Table of Contents

No Warnings!!

Project Design Data and Summary

Back

Project Data

Job : 2024-09-14-06-15
Date of Calcs. : 17-Sep-2024
Mfg. or Insp. Date :
Designer : Melior
Project :
Tag ID : Q9027 API
Plant :
Plant Location :
Site :
Design Basis : API-650 13th Edition Errata 1, 2021
Annexes Used : E, F, J, M, S

Design Parameters and Operating Conditions

Design Parameters

Design Internal Pressure = 2.5 psi or 69.2017 inh2o
Design External Pressure = -0 psi or -0 inh2o

D of Tank = 10 ft
OD of Tank = 10 ft
ID of Tank = 9.9688 ft
CL of Tank = 9.9844 ft
Shell Height = 16 ft
S.G of Contents = 1.05
S.G of Hydrotest = 1
Hydrotest Liquid Level = 15 ft
Max Design Liq. Level = 15 ft
Max Operating Liq. Level = 15 ft
Min Liq. Level = 1 ft
Design Temperature = 120 ºF
MDMT (Minimum Design Metal Temperature) = -20 ºF
Tank Joint Efficiency = 0.7
Ground Snow Load = 0 psf
Roof Live Load = 20 psf
Additional Roof Dead Load = 0 psf

Appendix F Data

Failure pressure (Pf) = 4.7882 psi
Maximum design pressure (P_max) = 2.5 psi

Wind Load Basis: ASCE 7-05
3 Second Gust Wind Speed (entered), Vg = 110 mph

Wind Importance Factor, Iw = 1
Design Wind Speed, V = Vg * SQRT(Iw) = 110 mph

Seismic Method: API-650 - ASCE7 Mapped(Ss & S1)
Seismic Use Group = I
Site Class = D
T_L (sec) = 12
Ss (g) = 0.223
S1 (g) = 0.084
Av (g) = 0.111
Q = 0.6667
Importance Factor = 1

Design Remarks

Summary Results

Shell

Shell #	Width (in)	Material	CA (in)	JE	Min Yield Strength (psi)	Tensile Strength (psi)	Reduction Factor	Sd (psi)	St (psi)
1	48	A240-304	0	0.7000	29,000	75,000	1	22,500	27,000
2	48	A240-304	0	0.7000	29,000	75,000	1	22,500	27,000
3	48	A240-304	0	0.7000	29,000	75,000	1	22,500	27,000
4	48	A240-304	0	0.7000	29,000	75,000	1	22,500	27,000

(continued)

Shell #	Weight (lbf)	Weight CA (lbf)	t-min Erection (in)	t-Des (in)	t-Test (in)	t-min Seismic (in)	t-min Ext-Pe (in)	t-min (in)	t-Actual (in)
1	982	982	0.1875	0.0338	0.0292	0.0321	NA	0.1875	0.1875
2	982	982	0.1875	0.0269	0.0237	0.0258	NA	0.1875	0.1875
3	982	982	0.1875	0.0199	0.0182	0.0196	NA	0.1875	0.1875
4	982	982	0.1875	0.013	0.0127	0.0134	NA	0.1875	0.1875

(continued)

Shell #	Status
1	OK
2	OK
3	OK
4	OK

Total Weight of Shell = 3,929.6376 lbf

Roof
Type = Self Supported Conical Roof
Plates Material = A240-304
t.required = 0.1875 in
t.actual = 0.1875 in
Roof corrosion allowance = 0 in
Roof Joint Efficiency = 0.7
Plates Overlap Weight = 0 lbf
Plates Weight = 635.6869 lbf

Bottom
Type : Flat Bottom Non Annular
Bottom Material = A240-304
t.required = 0.1875 in
t.actual = 0.1875 in
Bottom corrosion allowance = 0 in
Bottom Joint Efficiency = 0.7
Total Weight of Bottom = 635.6364 lbf

Top Member
Type = Detail B
Size = L2x2x1/4
Material = A240-304
Weight = 100.0838 lbf

Anchors
Quantity = 4
Size = 1 in
Material = A36
Bolt Hole Circle Radius = 5.1458 ft

Nameplate Information

Pressure Combination Factor	0.4
Design Standard	API-650 13th Edition Errata 1, 2021
Appendices Used	E, F, J, M, S
Roof	A240-304 : 0.1875 in
Shell (1)	A240-304 : 0.1875 in
Shell (2)	A240-304 : 0.1875 in
Shell (3)	A240-304 : 0.1875 in
Shell (4)	A240-304 : 0.1875 in
Bottom	A240-304 : 0.1875 in

Anchor Chair Design Back

Anchor Chair Design per AISI T-192 Part V

a = Top Plate Width Along Shell (in)
b = Top Plate Length (in)
bmin = Top Plate Minimum Length (in)
c = Top Plate Thickness (in)
CA = Chair Corrosion Allowance (in)
c_corr = Top Plate Corroded Thickness (in)
D = Tank Nominal Diameter (ft)
d = Anchor Bolt Diameter (in)
e = Anchor Bolt Eccentricity (in)
Earthquakes-Considered = Earthquakes Considered
emin = Minimum Calculated Eccentricity (in)
emin-btm = Minimum Eccentricity Based on Bolt Clearance From Bottom Plates per *API-650 5.12.4* (in)
emin-req = Minimum Required Eccentricity (in)
Et = Bottom Plates Thermal Expansion Coefficient per *API-650 Table P.1b* (in/in.fdeg)
f = Top Plate Outside To Hole Edge Distance (in)
f_min = Distance from Outside of Top Plate to Edge of Hole per *AISI T-192 Part V, Notation* (in)
g = Vertical Plates Distance (in)
g_min = Minimum Distance Between Vertical Plates per *AISI T-192, PartV, Notation* (in)
h = Chair Height (in)
h-eff = Effective Chair Height (in)
hmax = Chair Maximum Height (in)
j = Vertical Plate Thickness (in)
j_corr = Vertical Plate Corroded Thickness (in)
j_min = Vertical Plate Minimum Thickness per *AISI T-192 Part V, Vertical Side Plates* (in)
k = Vertical Plates Average Width (in)
m = Base or Bottom Plate Thickness (in)
Ma-chair = Chair Material
outside-projection = Bottom Outside Projection (in)
R = Nominal Shell Radius (in)
Ssw-chair = Chair Allowable Stress for Seismic or Wind Design per *API-650 5.12.9* (psi)
T = Difference between ambient and design temperature per *API 650 5.12.4* (°F)
t = Shell Thickness (in)
T_ambient = Ambient Temperature (°F)
T_design = Design Temperature (°F)
V = Wind Velocity (mph)
Y-bolt = Anchor Bolt Yield Load (lbf)

a = 8 in
b = 8 in
c = 0.5 in

CA = 0 in
d = 1 in
D = 10.0 ft
e = 1.75 in
Earthquakes-Considered = ASCE7-MAPPED-SS-AND-S1
Et = 6.67E-6 in/in.fdeg
f = 4.25 in
g = 4.25 in
h = 12 in
j = 0.5 in
k = 4.4417 in
m = 0.1875 in
Ma-chair = A240-304
outside-projection = 1 in
R = 60.0 in
t = 0.1875 in
T_ambient = 70 °F
T_design = 120 °F
V = 110.0 mph
Y-bolt = 19,831.7945 lbf

Anchor Chair Material Properties
Material = A240-304
Minimum Tensile Strength (Sut-chair) = 75,000 psi
As per API-650 S.5.b, Minimum Yield Strength (Sy-chair) = 29,000 psi
As per API-650 S.2b, Allowable Design Stress (Sd-chair) = 22,500 psi
As per API-650 S.2b, Allowable Hydrostatic Test Stress (St-chair) = 27,000 psi

Ssw-chair = 1.33 * Sd-chair
Ssw-chair = 1.33 * 22,500
Ssw-chair = 29,925 psi

Size Requirements
c_corr = c - (2 * CA)
c_corr = 0.5 - (2 * 0)
c_corr = 0.5 in

j_corr = j - (2 * CA)
j_corr = 0.5 - (2 * 0)
j_corr = 0.5 in

Chair Minimum Height (hmin) = 12 in

h >= hmin ==> PASS

Appurtenances Design Back

Plan View

LABEL	MARK	CUST. MARK	DESCRIPTION	OUTSIDE PROJ (in)	INSIDE PROJ (in)	ORIENT	RADIUS (in)	REMARKS	REF DWG
Circular-Manway-0001	RM01A	M1	24" ROOF MANWAY	8"	1"	270 '	2'-9"		
Nozzle-0001	RN01A	A	8" ROOF NOZZLE	6"	1"	20 '	3'-4"		
Nozzle-0002	RN02A	B	2" ROOF NOZZLE	6"	1"	90 '	3'-4"	W/ BLIND	
Nozzle-0004	RN03A	VENT	4" ROOF NOZZLE	6"	1"	0 '	0"		
Nozzle-0005	RN04A		3" ROOF NOZZLE	6"	0"	0 '	0"		
Nozzle-0006	RN02A	B	2" ROOF NOZZLE	6"	1"	180 '	3'-4"	W/ BLIND	

Elevation View

LABEL	MARK	CUST. MARK	DESCRIPTION	OUTSIDE PROJ (in)	INSIDE PROJ (in)	ORIENT	ELEVATION (in)	REMARKS	REF DWG
Anchor-Chair-Bolts	AC01A		ANCHOR CHAIRS	--	--	SEE TABLE	--		
Name-Plate	NP01A		STD API	--	--	0 '	3'-4"		
Nozzle-0001	SN01A	FILL	6" SHELL NOZZLE	8"	0"	0 '	1'-0 1/8"		
Nozzle-0002	SN02A	OUTLET	3" SHELL NOZZLE	7"	0"	90 '	9 1/2"		
Nozzle-0003	SN03A	T1	2" SHELL NOZZLE	6"	0"	20 '	7"		
Nozzle-0004	SN03A	T2	2" SHELL NOZZLE	6"	0"	70 '	7"		
Nozzle-0005	SN03A	T3	2" SHELL NOZZLE	6"	0"	110 '	7"		

Nozzle-0006	SN04A	SAMPLE	1" SHELL NOZZLE	6"	0"	300 '	6"	

Shell Nozzle: Nozzle-0001

Repad Design

NOZZLE Description : 6 in SCH 40 TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Shell Course Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON SHELL 1 : Elevation = 1.0104 ft

COURSE PARAMETERS:
t-calc = 0.0338 in
t_cr = 0.0338 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0338 in

(SHELL NOZZLE REF. API-650 S.3.3.1, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0338 * 6.625
Required Area = 0.2238 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0338) * 6.625
Available Shell Area = 1.0184 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - CA) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.28 - 0)) + 0.1875] * (0.28 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.7322 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.2238 - 1.0184 - 0.7322
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

Nozzle Neck Material Properties
Material = A312-TP304

As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

Shell Nozzle: Nozzle-0002

Repad Design

NOZZLE Description : 3 in SCH 40S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Shell Course Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON SHELL 1 : Elevation = 0.7917 ft

COURSE PARAMETERS:
t-calc = 0.0338 in
t_cr = 0.0338 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0338 in

(SHELL NOZZLE REF. API-650 S.3.3.1, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0338 * 3.5
Required Area = 0.1183 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0338) * 3.5
Available Shell Area = 0.538 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - CA) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.216 - 0)) + 0.1875] * (0.216 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4542 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.1183 - 0.538 - 0.4542
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

Nozzle Neck Material Properties
Material = A312-TP304
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

Shell Nozzle: Nozzle-0003

Repad Design

NOZZLE Description : 2 in SCH 80S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Shell Course Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON SHELL 1 : Elevation = 0.5833 ft

COURSE PARAMETERS:
t-calc = 0.0338 in
t_cr = 0.0338 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0338 in

(SHELL NOZZLE REF. API-650 S.3.3.1, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0338 * 2.375
Required Area = 0.0802 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0338) * 2.375
Available Shell Area = 0.3651 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - CA) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.218 - 0)) + 0.1875] * (0.218 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4619 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.0802 - 0.3651 - 0.4619
A-rpr = 0 in2

Since Nozzle size <= NPS 2 (per API-650 Table 5.6 Note f), t_rpr = 0

No Reinforcement Pad required.

Nozzle Neck Material Properties
Material = A312-TP304
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

Shell Nozzle: Nozzle-0004

Repad Design

NOZZLE Description : 2 in SCH 80S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Shell Course Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON SHELL 1 : Elevation = 0.5833 ft

COURSE PARAMETERS:
t-calc = 0.0338 in
t_cr = 0.0338 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0338 in

(SHELL NOZZLE REF. API-650 S.3.3.1, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0338 * 2.375
Required Area = 0.0802 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0338) * 2.375
Available Shell Area = 0.3651 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - CA) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.218 - 0)) + 0.1875] * (0.218 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4619 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.0802 - 0.3651 - 0.4619
A-rpr = 0 in2

Since Nozzle size <= NPS 2 (per API-650 Table 5.6 Note f), t_rpr = 0

No Reinforcement Pad required.

Nozzle Neck Material Properties
Material = A312-TP304
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

Shell Nozzle: Nozzle-0005

Repad Design

NOZZLE Description : 2 in SCH 80S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Shell Course Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON SHELL 1 : Elevation = 0.5833 ft

COURSE PARAMETERS:
t-calc = 0.0338 in
t_cr = 0.0338 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0338 in

(SHELL NOZZLE REF. API-650 S.3.3.1, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0338 * 2.375
Required Area = 0.0802 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0338) * 2.375
Available Shell Area = 0.3651 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - CA) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.218 - 0)) + 0.1875] * (0.218 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4619 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.0802 - 0.3651 - 0.4619
A-rpr = 0 in2

Since Nozzle size <= NPS 2 (per API-650 Table 5.6 Note f), t_rpr = 0

No Reinforcement Pad required.

Nozzle Neck Material Properties
Material = A312-TP304
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

Shell Nozzle: Nozzle-0006

Repad Design

NOZZLE Description : 1 in SCH 80S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Shell Course Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON SHELL 1 : Elevation = 0.5 ft

COURSE PARAMETERS:
t-calc = 0.0338 in
t_cr = 0.0338 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0338 in

(SHELL NOZZLE REF. API-650 S.3.3.1, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0338 * 1.315
Required Area = 0.0444 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0338) * 1.315
Available Shell Area = 0.2021 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - CA) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.179 - 0)) + 0.1875] * (0.179 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.3235 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.0444 - 0.2021 - 0.3235
A-rpr = 0 in2

Since Nozzle size <= NPS 2 (per API-650 Table 5.6 Note f), t_rpr = 0

No Reinforcement Pad required.

Nozzle Neck Material Properties
Material = A312-TP304
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

Roof Nozzle: Nozzle-0001

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 8 in SCH 40S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Roof Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON ROOF: Elevation = 16.3174 ft

ROOF PARAMETERS:
t-calc = 0.1875 in
t_cr = 0.1875 in (Roof t-act less C.A)
t_c = 0.1875 in
t_Basis = 0.1875 in
Repad Type: Circular
Repad Size (Do): = 12.75 in

(FOR ROOF NOZZLES, REF. API-650 FIG 5-19, TABLE 5-14 AND FOOTNOTE A OF TABLE 5-14, or API-650 FIG 5-20, TABLE 5-15 AND FOOTNOTE A OF TABLE 5-15, API-650 F.2.4)

Required Area = t_Basis * D
Required Area = 0.1875 * 8.625
Required Area = 1.6172 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 8.625
Available Roof Area = 0 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - ca) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.322 - 0)) + 0.1875] * (0.322 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.9502 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 1.6172 - 0 - 0.9502
A_rpr = 0.667 in2

t_rpr = (A_rpr / (repad-min-OD - D)) + repad_CA
t_rpr = (0.667 / (12.75 - 8.625)) + 0
t_rpr = 0.1617 in

As per API-650 J.3.6.3, reinforcement pad is required since roof loads exceed 25 psf.

Reinforcement Pad is required.
Based on Roof Nozzle Size of 8"
Repad Size (OD) Must be = 18 in

Roof Nozzle: Nozzle-0002

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 2 in SCH 80 TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Roof Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON ROOF: Elevation = 16.3174 ft

ROOF PARAMETERS:
t-calc = 0.1875 in
t_cr = 0.1875 in (Roof t-act less C.A)
t_c = 0.1875 in
t_Basis = 0.1875 in
Repad Type: Circular
Repad Size (Do): = 6.5 in

(FOR ROOF NOZZLES, REF. API-650 FIG 5-19, TABLE 5-14 AND FOOTNOTE A OF TABLE 5-14, or API-650 FIG 5-20, TABLE 5-15 AND FOOTNOTE A OF TABLE 5-15, API-650 F.2.4)

Required Area = t_Basis * D
Required Area = 0.1875 * 2.375
Required Area = 0.4453 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 2.375
Available Roof Area = 0 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - ca) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.218 - 0)) + 0.1875] * (0.218 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4619 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 0.4453 - 0 - 0.4619
Required A_rpr calculated value = -0.0166 in^2 is less than zero. A_rpr will be set to zero.
A_rpr = 0 in2

t_rpr = (A_rpr / (repad-min-OD - D)) + repad_CA
t_rpr = (0 / (6.5 - 2.375)) + 0
t_rpr = 0 in

As per API-650 J.3.6.3, reinforcement pad is required since roof loads exceed 25 psf.

Reinforcement Pad is required.
Based on Roof Nozzle Size of 2"
Repad Size (OD) Must be = 7 in

Roof Nozzle: Nozzle-0004

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 4 in SCH 80 TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Roof Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON ROOF: Elevation = 16.8886 ft

ROOF PARAMETERS:
t-calc = 0.1875 in
t_cr = 0.1875 in (Roof t-act less C.A)
t_c = 0.1875 in
t_Basis = 0.1875 in
Repad Type: Circular
Repad Size (Do): = 8.5 in

(FOR ROOF NOZZLES, REF. API-650 FIG 5-19, TABLE 5-14 AND FOOTNOTE A OF TABLE 5-14, or API-650 FIG 5-20, TABLE 5-15 AND FOOTNOTE A OF TABLE 5-15, API-650 F.2.4)

Required Area = t_Basis * D
Required Area = 0.1875 * 4.5
Required Area = 0.8438 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 4.5
Available Roof Area = 0 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - ca) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.337 - 0)) + 0.1875] * (0.337 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 1.0349 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 0.8438 - 0 - 1.0349
Required A_rpr calculated value = -0.1912 in^2 is less than zero. A_rpr will be set to zero.
A_rpr = 0 in2

t_rpr = (A_rpr / (repad-min-OD - D)) + repad_CA
t_rpr = (0 / (8.5 - 4.5)) + 0
t_rpr = 0 in

As per API-650 J.3.6.3, reinforcement pad is required since roof loads exceed 25 psf.

Reinforcement Pad is required.
Based on Roof Nozzle Size of 4"
Repad Size (OD) Must be = 11 in

Roof Nozzle: Nozzle-0005

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 3 in SCH 40S TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Roof Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON ROOF: Elevation = 16.8886 ft

ROOF PARAMETERS:
t-calc = 0.1875 in
t_cr = 0.1875 in (Roof t-act less C.A)
t_c = 0.1875 in
t_Basis = 0.1875 in
Repad Type: Circular
Repad Size (Do): = 7.5 in

(FOR ROOF NOZZLES, REF. API-650 FIG 5-19, TABLE 5-14 AND FOOTNOTE A OF TABLE 5-14, or API-650 FIG 5-20, TABLE 5-15 AND FOOTNOTE A OF TABLE 5-15, API-650 F.2.4)

Required Area = t_Basis * D
Required Area = 0.1875 * 3.5
Required Area = 0.6563 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 3.5
Available Roof Area = 0 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - ca) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.216 - 0)) + 0.1875] * (0.216 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4542 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 0.6563 - 0 - 0.4542
A_rpr = 0.202 in2

t_rpr = (A_rpr / (repad-min-OD - D)) + repad_CA
t_rpr = (0.202 / (7.5 - 3.5)) + 0
t_rpr = 0.0505 in

As per API-650 J.3.6.3, reinforcement pad is required since roof loads exceed 25 psf.

Reinforcement Pad is required.
Based on Roof Nozzle Size of 3"
Repad Size (OD) Must be = 9 in

Roof Nozzle: Nozzle-0006

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 2 in SCH 80 TYPE RFSO
Material: A312-TP304

t_rpr = (Repad Required Thickness)
t_n = (Thickness of Neck)
Sd_n = (Stress of Neck Material)
Sd_s = (Stress of Roof Material)
CA = (Corrosion Allowance of Neck)

MOUNTED ON ROOF: Elevation = 16.3174 ft

ROOF PARAMETERS:
t-calc = 0.1875 in
t_cr = 0.1875 in (Roof t-act less C.A)
t_c = 0.1875 in
t_Basis = 0.1875 in
Repad Type: Circular
Repad Size (Do): = 6.5 in

(FOR ROOF NOZZLES, REF. API-650 FIG 5-19, TABLE 5-14 AND FOOTNOTE A OF TABLE 5-14, or API-650 FIG 5-20, TABLE 5-15 AND FOOTNOTE A OF TABLE 5-15, API-650 F.2.4)

Required Area = t_Basis * D
Required Area = 0.1875 * 2.375
Required Area = 0.4453 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 2.375
Available Roof Area = 0 in2

Available Nozzle Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - ca) * MIN((Sd_n/Sd_s) 1)
Available Nozzle Neck Area = 2 * [(4 * (0.218 - 0)) + 0.1875] * (0.218 - 0) * MIN((22,500/22,500) 1)
Available Nozzle Neck Area = 0.4619 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 0.4453 - 0 - 0.4619
Required A_rpr calculated value = -0.0166 in^2 is less than zero. A_rpr will be set to zero.
A_rpr = 0 in2

t_rpr = (A_rpr / (repad-min-OD - D)) + repad_CA
t_rpr = (0 / (6.5 - 2.375)) + 0
t_rpr = 0 in

As per API-650 J.3.6.3, reinforcement pad is required since roof loads exceed 25 psf.

Reinforcement Pad is required.
Based on Roof Nozzle Size of 2"
Repad Size (OD) Must be = 7 in

Roof Manway: Circular-Manway-0001

Repad Design

(Per API-650 Section 5.8.4 and other references below)
MANWAY Description : 24 in Neck Thickness 0.25
Material: A240-304

t_rpr = (Repad Required Thickness)
MOUNTED ON ROOF: Elevation = 16.4146 ft

ROOF PARAMETERS:
t-calc = 0.1875 in
t_cr = 0.1875 in (Roof t-act less C.A)
t_c = 0.1875 in
t_Basis = 0.1875 in
Repad Type: Circular
Repad Size (Do): = 40 in

(FOR ROOF MANWAY,REF. API-650 FIG 5-16, TABLE 5-13)

Required Area = t_Basis * D
Required Area = 0.1875 * 24
Required Area = 4.5 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 24
Available Roof Area = 0 in2

Available Manway Neck Area = 2 * [(4 * (t_n - CA)) + t_c] * (t_n - ca) * MIN((Sd_n/Sd_s) 1)

Available Manway Neck Area = 2 * [(4 * (0.25 - 0)) + 0.1875] * (0.25 - 0) * MIN((22,500/22,500) 1)
Available Manway Neck Area = 0.5938 in2

A-rpr = (Required Area - Available Roof Area - Available Manway Neck Area)
A-rpr = 4.5 - 0 - 0.5938
A-rpr = 3.9063 in2

t_rpr = (A_rpr / (repad-min-OD - D)) + repad_CA
t_rpr = (3.9063 / (40 - 24)) + 0
t_rpr = 0.2441 in

Reinforcement Pad is required.
Based on Roof Manway Size of 24"
Repad Size (OD) Must be = 46 in

Capacities and Weights Back

Capacity to Top of Shell (to Tank Height) : 9,341 gal
Capacity to Design Liquid Level : 8,757 gal
Capacity to Maximum Liquid Level : 8,757 gal
Working Capacity (to Normal Working Level) : 8,757 gal
Net working Capacity (Working Capacity - Min Capacity) : 8,173 gal
Minimum Capacity (to Min Liq Level) : 583 gal

Component	New Condition (lbf)	Corroded (lbf)
SHELL	3,930	3,930
ROOF	602	602
RAFTERS	0	0
GIRDERS	0	0
FRAMING	0	0
COLUMNS	0	0
TRUSS	0	0
STRUCTURE COMPONENTS	0	0
BOTTOM	635	635
STAIRWAYS	0	0
ACCESS	0	0
STIFFENERS	101	101
WIND GIRDERS	0	0
ANCHOR CHAIRS	62	62
SHELL APPURTENANCES	70	70
ROOF APPURTENANCES	457	457
BOTTOM APPURTENANCES	0	0
INSULATION	0	0
FLOATING ROOF	0	0
TOTAL	5,858.1886	5,858.1886

Weight of Tank, Empty : 5,858.1886 lbf
Weight of Tank, Full of Product (Design SG = 1.05) : 83,081.1886 lbf
Weight of Tank, Full of Water : 79,404.3257 lbf
Net Working Weight, Full of Product (Design SG = 1.05) : 77,933.4029 lbf
Net Working Weight Full of Water : 74,501.2499 lbf

Foundation Area Req'd : 81.1796 ft2
Foundation Loading, Empty : 72.1632 lbf/ft2
Foundation Loading, Full of Product Design : 1,023.4241 lbf/ft2
Foundation Loading, Full of Water : 978.1311 lbf/ft2

SURFACE AREAS
Roof : 81.186 ft2
Shell : 501.084 ft2
Bottom : 81.1796 ft2