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Warnings!!

Shell Nozzles

SUCTION
1.- Start Elevation is less than min elevation per table 5.6.

Project Design Data and Summary

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Project Data

Job : 2024-08-23-00-09
Date of Calcs. : 26-Aug-2024
Mfg. or Insp. Date :
Designer : Melior
Project :
Tag ID : Q9003
Plant :
Plant Location :
Site :
Design Basis : API-650 13th Edition Errata 1, 2021
Annexes Used : E, J, S

Design Parameters and Operating Conditions

Design Parameters

Design Internal Pressure = 0 psi or 0 inh2o
Design External Pressure = -0 psi or -0 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 = 17 ft
S.G of Contents = 1
S.G of Hydrotest = 1
Hydrotest Liquid Level = 17 ft
Max Design Liq. Level = 17 ft
Max Operating Liq. Level = 17 ft
Min Liq. Level = 1 ft
Design Temperature = 100 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

Wind Load Basis: ASCE 7-05
3 Second Gust Wind Speed (entered), Vg = 109 mph

Wind Importance Factor, Iw = 1
Design Wind Speed, V = Vg * SQRT(Iw) = 109 mph

Seismic Method: API-650 - ASCE7 Mapped(Ss & S1)
Seismic Use Group = II
Site Class = C
T_L (sec) = 12
Ss (g) = 0.121
S1 (g) = 0.049
Av (g) = 0.0452
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)	Sd (psi)	St (psi)	Weight (lbf)
1	60	A240-304	0	0.7000	30,000	75,000	22,500	27,000	1,228
2	48	A240-304	0	0.7000	30,000	75,000	22,500	27,000	982
3	48	A240-304	0	0.7000	30,000	75,000	22,500	27,000	982
4	48	A240-304	0	0.7000	30,000	75,000	22,500	27,000	982

(continued)

Shell #	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)	Status
1	1,228	0.1875	0.0264	0.022	0.0239	NA	0.1875	0.1875	OK
2	982	0.1875	0.0182	0.0151	0.0169	NA	0.1875	0.1875	OK
3	982	0.1875	0.0116	0.0096	0.0113	NA	0.1875	0.1875	OK
4	982	0.1875	0.005	0.0041	0.0057	NA	0.1875	0.1875	OK

Total Weight of Shell = 4,188.308 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 = 7.1487 lbf

Plates Weight = 639.6276 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 = 639.55 lbf

Top Member

Type = Detail B
Size = L2x2x1/4
Material = A240-304
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, J, 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 = 6 in
b = 8 in
c = 0.375 in

CA = 0 in
d = 1 in
D = 10 ft
e = 2 in
Earthquakes-Considered = ASCE7-MAPPED-SS-AND-S1
Et = 6.67E-6 in/in.fdeg
f = 4.0 in
g = 3 in
h = 12 in
j = 0.5 in
k = 4.4124 in
m = 0.1875 in
Ma-chair = A240-304
outside-projection = 1 in
R = 60.0 in
t = 0.1875 in
T_ambient = 0 °F
T_design = 100 °F
V = 109.0 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) = 30,000 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 = 0.375 - (2 * 0)
c_corr = 0.375 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	N11	24" ROOF MANWAY	8"	1"	60 '	2'-11"		
FILL	RN02A	N5	3" ROOF NOZZLE	6"	1"	0 '	3'-9"		
LEVEL	RN02A	N8	3" ROOF NOZZLE	6"	1"	240 '	3'-9"		
LEVEL	RN02A	N12	3" ROOF NOZZLE	6"	1"	180 '	3'-9"		
PRESSURE	RN02A	N6	3" ROOF NOZZLE	6"	1"	120 '	3'-9"		
SPARE	RN01A	N4	3" ROOF NOZZLE	6"	1"	270 '	3'-9"	W/ BLIND	
VALVE	RN03A	N7	6" ROOF NOZZLE	6"	1"	0 '	0"		
VAPOR	RN02A	N10	3" ROOF NOZZLE	6"	1"	300 '	3'-9"		

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	--		
Circular-Manway-0001	SM01A	N2	24" SHELL MANWAY	11"	0"	135 '	2'-6"	W/ DAVIT	
LEVEL	SN01A	N3	3" SHELL NOZZLE	7"	0"	180 '	1'-9 1/2"		
Name-Plate	NP01A		STD API	--	--	0 '	3'-4"		

SPARE	SN02A	N14	3" SHELL NOZZLE	7"	0"	180 '	8"	W/ BLIND
SPARE	SN02A	N9	3" SHELL NOZZLE	7"	0"	270 '	8"	W/ BLIND
SUCTION	SN01A	N1	3" SHELL NOZZLE	7"	0"	0 '	1 9/16"	
TEMP	SN03A	N13	3" SHELL NOZZLE	7"	0"	342 '	8"	

Warnings!!

Shell Nozzles

SUCTION
1.- Start Elevation is less than min elevation per table 5.6.

Shell Nozzle: SUCTION

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 = 0.1302 ft

COURSE PARAMETERS:
t-calc = 0.0264 in
t_cr = 0.0264 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0264 in

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

Required Area = t_Basis * D
Required Area = 0.0264 * 3.5
Required Area = 0.0924 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0264) * 3.5

Available Shell Area = 0.5638 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 = 0.0924 - 0.5638 - 0.4542
A-rpr = 0 in2

Since A-rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

Notes:
- As per API-650 J.3.6.6, the provisions for stress relief specified in API-650 5.7.4 and 5.7.8.3 are not required

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

Shell Nozzle: LEVEL

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 = 1.7917 ft

COURSE PARAMETERS:
t-calc = 0.0264 in
t_cr = 0.0264 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0264 in

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

Required Area = t_Basis * D
Required Area = 0.0264 * 3.5
Required Area = 0.0924 in2

Available Shell Area = (t_c - t_Basis) * D

Available Shell Area = (0.1875 - 0.0264) * 3.5
Available Shell Area = 0.5638 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 = 0.0924 - 0.5638 - 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: SPARE

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 = 0.6667 ft

COURSE PARAMETERS:
t-calc = 0.0264 in
t_cr = 0.0264 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0264 in
Repad Type: Dog House
Repad Size (Do): = 10.5 in

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

Required Area = t_Basis * D
Required Area = 0.0264 * 3.5
Required Area = 0.0924 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0264) * 3.5

Available Shell Area = 0.5638 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 = 0.0924 - 0.5638 - 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

Nozzle Repad Material Properties
Material = A240-304

Shell Nozzle: TEMP

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 = 0.6667 ft

COURSE PARAMETERS:
t-calc = 0.0264 in
t_cr = 0.0264 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0264 in
Repad Type: Dog House
Repad Size (Do): = 10.5 in

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

Required Area = t_Basis * D
Required Area = 0.0264 * 3.5
Required Area = 0.0924 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0264) * 3.5
Available Shell Area = 0.5638 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 = 0.0924 - 0.5638 - 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

Nozzle Repad Material Properties
Material = A240-304

Shell Nozzle: SPARE

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 = 0.6667 ft

COURSE PARAMETERS:
t-calc = 0.0264 in
t_cr = 0.0264 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0264 in
Repad Type: Dog House
Repad Size (Do): = 10.5 in

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

Required Area = t_Basis * D
Required Area = 0.0264 * 3.5

Required Area = 0.0924 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0264) * 3.5
Available Shell Area = 0.5638 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 = 0.0924 - 0.5638 - 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

Nozzle Repad Material Properties
Material = A240-304

Shell Manway: Circular-Manway-0001

Repad Design

MANWAY Description : 24 in Neck Thickness 0.25
Material: A240-304

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 = 0.0264 in
t_cr = 0.0264 in (Course t-calc less C.A)
t_c = 0.1875 in (Course t less C.A.)
t_Basis = 0.0264 in

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

Required Area = t_Basis * D

Required Area = 0.0264 * 24
Required Area = 0.6339 in2

Available Shell Area = (t_c - t_Basis) * D
Available Shell Area = (0.1875 - 0.0264) * 24
Available Shell Area = 3.8661 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 Shell Area - Available Manway Neck Area)
A-rpr = 0.6339 - 3.8661 - 0.5938
A-rpr = 0 in2

Since A_rpr <= 0, t_rpr = 0

No Reinforcement Pad required.

Manway Neck Material Properties
Material = A240-304
As per API-650 S.2b, Allowable Design Stress (Sd-neck) = 22,500 psi

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 = Bolting Flange Thickness Multiplication Factor per *API-650 S.3.3.3*
M = Cover Plate 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)

CA-cover = 0 in
Db = 30.25 in
H = 17.0 ft
Ma-cover = A240-304
Ma-flange = A240-304
SG = 1
tc = 0.625 in
tf = 0.625 in

Water Density (Y) = 0.433 psi/ft
As per API-650 5.7.5.6, Coefficient For Circular Plate (C) = 0.3

Cover Plate Material Properties and Required Thickness
Material = A240-304

As per API-650 S.5.b, Minimum Yield Strength at Ambient Temperature (Sy-ambient-cover) = 30,000 psi
As per API-650 S.5.b, Minimum Yield Strength (Sy-cover) = 30,000 psi

Sd = MIN(Sy-ambient-cover , 30000) / 2 = 15,000 psi

M = MAX(SQRT((Sy-ambient-cover / Sy-cover)) , SQRT((30000 / Sy-cover)) , 1) = 1.0

As per API-650 5.7.5.6, Cover Plate Erection Thickness (tc-erec) = 0.3125 in

tc-design = ((Db * SQRT(((C * Y * H * MAX(SG , 1)) / Sd))) + CA-cover) * M
tc-design = ((30.25 * SQRT(((0.3 * 0.433 * 17.0 * MAX(1 , 1)) / 15,000))) + 0) * 1.0
tc-design = 0.367 in

tc-req = MAX(tc-erec , tc-design)
tc-req = MAX(0.3125 , 0.367)
tc-req = 0.367 in

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

Bolting Flange Material Properties and Required Thickness
Material = A240-304
As per API-650 S.5.b, Minimum Yield Strength at Ambient Temperature (Sy-ambient-flange) = 30,000 psi
As per API-650 S.5.b, Minimum Yield Strength (Sy-flange) = 30,000 psi

M = MAX(SQRT((Sy-ambient-flange / Sy-flange)) , SQRT((30000 / Sy-flange)) , 1) = 1.0

As per API-650 5.7.5.6, Bolting Flange Erection Thickness (tf-erec) = 0.25 in

tf-design = tc-design - 0.125
tf-design = 0.367 - 0.125
tf-design = 0.242 in

tf-req = MAX(tf-erec , tf-design)
tf-req = MAX(0.25 , 0.242)
tf-req = 0.25 in

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

Roof Nozzle: SPARE

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 = 17.2505 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 * 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

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: FILL

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 = 17.2505 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 * 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

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: PRESSURE

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 = 17.2505 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 * 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

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: VALVE

Repad Design

(Per API-650 and other references below)

NOZZLE Description : 6 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 = 17.8753 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((22,500/22,500) 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: LEVEL

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 = 17.2505 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 * 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

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: VAPOR

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 = 17.2505 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 * 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

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: LEVEL

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 = 17.2505 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 * 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

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: 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 = 17.3894 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((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

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) : 9,987 gal
Capacity to Design Liquid Level : 9,987 gal
Capacity to Maximum Liquid Level : 9,987 gal
Working Capacity (to Normal Working Level) : 9,987 gal
Net working Capacity (Working Capacity - Min Capacity) : 9,400 gal
Minimum Capacity (to Min Liq Level) : 587 gal

Component	New Condition (lbf)	Corroded (lbf)
SHELL	4,189	4,189
ROOF	647	647
RAFTERS	0	0
GIRDERS	0	0
FRAMING	0	0
COLUMNS	0	0
TRUSS	0	0
STRUCTURE COMPONENTS	0	0
BOTTOM	639	639
STAIRWAYS	0	0
ACCESS	0	0
STIFFENERS	101	101
WIND GIRDERS	0	0
ANCHOR CHAIRS	59	59
SHELL APPURTENANCES	439	439
ROOF APPURTENANCES	262	262
BOTTOM APPURTENANCES	0	0
INSULATION	0	0
FLOATING ROOF	0	0
TOTAL	6,336.5188	6,336.5188

Weight of Tank, Empty : 6,336.5188 lbf
Weight of Tank, Full of Product (Design SG = 1) : 89,688.5188 lbf
Weight of Tank, Full of Water : 89,688.8074 lbf
Net Working Weight, Full of Product (Design SG = 1) : 84,785.7316 lbf
Net Working Weight Full of Water : 84,785.7316 lbf

Foundation Area Req'd : 81.6794 ft2
Foundation Loading, Empty : 77.5778 lbf/ft2
Foundation Loading, Full of Product Design : 1,098.0548 lbf/ft2
Foundation Loading, Full of Water : 1,098.0584 lbf/ft2

SURFACE AREAS
Roof : 81.6893 ft2
Shell : 534.0707 ft2
Bottom : 81.6794 ft2