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Project Design Data and Summary

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Project Data

Job : 2025-06-19-00-40
Date of Calcs. : 20-Jun-2025
Mfg. or Insp. Date :
Designer : Melior
Project :
Tag ID : Q9270 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 = 0.1084 psi or 3 inh2o
Design External Pressure = -0.0361 psi or -1 inh2o

D of Tank = 10 ft
OD of Tank = 10.0313 ft
ID of Tank = 10 ft
CL of Tank = 10.0156 ft
Shell Height = 30 ft
S.G of Contents = 1.1
S.G of Hydrotest = 1
Hydrotest Liquid Level = 30 ft
Max Design Liq. Level = 30 ft
Max Operating Liq. Level = 30 ft
Min Liq. Level = 1 ft
Design Temperature = 375 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) = 3.6067 psi
Maximum design pressure (P_max) = 2.2841 psi

Wind Load Basis: ASCE 7-16
3 Second Gust Wind Speed (entered), Vg = 105 mph

Design Wind Speed, V = Vg = 105 mph

Seismic Method: API-650 - ASCE7 Mapped(Ss & S1)
Seismic Use Group = II
Site Class = C
T_L (sec) = 12
Ss (g) = 0.24
S1 (g) = 0.093
Av (g) = 0.0896
Q = 0.6667
Importance Factor = 1.25

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	60	A240-316	0	0.7000	21,875	75,000	0.8575	19,725	27,000
2	60	A240-316	0	0.7000	21,875	75,000	0.8575	19,725	27,000
3	60	A240-316	0	0.7000	21,875	75,000	0.8575	19,725	27,000
4	60	A240-316	0	0.7000	21,875	75,000	0.8575	19,725	27,000
5	60	A240-316	0	0.7000	21,875	75,000	0.8575	19,725	27,000
6	59.375	A240-316	0	0.7000	21,875	75,000	0.8575	19,725	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	1,228	1,228	0.1875	0.0601	0.0399	0.0646	NA	0.1875	0.1875
2	1,228	1,228	0.1875	0.0497	0.033	0.0539	NA	0.1875	0.1875
3	1,228	1,228	0.1875	0.0394	0.0261	0.0431	NA	0.1875	0.1875
4	1,228	1,228	0.1875	0.029	0.0193	0.0324	NA	0.1875	0.1875
5	1,228	1,228	0.1875	0.0186	0.0124	0.0218	NA	0.1875	0.1875
6	1,215	1,215	0.1875	0.0083	0.0055	0.0111	NA	0.1875	0.1875

(continued)

Shell #	Status
1	OK

2	OK
3	OK
4	OK
5	OK
6	OK

Total Weight of Shell = 7,378.2999 lbf

Roof

Type = Self Supported Conical Roof
Plates Material = A240-316
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 = 639.6276 lbf

Bottom

Type : Flat Bottom Non Annular
Bottom Material = A240-316
t.required = 0.1875 in
t.actual = 0.1875 in
Bottom corrosion allowance = 0 in
Bottom Joint Efficiency = 0.7
Total Weight of Bottom = 639.55 lbf

Top Member

Type = Detail B
Size = L2x2x1/4
Material = A240-316
Weight = 100.397 lbf

Anchors

Quantity = 4
Size = 1 in
Material = A36
Bolt Hole Circle Radius = 5.1822 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	A240-316 : 0.1875 in
Shell (1)	A240-316 : 0.1875 in
Shell (2)	A240-316 : 0.1875 in
Shell (3)	A240-316 : 0.1875 in

Shell (4)	A240-316 : 0.1875 in
Shell (5)	A240-316 : 0.1875 in
Shell (6)	A240-316 : 0.1875 in
Bottom	A240-316 : 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 = 10.0 in
b = 10.0 in
c = 0.50 in

CA = 0.0 in
d = 1.0 in
D = 10.0 ft
e = 2.0 in
Earthquakes-Considered = ASCE7-MAPPED-SS-AND-S1
Et = 7.070e-6 in/in.fdeg
f = 6.0 in
g = 4.250 in
h = 14.0 in
j = 0.56250 in
k = 5.47902 in
m = 0.18750 in
Ma-chair = A240-316
outside-projection = 1.0 in
R = 60.0 in
t = 0.18750 in
T_ambient = 70.0 °F
T_design = 375.0 °F
V = 81.90 mph
Y-bolt = 19.8318e3 lbf

Anchor Chair Material Properties
Material = A240-316
Minimum Tensile Strength (Sut-chair) = 75.0e3 psi
As per API-650 S.5.b, Minimum Yield Strength (Sy-chair) = 21.8750e3 psi
As per API-650 S.2b, Allowable Design Stress (Sd-chair) = 19.7250e3 psi
As per API-650 S.2b, Allowable Hydrostatic Test Stress (St-chair) = 27.0e3 psi

Ssw-chair = 1.33 * Sd-chair
Ssw-chair = 1.33 * 19.7250e3
Ssw-chair = 26.2342e3 psi

Size Requirements
c_corr = c - (2 * CA)
c_corr = 0.50 - (2 * 0.0)
c_corr = 0.50 in

j_corr = j - (2 * CA)
j_corr = 0.56250 - (2 * 0.0)
j_corr = 0.56250 in

Chair Minimum Height (hmin) = 12.0 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
Agitator-Bridge	AB01		AGITATOR BRIDGE	--	--	0 '	--		
M1	RM01A		24" ROOF MANWAY	10"	1"	270 '	3'-4"		
N1	RN01A		6" ROOF NOZZLE	6"	1"	0 '	3'-9"		
N2	RN01A		6" ROOF NOZZLE	6"	1"	45 '	3'-9"		
N3	RN01A		6" ROOF NOZZLE	6"	1"	90 '	3'-9"		
N4	RN01A		6" ROOF NOZZLE	6"	1"	135 '	3'-9"		

Elevation View

LABEL	MARK	CUST. MARK	DESCRIPTION	OUTSIDE PROJ (in)	INSIDE PROJ (in)	ORIENT	ELEVATION (in)	REMARKS	REF DWG
Agitator-Bridge	AB01		AGITATOR BRIDGE	--	--	0 '	2'-5"		
Anchor-Chair-Bolts	AC01A		ANCHOR CHAIRS	--	--	SEE TABLE	--		
M2	SM01A		24" SHELL MANWAY	10"	1"	325 '	2'-6"	W/ DAVIT	
N5	SN01A		6" SHELL NOZZLE	8"	1"	0 '	1'-0 1/8"		
N6	SN01A		6" SHELL NOZZLE	8"	1"	45 '	1'-0 1/8"		
N7	SN01A		6" SHELL NOZZLE	8"	1"	90 '	1'-0 1/8"		
N8	SN01A		6" SHELL NOZZLE	8"	1"	135 '	1'-0 1/8"		

N9	SN02A		3" SHELL NOZZLE	7"	1"	180 '	9 1/2"	
N10	SN02A		3" SHELL NOZZLE	7"	1"	160 '	9 1/2"	
N11	SN02A		3" SHELL NOZZLE	7"	1"	220 '	9 1/2"	
N12	SN02A		3" SHELL NOZZLE	7"	1"	240 '	9 1/2"	
Name-Plate	NP01A		STD API	--	--	0 '	3'-4"	

Shell Nozzle: N5

Repad Design

NOZZLE Description : 6 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 6.625
Required Area = 0.4279 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 6.625
Available Shell Area = 0.8143 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.4279 - 0.8143 - 0.7322

A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 6.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N6

Repad Design

NOZZLE Description : 6 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 6.625
Required Area = 0.4279 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 6.625
Available Shell Area = 0.8143 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.4279 - 0.8143 - 0.7322
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 6.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N7

Repad Design

NOZZLE Description : 6 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 6.625
Required Area = 0.4279 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 6.625
Available Shell Area = 0.8143 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.4279 - 0.8143 - 0.7322
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 6.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for

Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N8

Repad Design

NOZZLE Description : 6 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 6.625
Required Area = 0.4279 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 6.625
Available Shell Area = 0.8143 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.4279 - 0.8143 - 0.7322
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 6.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N9

Repad Design

NOZZLE Description : 3 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 3.5
Required Area = 0.2261 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 3.5
Available Shell Area = 0.4302 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.4542 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.2261 - 0.4302 - 0.4542
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 3.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N10

Repad Design

NOZZLE Description : 3 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 3.5
Required Area = 0.2261 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 3.5
Available Shell Area = 0.4302 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.4542 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.2261 - 0.4302 - 0.4542
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 3.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N11

Repad Design

NOZZLE Description : 3 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 3.5
Required Area = 0.2261 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 3.5
Available Shell Area = 0.4302 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.4542 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.2261 - 0.4302 - 0.4542
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 3.0 in
Group = None

t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Nozzle: N12

Repad Design

NOZZLE Description : 3 in SCH 40S TYPE RFSO
Material: A312-TP316

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 = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

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

Required Area = t_Basis * D
Required Area = 0.0646 * 3.5
Required Area = 0.2261 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 3.5
Available Shell Area = 0.4302 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((19,725/19,725) 1)
Available Nozzle Neck Area = 0.4542 in2

A-rpr = (Required Area - Available Shell Area - Available Nozzle Neck Area)
A-rpr = 0.2261 - 0.4302 - 0.4542
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Nozzle Neck Material Properties
Material = A312-TP316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 3.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Shell Manway: M2

Repad Design

MANWAY Description : 24 in Neck Thickness 0.25
Material: A240-316

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 = 2.5 ft

COURSE PARAMETERS:
t-calc = 0.0646 in
t_cr = 0.0646 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0646 in

(SHELL MANWAY REF. API-650 TABLE 5-6, AND FOOTNOTE A OF TABLE 5-7)

Required Area = t_Basis * D
Required Area = 0.0646 * 24
Required Area = 1.5501 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0646) * 24
Available Shell Area = 2.9499 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((19,725/19,725) 1)
Available Manway Neck Area = 0.5938 in2

A-rpr = (Required Area - Available Shell Area - Available Manway Neck Area)
A-rpr = 1.5501 - 2.9499 - 0.5938
A-rpr = 0 in2

Since A_rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

t_shell_PWHT = Thickness of the shell plate, insert plate, or thickened insert plate for PWHT (in)

Manway Neck Material Properties
Material = A240-316
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 19.7250e3 psi

t_shell_PWHT = t-plate
t_shell_PWHT = 0.18750
t_shell_PWHT = 0.18750 in

Thermal Stress Relief (PWHT) Requirements
D = Nozzle Nominal Diameter (NPS) (in)
Group = Shell Material Group
t_shell = Shell Plate Thickness (in)

D = 24.0 in
Group = None
t_shell = 0.18750 in

Shell material group (None) is not a group specified by API 650, 13th Ed, Section 5.7.4. Requirement for Thermal Stress Relief (PWHT) is unknown.

Cover Plate and Bolting Flange Design

CA-cover = Cover Plate and Bolting Flange Corrosion Allowance (in)
Db = Bolt Circle Diameter (in)
H = Design Liquid Level (ft)
M = Cover Plate Thickness Multiplication Factor per *API-650 S.3.3.3*
M = Bolting Flange Thickness Multiplication Factor per *API-650 S.3.3.3*
Ma-cover = Cover Plate Material
Ma-flange = Bolting Flange Material
Sd = Allowable Stress per *API-650 5.7.5.6* (psi)
SG = Product Specific Gravity
tc = Cover Plate Thickness (in)
tc-design = Cover Plate Required Thickness per *API-650 5.7.5.6* (in)
tc-req = Cover Plate Minimum Required Thickness (in)
tf = Bolting Flange Thickness (in)
tf-design = Cover Plate Required Thickness per *API-650 5.7.5.6* (in)
tf-req = Bolting Flange Minimum Required Thickness (in)
t-neck = Neck Thickness (in)

CA-cover = 0.0 in
Db = 30.250 in

H = 30.0 ft
Ma-cover = A240-316
Ma-flange = A240-316
SG = 1.10
tc = 0.6250 in
tf = 0.50 in
t-neck = 0.250 in

Water Density (Y) = 0.4330 psi/ft
As per API-650 5.7.5.6, Coefficient For Circular Plate (C) = 0.30

Cover Plate Material Properties and Required Thickness
Material = A240-316
As per API-650 S.5.b, Minimum Yield Strength at Ambient Temperature (Sy-ambient-cover) = 30.0e3 psi
As per API-650 S.5.b, Minimum Yield Strength (Sy-cover) = 21.8750e3 psi
Thickness for MDMT-permissible-cover (per API-650 Figure 4.3) = 0.156250 in

Sd = MIN(Sy-ambient-cover , 30000) / 2 = 15.0e3 psi

M = MAX(SQRT((Sy-ambient-cover / Sy-cover)) , SQRT((30000 / Sy-cover)) , 1) = 1.17108

As per API-650 5.7.5.6, Cover Plate Erection Thickness (tc-erec) = 0.31250 in

tc-design = ((Db * SQRT(((C * Y * H * MAX(SG , 1)) / Sd))) + CA-cover) * M
tc-design = ((30.250 * SQRT(((0.30 * 0.4330 * 30.0 * MAX(1.10 , 1)) / 15.0e3))) + 0.0) * 1.17108
tc-design = 0.598864 in

tc-req = MAX(tc-erec , tc-design)
tc-req = MAX(0.31250 , 0.598864)
tc-req = 0.598864 in

t-cover >= tc-req ==> PASS

Bolting Flange Material Properties and Required Thickness
Material = A240-316
As per API-650 S.5.b, Minimum Yield Strength at Ambient Temperature (Sy-ambient-flange) = 30.0e3 psi
As per API-650 S.5.b, Minimum Yield Strength (Sy-flange) = 21.8750e3 psi
Thickness for MDMT-permissible-flange (per API-650 Figure 4.3) = 0.250 in

M = MAX(SQRT((Sy-ambient-flange / Sy-flange)) , SQRT((30000 / Sy-flange)) , 1) = 1.17108

As per API-650 5.7.5.6, Bolting Flange Erection Thickness (tf-erec) = 0.250 in

tf-design = tc-design - 0.125
tf-design = 0.598864 - 0.125
tf-design = 0.473864 in

tf-req = MAX(tf-erec , tf-design)
tf-req = MAX(0.250 , 0.473864)
tf-req = 0.473864 in

t-flange >= tf-req ==> PASS

Roof Nozzle: N1

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 6 in SCH 40 TYPE RFSO
Material: A312-TP316

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 = 30.2558 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

(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)

Required Area = t_Basis * D
Required Area = 0.1875 * 6.625
Required Area = 1.2422 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 6.625
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 * (0.28 - 0)) + 0.1875] * (0.28 - 0) * MIN((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 1.2422 - 0 - 0.7322
A_rpr = 0.51 in2

As per API-650 J.3.6.3, reinforcement pad is not required since roof loads do not exceed 25 psf.

No Reinforcement Pad required.

Roof Nozzle: N2

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 6 in SCH 40 TYPE RFSO
Material: A312-TP316

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 = 30.2558 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

(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)

Required Area = t_Basis * D
Required Area = 0.1875 * 6.625
Required Area = 1.2422 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 6.625
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 * (0.28 - 0)) + 0.1875] * (0.28 - 0) * MIN((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 1.2422 - 0 - 0.7322
A_rpr = 0.51 in2

As per API-650 J.3.6.3, reinforcement pad is not required since roof loads do not exceed 25 psf.

No Reinforcement Pad required.

Roof Nozzle: N3

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 6 in SCH 40 TYPE RFSO
Material: A312-TP316

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 = 30.2558 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

(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)

Required Area = t_Basis * D
Required Area = 0.1875 * 6.625
Required Area = 1.2422 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 6.625
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 * (0.28 - 0)) + 0.1875] * (0.28 - 0) * MIN((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 1.2422 - 0 - 0.7322
A_rpr = 0.51 in2

As per API-650 J.3.6.3, reinforcement pad is not required since roof loads do not exceed 25 psf.

No Reinforcement Pad required.

Roof Nozzle: N4

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 6 in SCH 40 TYPE RFSO
Material: A312-TP316

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 = 30.2558 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

(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)

Required Area = t_Basis * D
Required Area = 0.1875 * 6.625
Required Area = 1.2422 in2

Available Roof Area = (t_c - t_Basis) * D
Available Roof Area = (0.1875 - 0.1875) * 6.625
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 * (0.28 - 0)) + 0.1875] * (0.28 - 0) * MIN((19,725/19,725) 1)
Available Nozzle Neck Area = 0.7322 in2

A_rpr = (Required Area - Available Roof Area - Available Nozzle Neck Area)
A_rpr = 1.2422 - 0 - 0.7322
A_rpr = 0.51 in2

As per API-650 J.3.6.3, reinforcement pad is not required since roof loads do not exceed 25 psf.

No Reinforcement Pad required.

Roof Manway: M1

Repad Design

(Per API-650 Section 5.8.4 and other references below)
MANWAY Description : 24 in Neck Thickness 0.25
Material: A240-316

t_rpr = (Repad Required Thickness)
MOUNTED ON ROOF: Elevation = 30.3252 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

(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((19,725/19,725) 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

As per API-650 J.3.6.3, since roof loads does not exceed 25 psf, t_rpr = 0

No Reinforcement Pad required.

Capacities and Weights Back

Capacity to Top of Shell (to Tank Height) : 17,625 gal
Capacity to Design Liquid Level : 17,625 gal
Capacity to Maximum Liquid Level : 17,625 gal
Working Capacity (to Normal Working Level) : 0 gal
Net working Capacity (Working Capacity - Min Capacity) : 0 gal
Minimum Capacity (to Min Liq Level) : 587 gal

Component	New Condition (lbf)	Corroded (lbf)
SHELL	7,379	7,379
ROOF	634	634
RAFTERS	0	0
GIRDERS	0	0
FRAMING	0	0
COLUMNS	0	0
TRUSS	0	0
STRUCTURE COMPONENTS	0	0
BOTTOM	626	626
STAIRWAYS	0	0
ACCESS	0	0
STIFFENERS	101	101
WIND GIRDERS	0	0
AGITATOR BRIDGE	1,000	1,000
ANCHOR CHAIRS	95	95
SHELL APPURTENANCES	498	498
ROOF APPURTENANCES	260	260
BOTTOM APPURTENANCES	0	0
INSULATION	0	0
FLOATING ROOF	0	0
TOTAL	10,594.4152	10,594.4152

Weight of Tank, Empty : 10,594.4152 lbf
Weight of Tank, Full of Product (Design SG = 1.1) : 172,396.4152 lbf
Weight of Tank, Full of Water : 157,686.6893 lbf
Net Working Weight, Full of Product (Design SG = 1.1) : 167,002.5333 lbf
Net Working Weight Full of Water : 152,783.6135 lbf

Foundation Area Req'd : 81.6794 ft2
Foundation Loading, Empty : 129.7072 lbf/ft2
Foundation Loading, Full of Product Design : 2,110.6461 lbf/ft2
Foundation Loading, Full of Water : 1,930.5552 lbf/ft2

SURFACE AREAS
Roof : 81.6893 ft2
Shell : 942.4777 ft2