lbs)
M_s = seismic moment in (N-m) (see Appendix E)
P = design pressure in inches of water column (see Appendix F)
P_f = failure pressure in inches of water column (see Appendix F)
P_t = test pressure in inches of water column (see Appendix F)
P_{WR} = wind uplift pressure on roof in inches of water column
P_{WS} = wind pressure on shell in (lbs/ft^2)
t_h = roof plate thickness in (in.)
W_1 = dead load of shell minus any corrosion allowance and any dead load other than roof plate acting on the shell minus any corrosion allowance (lbf)
W_2 = dead load of shell minus any corrosion allowance and any dead load including roof plate acting on the shell minus any corrosion allowance (lbf)
W_3 = dead load of the shell using as-built thicknesses and any dead load other than roof plate acting on the shell using as-built thicknesses (lbf)

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

[b]Refer to note R.2 in Appendix R for Purchaser guidance when specifying the 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 as-built thicknesses.

FRANGIBILITY PRESSURE[c] $[(3 \times P_f - 8t_h) \times D^2 \times 4.08] - W_3$