PLATINUM ENERGY SERVICES ULC

SUITE 400, 333 - 11 AVENUE S.W. CALGARY, ALBERTA T2R 1L9

Date Printed: 2/12/2016

VESSEL DESCRIPTION

TWO (2) 8'-0" OD x 30'-0" LONG TREATERS

Vessel designed with DesignCalcs, Version: 2016.1
Vessel is ASME Code Stamped

Wind Analysis performed in accordance with ASCE 7-10
Seismic Analysis performed in accordance with ASCE 7-10

Job No: 30137 & 30138
Vessel Number: 01

NAMEPLATE INFORMATION

Vessel MAWP:	75.00 PSI at 350 °F
MDMT:	-20 °F at 75.00 PSI
Serial Number(s):	30137 & 30138
National Board Number(s):	
Canadian Registration Number(s):	TBA
Year Built:	2016
Radiography:	RT 2
Postweld Heat Treated:	NONE
Construction Type :	W

Notes

BUILT IN ACCORDANCE WITH ASME SECTION VIII, DIV 1, 2015 EDITION
UG-22 LOADINGS HAVE BEEN CONSIDERED
CALCULATION NO: 30137/8-VES-01 REV 0

Signatures

BOB DAVIES: _____ Date: 16/02/12

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SUITE 400, 333 - 11 AVENUE S.W. CALGARY, ALBERTA T2R 1L9

Date Printed: 2/12/2016

Project Description

TWO (2) VESSELS

DRAWING NO'S:
30137-VES-01 REV 0
30138-VES-01 REV 0

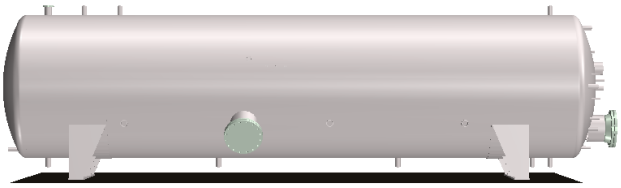
CALCULATION NO'S:
30137-VES-01 REV 0
30138-VES-01 REV 0

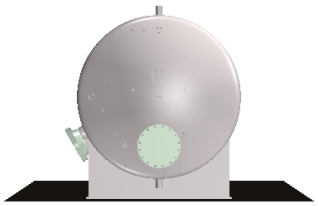
CRN DRAWING NO:
96OD-360-75-TR-1FT REV A

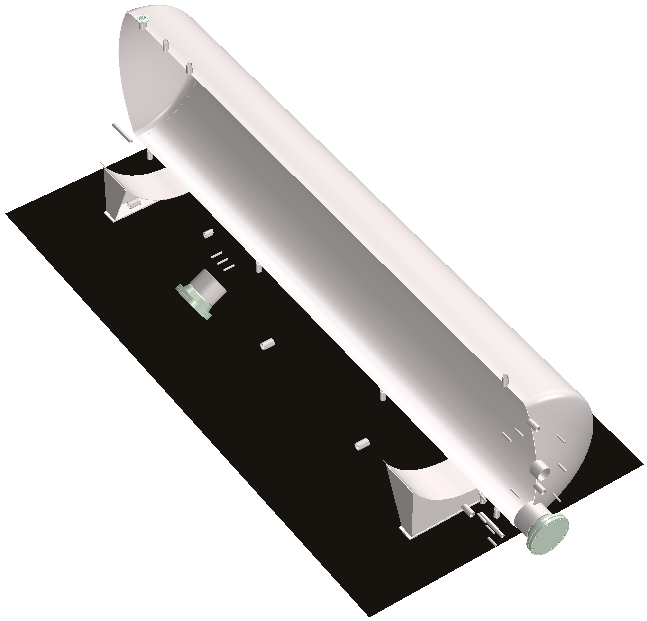
PLATINUM ENERGY SERVICES ULC

SUITE 400, 333 - 11 AVENUE S.W. CALGARY, ALBERTA T2R 1L9

Date Printed: 2/12/2016







PLATINUM ENERGY SERVICES ULC

8'-0" OD x 30'-0" LONG SHELL

Job No: 30137 & 30138 Vessel Number: 01
Number: 1 Mark Number: S1

Date Printed: 2/12/2016

Cylindrical Shell Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Long. Joint Efficiency:	100	%
Shell Material:	SA-516 Gr. 70		Factor B Chart:	CS-2	
Material Condition:	Normalized		Material Stress (hot):	20000	PSI
Shell Length:	360.0000	in.	Material Stress (cold):	20000	PSI
			Compressive Stress:	10942	PSI
Corrosion Allowance:	0.0625	in.	Actual Circumferential Stress:	12026	PSI
External Corrosion Allowance:	0.0000	in.	Actual Longitudinal Stress:	5974	PSI
Outside Diameter (new):	96.0000	in.	Extreme Fiber Elongation:	0.39	%
Outside Diameter (corroded):	96.0000	in.	Specific Gravity:	1.00	
Shell Surface Area:	753.98	Sq. Ft.	Weight of Fluid:	92780.70	lb.
Shell Estimated Volume:	11106.06	Gal.	Total Flooded Shell Weight:	104136.38	lb.
Circ. Joint Efficiency:	100	%	Shell Weight:	11355.68	lb.

Minimum Design Metal Temperature Data

Min. Temperature Curve:	D	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	No	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-55 °F

Design Thickness Calculations

Longitudinal Stress Calculations per Paragraph UG-27(c)(2)

$$t = \frac{PR}{2SE + 0.4P} = \frac{78.50 * 47.6875}{2 * 20000 * 1.00 + 0.4 * 78.50} = 0.0935 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}}$$ = minimum of **0.1560** in.

Circumferential Stress Calculations per Appendix 1-1

$$t = \frac{PR_o}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1.00 + 0.4 * 78.50} = 0.1881 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}}$$ = minimum of **0.2506** in.

External loads do not control design.

Nominal Shell Thickness Selected = **0.3750** in.

PLATINUM ENERGY SERVICES ULC

96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Job No: 30137 & 30138 Vessel Number: 01
Number: 1 Mark Number: H1

Date Printed: 2/12/2016

ASME F&D Head Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Joint Efficiency:	100	%
Head Material:	SA-516 Gr. 70		Factor B Chart:	CS-2	
Material Condition:	Normalized		Material Stress (hot):	20000	PSI
Corrosion Allowance:	0.0625	in.	Material Stress (cold):	20000	PSI
External Corrosion Allowance:	0.0000	in.	Actual Head Stress:	17654	PSI
Head Location:	Right		Straight Flange :	1.5000	in.
Outside Diameter :	96.0000	in.	Knuckle (r) :	5.7600	in.
Thin Out :	0.0000	in.			
Crown Radius (Lo) :	96.0000	in.	$M = \frac{1}{4}[3 + \sqrt{L/r}]$:	1.7631	
Extreme Fiber Elongation:	5.49	%			
Head Surface Area:	61.34	Sq. Ft.	Specific Gravity:	1.00	
Head Estimated Volume:	376.06	Gal.	Weight of Fluid:	3136.30	lb.
Head Weight:	1082.13	lb.	Total Flooded Head Weight:	4218.43	lb.

Minimum Design Metal Temperature Data

Min. Temperature Curve:	D	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	No	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-55 °F

Design Thickness Calculations

Design Thickness Calculations per Appendix 1-4(d)

$$\mathbf{t} = \frac{PL_oM}{2SE + P(M - 0.2)} = \frac{78.50 * 96.0000 * 1.7631}{2 * 20000 * 1.00 + 78.50 (1.7631 - 0.2)}$$

$= 0.3312 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0000_{\text{(thin out)}}$ = minimum of **0.3937** in.

Minimum Head Thickness Selected = **0.4375** in.

PLATINUM ENERGY SERVICES ULC

8'-0" OD FLANGED & DISHED HEAD C/W 1.5" SF (LEFT SIDE)

Job No: 30137 & 30138 Vessel Number: 01

Number: 2 Mark Number: H2

Date Printed: 2/12/2016

ASME F&D Head Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Joint Efficiency:	100	%
Head Material:	SA-516 Gr. 70		Factor B Chart:	CS-2	
Material Condition:	Normalized		Material Stress (hot):	20000	PSI
Corrosion Allowance:	0.0625	in.	Material Stress (cold):	20000	PSI
External Corrosion Allowance:	0.0000	in.	Actual Head Stress:	15121	PSI
Head Location:	Left		Straight Flange :	1.5000	in.
Outside Diameter :	96.0000	in.	Knuckle (r) :	5.7600	in.
Thin Out :	0.0000	in.			
Crown Radius (Lo) :	96.0000	in.	$M = \frac{1}{4}[3 + \sqrt{L/r}]$:	1.7628	
Extreme Fiber Elongation:	6.24	%			
Head Surface Area:	61.27	Sq. Ft.	Specific Gravity:	1.00	
Head Estimated Volume:	374.56	Gal.	Weight of Fluid:	3123.84	lb.
Head Weight:	1235.14	lb.	Total Flooded Head Weight:	4358.98	lb.

Minimum Design Metal Temperature Data

Min. Temperature Curve:	D	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	No	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-55 °F

Design Thickness Calculations

Design Thickness Calculations per Appendix 1-4(d)

$$\mathbf{t} = \frac{PL_oM}{2SE + P(M - 0.2)} = \frac{78.50 * 96.0000 * 1.7628}{2 * 20000 * 1.00 + 78.50 (1.7628 - 0.2)}$$

$= 0.3311 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0000_{\text{(thin out)}}$ = minimum of **0.3936** in.

Minimum Head Thickness Selected = **0.5000** in.

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N1)

Job No: 30137 & 30138
Number: 1
ID Number: 1

Vessel Number: 01
Mark Number: N1

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.5000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	4		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	3.8260	in.	Nozzle Wall Thickness(new):	0.3370	in.
Nozzle ID (corroded):	3.9510	in.	Nozzle Wall Thickness(corroded):	0.2745	in.
External Limit of Reinforcement:	0.6863	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.5300	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	7.9020	in.	Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

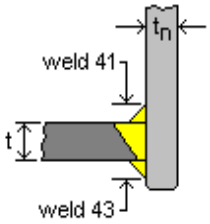


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3370 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 4 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.9755}{17100 * 1 - 0.6 * 78.50}$$ = **0.0091** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.9755}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0716** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2695** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2950** is greater than or equal to UG-45 value of **0.2506**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(3.9510, 1.9755 + 0.3125 + 0.2745) = **3.9510** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3125, 2.5 * 0.2745 + 0.0000) = **0.6863** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3125, 2.5 * 0.2120) = **0.5300** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [3.9510 * 0.1881 * 1.00 + 2 * 0.2745 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **0.7582** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 3.9510 - 3.9510) * (1.0000 * 0.3125 - 1.00 * 0.1881) - 2 * 0.2745 * (1.0000 * 0.3125 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **0.4816** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(6.0000, 0.6863) * [min(0.2745, 3.9510 - 0.5 * 3.9510) - 0.0091] * 0.8550, 0} = **0.3114** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.4375, 0.5300) * min(0.2120, 3.9510 - 0.5 * 3.9510) * 0.8550, 0} = **0.1586** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2] = **0.0698** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 1.1417 sq. in., which is **>=** A (0.7582)

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N2)

Job No: 30137 & 30138
Number: 2
ID Number: 2

Vessel Number: 01
Mark Number: N2

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350	°F
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000	in.
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375	in.
Developed Opening:	3.1760 in.		Tangential Dimension L:	39.0000	in.
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	6.6020 in.		Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

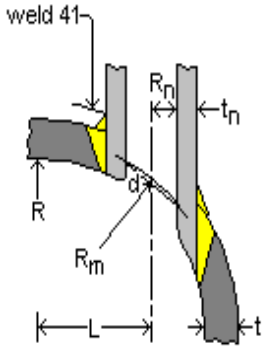


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0070} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0695} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2515** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2515** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2515**

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N3)

Job No: 30137 & 30138
Number: 3
ID Number: 3

Vessel Number: 01
Mark Number: N3

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350	°F
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000	in.
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375	in.
Developed Opening:	2.9004 in.		Tangential Dimension L:	1.6694	in.
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	6.0510 in.		Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

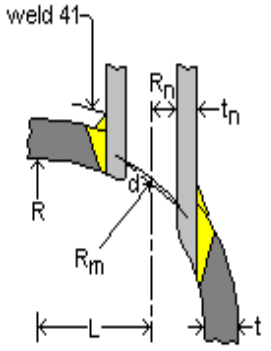


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000$$ = **0.3937** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2515** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2515** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2515**

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N4)

Job No: 30137 & 30138
Number: 4
ID Number: 4

Vessel Number: 01
Mark Number: N4

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B		Pressure at MDMT:	75.00 PSI	
UCS-66(b) reduction:	Yes		Minimum Design Metal Temperature:	-20 °F	
UCS-68(c) reduction:	No		Computed Minimum Temperature:	-155 °F	

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.3750 in.	
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.3125 in.	

Nozzle Detail Information

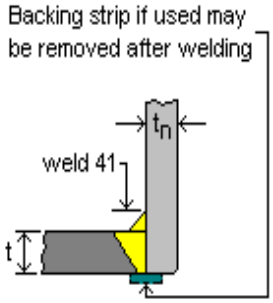


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

8" 150# RFSO (N5)

Job No: 30137 & 30138
Number: 5
ID Number: 5

Vessel Number: 01
Mark Number: N5

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	8		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	7.6250	in.	Nozzle Wall Thickness(new):	0.5000	in.
Nozzle ID (corroded):	7.7500	in.	Nozzle Wall Thickness(corroded):	0.4375	in.
Developed Opening:	7.6858	in.	Tangential Dimension L:	12.0000	in.
External Limit of Reinforcement:	0.9375	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.9375	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	15.6234	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-153 °F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375 in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750 in.

Nozzle Detail Information

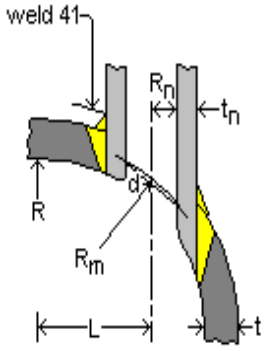


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.5000 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 8 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 3.8750}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0178} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 3.8750}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0803} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.3445** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.3445** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.3445** in.

Wall thickness = tn * 0.875(pipe) = **0.4370** is greater than or equal to UG-45 value of **0.3445**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(7.8117, 3.8750 + 0.3750 + 0.4375) = **7.8117** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3750, 2.5 * 0.4375 + 0.0000) = **0.9375** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3750, 2.5 * 0.3750) = **0.9375** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [7.8117 * 0.1881 * 1.00 + 2 * 0.4375 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **1.4932** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 7.8117 - 7.8117) * (1.0000 * 0.3750 - 1.00 * 0.1881) - 2 * 0.4375 * (1.0000 * 0.3750 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **1.4363** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(6.0000, 0.9375) * [min(0.4375, 7.8117 - 0.5 * 7.8117) - 0.0178] * 0.8550, 0} = **0.6728** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.0000, 0.9375) * min(0.3750, 7.8117 - 0.5 * 7.8117) * 0.8550, 0} = **0.0000** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} $L_{43pareff}$ $L_{43noreff}$ =
0.8550 * 0.0000 * 0.0000 = **0.0000** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 2.2294 sq. in., which is **>=** A (1.4932)

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N6A)

Job No: 30137 & 30138
Number: 6
ID Number: 6

Vessel Number: 01
Mark Number: N6A

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B		Pressure at MDMT:	75.00 PSI	
UCS-66(b) reduction:	Yes		Minimum Design Metal Temperature:	-20 °F	
UCS-68(c) reduction:	No		Computed Minimum Temperature:	-155 °F	

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.3750 in.	
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.3125 in.	

Nozzle Detail Information

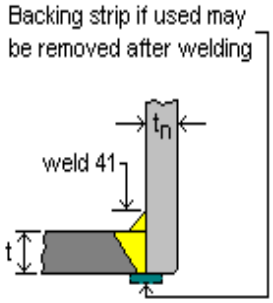


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N6A)

Job No: 30137 & 30138
Number: 6
ID Number: 6

Vessel Number: 01
Mark Number: N6A

Date Printed: 2/12/2016

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N6B)

Job No: 30137 & 30138
Number: 7
ID Number: 7

Vessel Number: 01
Mark Number: N6B

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B		Pressure at MDMT:	75.00 PSI	
UCS-66(b) reduction:	Yes		Minimum Design Metal Temperature:	-20 °F	
UCS-68(c) reduction:	No		Computed Minimum Temperature:	-155 °F	

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.3750 in.	
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.3125 in.	

Nozzle Detail Information

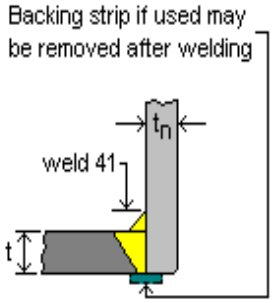


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N6B)

Job No: 30137 & 30138
Number: 7
ID Number: 7

Vessel Number: 01
Mark Number: N6B

Date Printed: 2/12/2016

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N6C)

Job No: 30137 & 30138
Number: 8
ID Number: 8

Vessel Number: 01
Mark Number: N6C

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B		Pressure at MDMT:	75.00 PSI	
UCS-66(b) reduction:	Yes		Minimum Design Metal Temperature:	-20 °F	
UCS-68(c) reduction:	No		Computed Minimum Temperature:	-155 °F	

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.3750 in.	
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.3125 in.	

Nozzle Detail Information

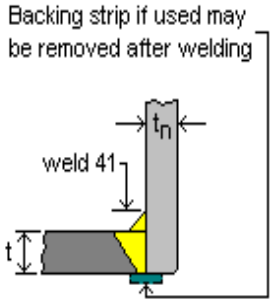


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

3" 150# RFWN (N6D)

Job No: 30137 & 30138
Number: 9
ID Number: 9

Vessel Number: 01
Mark Number: N6D

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B		Pressure at MDMT:	75.00 PSI	
UCS-66(b) reduction:	Yes		Minimum Design Metal Temperature:	-20 °F	
UCS-68(c) reduction:	No		Computed Minimum Temperature:	-155 °F	

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.3750 in.	
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.3125 in.	

Nozzle Detail Information

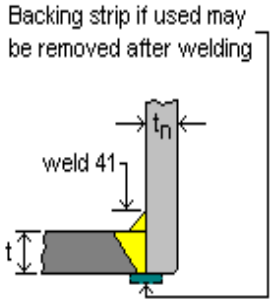


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N7A)

Job No: 30137 & 30138
Number: 10
ID Number: 10

Vessel Number: 01
Mark Number: N7A

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.5000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	4		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	3.8260	in.	Nozzle Wall Thickness(new):	0.3370	in.
Nozzle ID (corroded):	3.9510	in.	Nozzle Wall Thickness(corroded):	0.2745	in.
Developed Opening:	4.4282	in.	Tangential Dimension L:	24.0000	in.
External Limit of Reinforcement:	0.6863	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.5300	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	9.1420	in.	Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155 °F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750 in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125 in.

Nozzle Detail Information

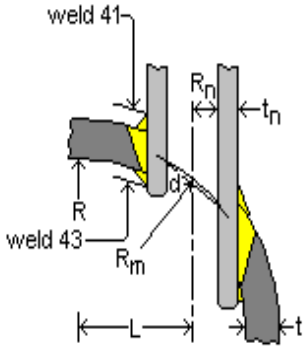


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3370 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 4 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.9755}{17100 * 1 - 0.6 * 78.50}$$ = **0.0091** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.9755}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0716** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2695** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2950** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N7A)

Job No: 30137 & 30138
Number: 10
ID Number: 10

Vessel Number: 01
Mark Number: N7A

Date Printed: 2/12/2016

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(4.5710, 1.9755 + 0.3125 + 0.2745) = **4.5710** in.

L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3125, 2.5 * 0.2745 + 0.0000) = **0.6863** in.

L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3125, 2.5 * 0.2120) = **0.5300** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [4.5710 * 0.1881 * 1.00 + 2 * 0.2745 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **0.8748** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 4.5710 - 4.5710) * (1.0000 * 0.3125 - 1.00 * 0.1881) - 2 * 0.2745 * (1.0000 * 0.3125 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **0.5587** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(6.0000, 0.6863) * [min(0.2745, 4.5710 - 0.5 * 4.5710) - 0.0091] * 0.8550, 0} = **0.3114** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.4375, 0.5300) * min(0.2120, 4.5710 - 0.5 * 4.5710) * 0.8550, 0} = **0.1586** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2] = **0.0698** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 1.2188 sq. in., which is **>=** A (0.8748)

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N7B)

Job No: 30137 & 30138
Number: 11
ID Number: 11

Vessel Number: 01
Mark Number: N7B

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.5000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	4		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	3.8260 in.		Nozzle Wall Thickness(new):	0.3370 in.	
Nozzle ID (corroded):	3.9510 in.		Nozzle Wall Thickness(corroded):	0.2745 in.	
Developed Opening:	4.4282 in.		Tangential Dimension L:	24.0000 in.	
External Limit of Reinforcement:	0.6863 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.5300 in.		Internal Weld Leg Size(Weld 43):	0.3750 in.	
Parallel Limit of Reinf (2Lpar):	9.1420 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

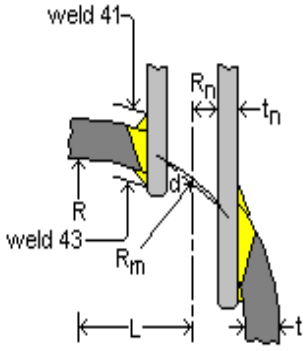


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3370 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 4 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.9755}{17100 * 1 - 0.6 * 78.50}$$ = **0.0091** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.9755}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0716** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2695** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2950** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N7B)

Job No: 30137 & 30138
Number: 11
ID Number: 11

Vessel Number: 01
Mark Number: N7B

Date Printed: 2/12/2016

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(4.5710, 1.9755 + 0.3125 + 0.2745) = **4.5710** in.

L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3125, 2.5 * 0.2745 + 0.0000) = **0.6863** in.

L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3125, 2.5 * 0.2120) = **0.5300** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [4.5710 * 0.1881 * 1.00 + 2 * 0.2745 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **0.8748** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 4.5710 - 4.5710) * (1.0000 * 0.3125 - 1.00 * 0.1881) - 2 * 0.2745 * (1.0000 * 0.3125 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **0.5587** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(6.0000, 0.6863) * [min(0.2745, 4.5710 - 0.5 * 4.5710) - 0.0091] * 0.8550, 0} = **0.3114** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.4375, 0.5300) * min(0.2120, 4.5710 - 0.5 * 4.5710) * 0.8550, 0} = **0.1586** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2] = **0.0698** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 1.2188 sq. in., which is **>=** A (0.8748)

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N7C)

Job No: 30137 & 30138
Number: 12
ID Number: 12

Vessel Number: 01
Mark Number: N7C

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.5000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	4		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	3.8260	in.	Nozzle Wall Thickness(new):	0.3370	in.
Nozzle ID (corroded):	3.9510	in.	Nozzle Wall Thickness(corroded):	0.2745	in.
Developed Opening:	4.4282	in.	Tangential Dimension L:	24.0000	in.
External Limit of Reinforcement:	0.6863	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.5300	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	9.1420	in.	Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155 °F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750 in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125 in.

Nozzle Detail Information

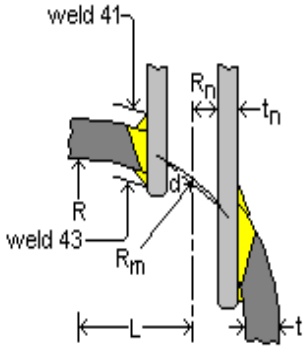


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3370 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 4 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.9755}{17100 * 1 - 0.6 * 78.50}$$ = **0.0091** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.9755}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0716** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2695** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2950** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

4" 150# RFSO (N7C)

Job No: 30137 & 30138
Number: 12
ID Number: 12

Vessel Number: 01
Mark Number: N7C

Date Printed: 2/12/2016

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(4.5710, 1.9755 + 0.3125 + 0.2745) = **4.5710** in.

L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3125, 2.5 * 0.2745 + 0.0000) = **0.6863** in.

L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3125, 2.5 * 0.2120) = **0.5300** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [4.5710 * 0.1881 * 1.00 + 2 * 0.2745 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **0.8748** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 4.5710 - 4.5710) * (1.0000 * 0.3125 - 1.00 * 0.1881) - 2 * 0.2745 * (1.0000 * 0.3125 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **0.5587** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(6.0000, 0.6863) * [min(0.2745, 4.5710 - 0.5 * 4.5710) - 0.0091] * 0.8550, 0} = **0.3114** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.4375, 0.5300) * min(0.2120, 4.5710 - 0.5 * 4.5710) * 0.8550, 0} = **0.1586** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2] = **0.0698** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 1.2188 sq. in., which is **>=** A (0.8748)

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N8)

Job No: 30137 & 30138
Number: 13
ID Number: 13

Vessel Number: 01
Mark Number: N8

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8497	in.	Tangential Dimension L:	13.5000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	1.9598	in.	Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

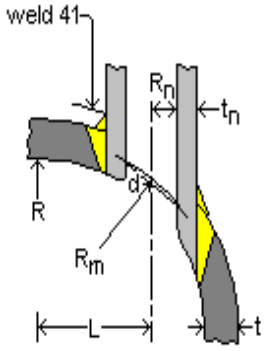


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N8)

Job No: 30137 & 30138
Number: 13
ID Number: 13

Vessel Number: 01
Mark Number: N8

Date Printed: 2/12/2016

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50}$$ = **0.0022** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0647** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N9)

Job No: 30137 & 30138
Number: 14
ID Number: 14

Vessel Number: 01
Mark Number: N9

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150 in.		Nozzle Wall Thickness(new):	0.2500 in.	
Nozzle ID (corroded):	0.9400 in.		Nozzle Wall Thickness(corroded):	0.1875 in.	
Developed Opening:	0.8497 in.		Tangential Dimension L:	13.5000 in.	
External Limit of Reinforcement:	0.4688 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.3125 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	1.9598 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

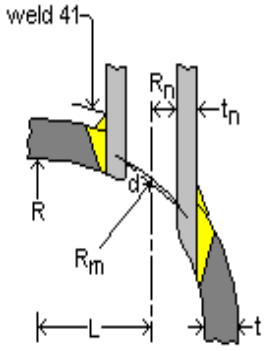


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50}$$ = **0.0022** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0647** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

2" 150# RFSO (N10A)

Job No: 30137 & 30138
Number: 15
ID Number: 15

Vessel Number: 01
Mark Number: N10A

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	12.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.6870 in.		Nozzle Wall Thickness(new):	0.3440 in.	
Nozzle ID (corroded):	1.8120 in.		Nozzle Wall Thickness(corroded):	0.2815 in.	
Developed Opening:	1.7251 in.		Tangential Dimension L:	20.0000 in.	
External Limit of Reinforcement:	0.7038 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.5475 in.		Internal Weld Leg Size(Weld 43):	0.3750 in.	
Parallel Limit of Reinf (2Lpar):	3.7002 in.		Outside Groove Weld Depth:	0.4375 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

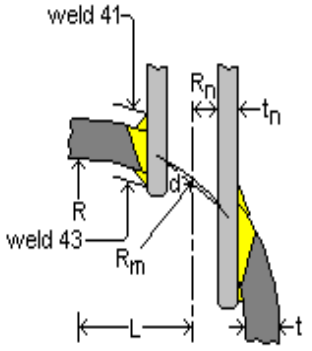


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3440 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.9060}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0042} \text{ in.}$$

Strength Reduction Factors

$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ $\mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.9060}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0667} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1975** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1975** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1975** in.

Wall thickness = tn * 0.875(pipe) = **0.3010** is greater than or equal to UG-45 value of **0.1975**

PLATINUM ENERGY SERVICES ULC

2" 150# RFSO (N10B)

Job No: 30137 & 30138
Number: 16
ID Number: 16

Vessel Number: 01
Mark Number: N10B

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	12.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.6870	in.	Nozzle Wall Thickness(new):	0.3440	in.
Nozzle ID (corroded):	1.8120	in.	Nozzle Wall Thickness(corroded):	0.2815	in.
Developed Opening:	2.3750	in.	Tangential Dimension L:	8.0000	in.
External Limit of Reinforcement:	0.7038	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.5475	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	5.0000	in.	Outside Groove Weld Depth:	0.5000	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 2 - 8'-0" OD FLANGED & DISHED HEAD C/W 1.5" SF (LEFT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.5000	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.4375	in.

Nozzle Detail Information

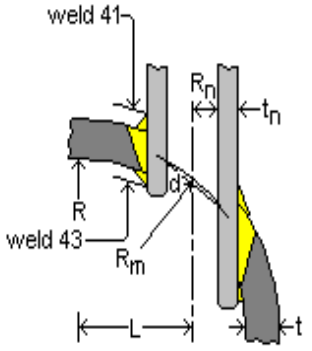


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3440 in.

Outside Groove Weld Depth: 0.5000 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7628}{(2 * 20000 * 1 + 78.50 * (1.7628 - 0.2))} = \mathbf{0.3311} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.9060}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0042} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.9060}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0667} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7628}{(2 * 20000 * 1 + 78.50 * (1.7628 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3936} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1975** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1975** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1975** in.

Wall thickness = tn * 0.875(pipe) = **0.3010** is greater than or equal to UG-45 value of **0.1975**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N11A)

Job No: 30137 & 30138
Number: 17
ID Number: 17

Vessel Number: 01
Mark Number: N11A

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8252	in.	Tangential Dimension L:	15.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

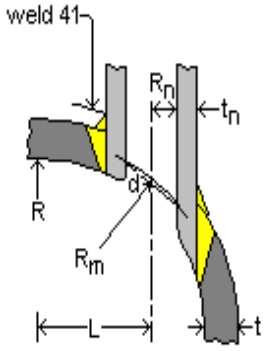


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{\text{Sn}}{\text{Sv}}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{\text{Sn}}{\text{Sv}}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N11B)

Job No: 30137 & 30138
Number: 18
ID Number: 18

Vessel Number: 01
Mark Number: N11B

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8252	in.	Tangential Dimension L:	15.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

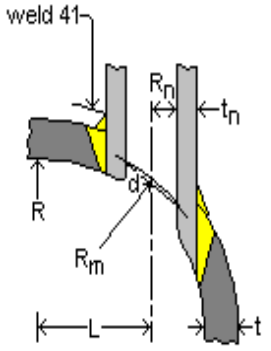


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N11C)

Job No: 30137 & 30138
Number: 19
ID Number: 19

Vessel Number: 01
Mark Number: N11C

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8252	in.	Tangential Dimension L:	15.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

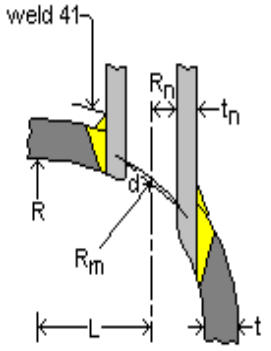


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N11D)

Job No: 30137 & 30138
Number: 20
ID Number: 20

Vessel Number: 01
Mark Number: N11D

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8252	in.	Tangential Dimension L:	15.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

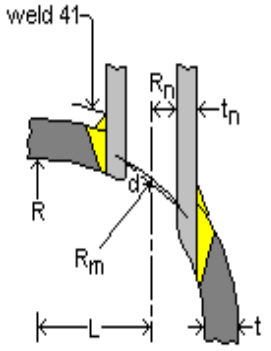


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N12)

Job No: 30137 & 30138
Number: 21
ID Number: 21

Vessel Number: 01
Mark Number: N12

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8260	in.	Tangential Dimension L:	16.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155 °F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000	PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

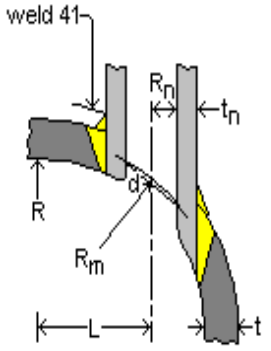


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N13)

Job No: 30137 & 30138
Number: 22
ID Number: 22

Vessel Number: 01
Mark Number: N13

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8497	in.	Tangential Dimension L:	13.5000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	1.9598	in.	Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

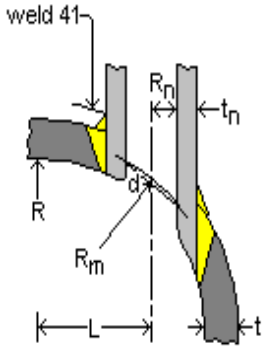


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50}$$ = **0.0022** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0647** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N14)

Job No: 30137 & 30138
Number: 23
ID Number: 23

Vessel Number: 01
Mark Number: N14

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8160	in.	Tangential Dimension L:	9.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155 °F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000	PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

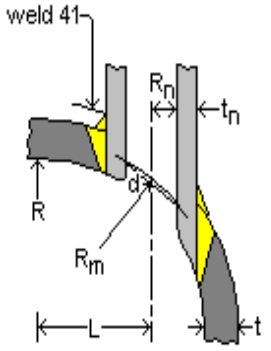


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N15A)

Job No: 30137 & 30138
Number: 24
ID Number: 24

Vessel Number: 01
Mark Number: N15A

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8252	in.	Tangential Dimension L:	15.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

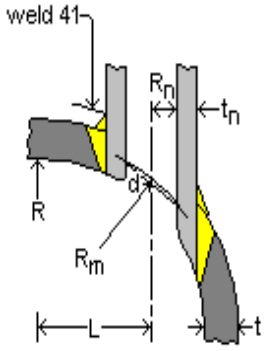


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))} = \mathbf{0.1881} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N15B)

Job No: 30137 & 30138
Number: 25
ID Number: 25

Vessel Number: 01
Mark Number: N15B

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8180	in.	Tangential Dimension L:	32.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

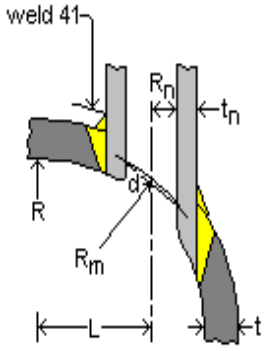


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N15C)

Job No: 30137 & 30138
Number: 26
ID Number: 26

Vessel Number: 01
Mark Number: N15C

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8701	in.	Tangential Dimension L:	26.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

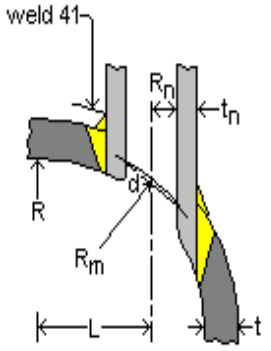


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N15D)

Job No: 30137 & 30138
Number: 27
ID Number: 27

Vessel Number: 01
Mark Number: N15D

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.9000	in.	Tangential Dimension L:	20.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

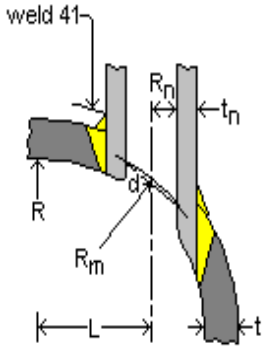


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

1" 150# RFSO (N15E)

Job No: 30137 & 30138
Number: 28
ID Number: 28

Vessel Number: 01
Mark Number: N15E

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
Developed Opening:	0.8180	in.	Tangential Dimension L:	32.0000	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	2.0650	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

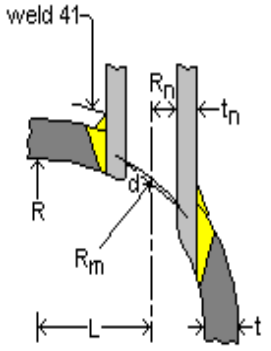


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE - 0.6P}} = \frac{78.50 * 0.4700}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0022} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE - 0.6P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 0.4700}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0647} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2SE + P * (M - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N16)

Job No: 30137 & 30138
Number: 29
ID Number: 29

Vessel Number: 01
Mark Number: N29

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B		Pressure at MDMT:	75.00 PSI	
UCS-66(b) reduction:	Yes		Minimum Design Metal Temperature:	-20 °F	
UCS-68(c) reduction:	No		Computed Minimum Temperature:	-155 °F	

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.3750 in.	
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.3125 in.	

Nozzle Detail Information

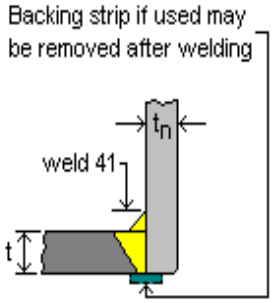


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N16)

Job No: 30137 & 30138
Number: 29
ID Number: 29

Vessel Number: 01
Mark Number: N29

Date Printed: 2/12/2016

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N17)

Job No: 30137 & 30138
Number: 30
ID Number: 30

Vessel Number: 01
Mark Number: N17

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

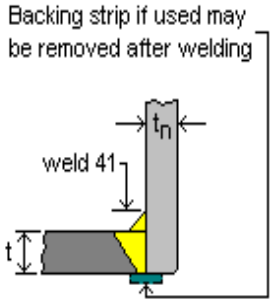


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N18)

Job No: 30137 & 30138
Number: 31
ID Number: 31

Vessel Number: 01
Mark Number: N18

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000 in.	
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375 in.	
External Limit of Reinforcement:	0.5938 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.0000 in.	
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.3750 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

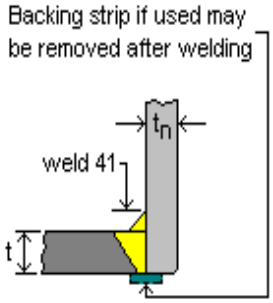


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N18)

Job No: 30137 & 30138
Number: 31
ID Number: 31

Vessel Number: 01
Mark Number: N18

Date Printed: 2/12/2016

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50}$$ = **0.0070** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0695** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

3" 150# RFSO (N19)

Job No: 30137 & 30138
Number: 32
ID Number: 32

Vessel Number: 01
Mark Number: N19

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000	in.	Nozzle Wall Thickness(new):	0.3000	in.
Nozzle ID (corroded):	3.0250	in.	Nozzle Wall Thickness(corroded):	0.2375	in.
Developed Opening:	2.9000	in.	Tangential Dimension L:	39.0000	in.
External Limit of Reinforcement:	0.5938	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.4375	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	6.0500	in.	Outside Groove Weld Depth:	0.4375	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155 °F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.4375	in.
Material Stress(S_v):	20000	PSI	Head wall thickness - thin out (corroded):	0.3750	in.

Nozzle Detail Information

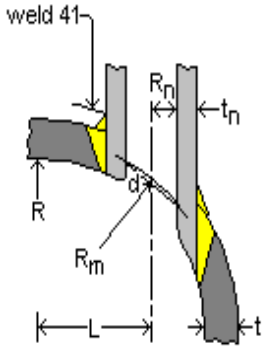


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PLoM}{(2SE + P * (M - 0.2))} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} = \mathbf{0.3312} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.5125}{17100 * 1 - 0.6 * 78.50} = \mathbf{0.0070} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.5125}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000 = \mathbf{0.0695} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PLoM}{(2SE + P * (M - 0.2))} + Ca + \text{ext. } Ca = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000 = \mathbf{0.3937} \text{ in.}$$

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2515** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2515** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2515**

PLATINUM ENERGY SERVICES ULC

18" 150# RFSO (M1)

Job No: 30137 & 30138
Number: 33
ID Number: 33

Vessel Number: 01
Mark Number: M1

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350 °F	
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100 %	
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	10.0000 in.		Allowable Stress at Design Temperature (S_n):	17100 PSI	
Internal Projection:	0.3750 in.		Allowable Stress at Ambient Temperature:	17100 PSI	
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	18		Nozzle Pipe Schedule:	40	
Nozzle ID (new):	16.8760 in.		Nozzle Wall Thickness(new):	0.5620 in.	
Nozzle ID (corroded):	17.0010 in.		Nozzle Wall Thickness(corroded):	0.4995 in.	
Developed Opening:	17.6561 in.		Tangential Dimension L:	28.0000 in.	
External Limit of Reinforcement:	0.9375 in.		Upper Weld Leg Size(Weld 41):	0.3750 in.	
Internal Limit of Reinforcement:	0.9375 in.		Internal Weld Leg Size(Weld 43):	0.3750 in.	
Parallel Limit of Reinf (2Lpar):	35.5622 in.		Outside Groove Weld Depth:	0.4375 in.	

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-153 °F

Host Component: Head 1 - 96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)

Material:	SA-516 Gr. 70	Head wall thickness(new):	0.4375 in.
Material Stress(S_v):	20000 PSI	Head wall thickness - thin out (corroded):	0.3750 in.

Nozzle Detail Information

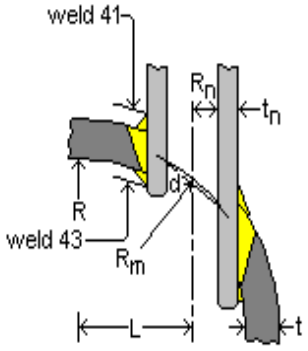


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.5620 in.

Outside Groove Weld Depth: 0.4375 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 18 Schedule: 40
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

18" 150# RFSO (M1)

Job No: 30137 & 30138
Number: 33
ID Number: 33

Vessel Number: 01
Mark Number: M1

Date Printed: 2/12/2016

Required Head Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{\text{PLoM}}{(2\text{SE} + \text{P} * (\text{M} - 0.2))} = \frac{78.50 * 96.0000 * 1.0000}{(2 * 20000 * 1 + 78.50 * (1.0000 - 0.2))}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{\text{PRn}}{\text{SE} - 0.6\text{P}} = \frac{78.50 * 8.5005}{17100 * 1 - 0.6 * 78.50}$$ = **0.0391** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{\text{Sn}}{\text{Sv}}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{\text{Sn}}{\text{Sv}}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{\text{PRn}}{\text{SE} - 0.6\text{P}} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 8.5005}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.1016** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{\text{PLoM}}{(2\text{SE} + \text{P} * (\text{M} - 0.2))} + \text{Ca} + \text{ext. Ca} = \frac{78.50 * 96.0000 * 1.7631}{(2 * 20000 * 1 + 78.50 * (1.7631 - 0.2))} + 0.0625 + 0.0000$$ = **0.3937** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.3905** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.3905** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.3905** in.

Wall thickness = tn * 0.875(pipe) = **0.4920** is greater than or equal to UG-45 value of **0.3905**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(17.7811, 8.5005 + 0.3750 + 0.4995) = **17.7811** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3750, 2.5 * 0.4995 + 0.0000) = **0.9375** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3750, 2.5 * 0.4370) = **0.9375** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [17.7811 * 0.1881 * 1.00 + 2 * 0.4995 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **3.3719** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 17.7811 - 17.7811) * (1.0000 * 0.3750 - 1.00 * 0.1881) - 2 * 0.4995 * (1.0000 * 0.3750 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **3.2962** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(10.0000, 0.9375) * [min(0.4995, 17.7811 - 0.5 * 17.7811) - 0.0391] * 0.8550, 0} = **0.7381** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.3125, 0.9375) * min(0.4370, 17.7811 - 0.5 * 17.7811) * 0.8550, 0} = **0.2335** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2] = **0.0698** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 4.4578 sq. in., which is **>=** A (3.3719)

PLATINUM ENERGY SERVICES ULC

18" 150# RFSO (M2)

Job No: 30137 & 30138
Number: 34
ID Number: 34

Vessel Number: 01
Mark Number: M2

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00 PSI		Design Temperature:	350	°F
Static Head:	3.50 PSI		Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	10.0000 in.		Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	1.0000 in.		Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	18		Nozzle Pipe Schedule:	40	
Nozzle ID (new):	16.8760 in.		Nozzle Wall Thickness(new):	0.5620	in.
Nozzle ID (corroded):	17.0010 in.		Nozzle Wall Thickness(corroded):	0.4995	in.
External Limit of Reinforcement:	0.7813 in.		Upper Weld Leg Size(Weld 41):	0.5000	in.
Internal Limit of Reinforcement:	0.7813 in.		Internal Weld Leg Size(Weld 43):	0.5000	in.
Parallel Limit of Reinf (2Lpar):	34.0020 in.		Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00	PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20	°F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155	°F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750	in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125	in.

Nozzle Detail Information

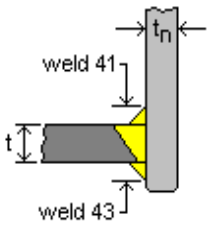


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.5000 in.

Internal Weld Leg Size(Weld 43): 0.5000 in.

Nozzle Wall Thickness(t_n): 0.5620 in.

Outside Groove Weld Depth: 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 18 Schedule: 40
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 8.5005}{17100 * 1 - 0.6 * 78.50}$$ = **0.0391** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 8.5005}{17100 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.1016** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.3905** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn * 0.875(pipe) = **0.4920** is greater than or equal to UG-45 value of **0.2506**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(17.0010, 8.5005 + 0.3125 + 0.4995) = **17.0010** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.3125, 2.5 * 0.4995 + 0.0000) = **0.7813** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.3125, 2.5 * 0.4370) = **0.7813** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [17.0010 * 0.1881 * 1.00 + 2 * 0.4995 * 0.1881 * 1.00 * (1 - 0.8550)], 0}
= **3.2251** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 17.0010 - 17.0010) * (1.0000 * 0.3125 - 1.00 * 0.1881) - 2 * 0.4995 * (1.0000 * 0.3125 - 1.00 * 0.1881) * (1 - 0.8550), 0]
= **2.0969** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(10.0000, 0.7813) * [min(0.4995, 17.0010 - 0.5 * 17.0010) - 0.0391] * 0.8550, 0} = **0.6151** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.9375, 0.7813) * min(0.4370, 17.0010 - 0.5 * 17.0010) * 0.8550, 0} = **0.5838** sq. in.

A41 = f_{r2} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.5000^2 - (0.5000 - 0.5000)^2 - (0.5000 - 0.5000)^2] = **0.2138** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
0.0000 * 0.0000 * 0.0000 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.4107^2 - (0.4107 - 0.4107)^2 - (0.4107 - 0.4107)^2] = **0.1442** sq. in.

A5
= **0.0000** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 3.6538 sq. in., which is **>=** A (3.2251)

PLATINUM ENERGY SERVICES ULC

2" 6000# CPLG (C1)

Job No: 30137 & 30138
Number: 35
ID Number: 35

Vessel Number: 01
Mark Number: C1

Date Printed: 2/12/2016

Nozzle Design Information

Design Pressure:	75.00	PSI	Design Temperature:	350	°F
Static Head:	3.50	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-105		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	4.0000	in.	Allowable Stress at Design Temperature (S_n):	20000	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	20000	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle ID (new):	2.3750	in.	Nozzle Wall Thickness(new):	0.6250	in.
Nozzle ID (corroded):	2.5000	in.	Nozzle Wall Thickness(corroded):	0.5625	in.
Developed Opening:	2.5646	in.	Tangential Dimension L:	18.0000	in.
External Limit of Reinforcement:	0.7813	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.7813	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	5.3980	in.	Outside Groove Weld Depth:	0.3750	in.

Minimum Design Metal Temperature

Min. Temp. Curve:	B	Pressure at MDMT:	75.00 PSI
UCS-66(b) reduction:	Yes	Minimum Design Metal Temperature:	-20 °F
UCS-68(c) reduction:	No	Computed Minimum Temperature:	-155 °F

Host Component: Shell 1 - 8'-0" OD x 30'-0" LONG SHELL

Material:	SA-516 Gr. 70	Shell wall thickness(new):	0.3750 in.
Material Stress(S_v):	20000 PSI	Shell wall thickness(corroded):	0.3125 in.

Nozzle Detail Information

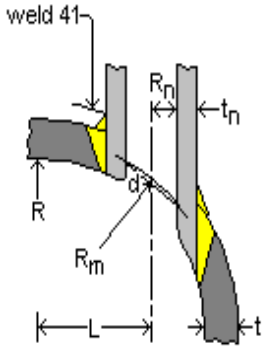


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.6250 in.

Outside Groove Weld Depth: 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

PLATINUM ENERGY SERVICES ULC

2" 6000# CPLG (C1)

Job No: 30137 & 30138
Number: 35
ID Number: 35

Vessel Number: 01
Mark Number: C1

Date Printed: 2/12/2016

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50}$$ = **0.1881** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{78.50 * 1.2500}{20000 * 1 - 0.6 * 78.50}$$ = **0.0049** in.

Strength Reduction Factors

fr1 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{20000}{20000}, 1.0000\right) = 1.0000$

fr2 = $\min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{20000}{20000}, 1.0000\right) = 1.0000$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{78.50 * 1.2500}{20000 * 1.00 - 0.6 * 78.50} + 0.0625 + 0.0000$$ = **0.0674** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{78.50 * 48.0000}{20000 * 1 + 0.4 * 78.50} + 0.0625 + 0.0000$$ = **0.2506** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2605** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2506** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2506** in.

Wall thickness = tn = **0.6250** is greater than or equal to UG-45 value of **0.2506**

PLATINUM ENERGY SERVICES ULC

TWO (2) SUPPORT SADDLES

Job No: 30137 & 30138 Vessel Number: 01

Number: 1 Mark Number: SDL1

Date Printed: 2/12/2016

Saddle Design Information

Design Temperature:	350	°F	Support Type:	Type II	
Material:	SA-36		Stiffener Quantity:	4	
Condition:			Material Stress (hot):	16600	PSI
Length (d):	83.7880	in.	Material Stress (cold):	16600	PSI
Top Width (b'):	24.0000	in.	Yield Strength:	31300	PSI
Bottom Width ($b_{b'}$):	9.0000	in.	Density:	0.2800	lb/in.^3
Outside Stiffener Thickness (t_{so}):	0.5000	in.	Web Plate Thickness (t_w):	0.5000	in.
Inside Stiffener Thickness (t_{si}):	0.5000	in.	Vessel Centerline Height (h):	61.0000	in.
Saddle Angle of contact (n):	120.0	°	Elevation above grade (g):	0.0000	in.
Dist. from saddle centerline to tang. line (A):	36.0000	in.			
Support Design Condition:	Shell unstiffened (A/R > 1/2)				

Wear Plate Information

Design Temperature:	350	°F			
Material:	SA-516 Gr. 70		Material Stress (hot):	20000	PSI
Condition:	Normalized		Material Stress (cold):	20000	PSI
Extension (j_w):	5.0000	in.	Use for S2:	Yes	
Width (b_w):	25.0000	in.	Use for S3:	Yes	
Thickness (t_{wp}):	0.3750	in.	Use for S5:	Yes	

Base Plate Information

Design Temperature:	350	°F	Ultimate 28 Day Concrete Strength:	3000.00	PSI
Material:	SA-36		Yield Strength:	31300	PSI
Condition:			Length (m):	87.0000	in.
Width (b_b):	10.0000	in.	Thickness (t_b):	1.0000	in.

Anchor Bolt Information

Material:	SA-449 Gr. 1		Material Stress (hot):	20200	PSI
Condition:			Material Stress (cold):	20200	PSI
Size:	1"		Number of Threads per in. :	8.0000	
Quantity:	2		Root Area:	0.5510	sq. in.
Anchor bolt slot width:	1.2500	in.	Slot Length:	1.6954	in.
Sliding saddle to support longitudinal Loads:	Yes				
Coeff. of thermal exp. from 70° to MDMT:	6.40	10^-6 in/in/°F			
Coeff. therm. exp. from 70° to design temp:	7.00	10^-6 in/in/°F			

ASME Flange Design Information

Host	Description	Type	Size (in.)	Material	ASME Class	Material Group	MAP (PSI)
4" 150# RFSO (N1)	4" 150# RFSO (N1)	Slip On	3	SA-105	150	1.1	215.00
18" 150# RFSO (M1)	18" 150# RFSO (M1)	Weld Neck	18	SA-105	150	1.1	215.00
18" 150# RFSO (M1)	18" 150# RFBLIND FLAN	Blind	18	SA-105	150	1.1	215.00
18" 150# RFSO (M2)	18" 150# RFSO (M2)	Weld Neck	18	SA-105	150	1.1	215.00
18" 150# RFSO (M2)	18" 150# RF BLIND	Blind	18	SA-105	150	1.1	215.00

Loading Summary

Type	Starting Point (in.)	Ending Point (in.)	Depth (in.)	Density (lb./Ft^3)	Wind Diameter (in.)
Liquid	-	-	108.0000	61.9000	-

Zick Analysis

ASCE 7-10 Wind Design Information

Basic Wind Speed (V): 90 MPH

ASCE 7-10 Seismic Design Information

0.2 s Spectral Response Accel (S_s):	0.250	1 s Spectral Response Accel. (S_1):	0.100
Response Modification Factor (R):	2.000		
Occupancy/Risk Category:	IV	Site Class:	D
Seismic Design Category:	D		

Operating Pressurized Condition - Occasional Loads - Seismic Case 8

Seismic Information

$V = C_s W = 0.2400 * 111892.00$ = **26854** lb.

$F_{LS} = VC_{eh} = 26854.0800 * 0.70$ = **18798** lb.

$$\mathbf{F}_{TS} = \frac{F_{LS}}{2} = \frac{18798}{2}$$ = **9399** lb.

Saddle Support Loads

$\mathbf{F}_L = F_{LS} = 18798$ = **18798** lb.

$\mathbf{F}_T = F_{TS} = 9399$ = **9399** lb.

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{18798 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **3940** lb.

$$\mathbf{Q}_T = \frac{1.5\, F_T\, h}{d} = \frac{1.5\ * 9399 * 61.0000}{83.7880}$$ = **10264** lb.

$$\mathbf{Q}_W = \frac{W(C_{de} + 0.2 S_{DS} C_{ev})}{2} = \frac{111892(0.60 + 0.2 * 0.2667 * -0.70)}{2}$$ = **31479** lb.

$\mathbf{Q}_N = Q_W = 31479$ = **31479** lb.

$\mathbf{Q}_C = Q_N + \text{Max}(Q_L, Q_T) = 31479 + \text{Max}(3940, 10264)$ = **41743** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_C = 41743$ = **41743** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_C = 41743$ = **41743** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

$$S_p = \frac{P\,R}{2\,t} = \frac{76.90 * 47.8438}{2 * 0.3125}$$ = **5887** PSI

Longitudinal Compressive Stress Due to External Pressure

$$S_{pe} = \frac{-P_e\,R}{2\,t} = \frac{-0.00 * 47.8438}{2 * 0.3125}$$ = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1\,Q\,L}{4\,Z_1} = \frac{0.57596 * 41743 * 363.0000}{4 * 2247}$$ = **971** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1'\,Q\,L}{4\,Z_1} = \frac{0.28585 * 41743 * 363.0000}{4 * 2247}$$ = **482** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2\,Q}{R\,t_e}\right] \left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{1.17074 * 41743}{47.8438 * 0.6875}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **1124** PSI

$$S_{2w} = \left[\frac{K_{2w}\,Q}{R\,t}\right] \left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{0.99845 * 41743}{47.8438 * 0.3125}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **2109** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4\,t_e\,(b + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_3\,Q\,R}{L\,t_e^2}\right]$$

$$= -\left[\frac{41743}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 41743 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-9710** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4\,t\,(b_w + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_{3w}\,Q\,R}{L\,t^2}\right]$$

$$= -\left[\frac{41743}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 41743 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-19600** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 41743}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **7067** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 41743$ = **8496** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{971 + 5887}{20000 * 1.00}$$ = **0.3429**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-971}{-\mathrm{Min}(20000,10942)}$$ = **0.0887**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{482 + 5887}{20000 * 1.00}$$ = **0.3185**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-482}{-\mathrm{Min}(20000,10942)}$$ = **0.0441**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{1124}{0.8 * 20000}$$ = **0.0703**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{2109}{0.8 * 20000}$$ = **0.1318**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-9710}{-\,(1.25 * 20000)}$$ = **0.3884**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-19600}{-\,(1.25 * 20000)}$$ = **0.7840**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{7067}{0.5 * 33050}$$ = **0.4277**

Operating Pressurized Condition - Occasional Loads - Wind Case 7

Wind Calculations

$q_z = 0.00256\ K_z\ K_{zt} K_d\ V^2\ I = 0.00256 * 0.85 * 1.000 * 1.00 * 90^2 * 1.0000$ **= 17.626**

$P = q_z\ G\ C_f = 17.626 * 0.89 * 0.70$ = **11.0** lb./Ft.²

$F_{LW} = P\ A_L\ C_{wi} = 11.0 * 50.2655 * 1.00$ = **552** lb.

$$F_{TW} = \frac{P\ A_T\ C_{wi}}{2} = \frac{11.0 * 263.6752 * 1.0000}{2}$$ = **1448** lb.

Saddle Support Loads

$F_L = F_{LW} = 552$ = **552** lb.

$F_T = F_{TW} = 1448$ = **1448** lb.

$$Q_L = \frac{F_L h}{L - 2A} = \frac{552 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **116** lb.

$$Q_T = \frac{1.5\ F_T\ h}{d} = \frac{1.5\ * 1448 * 61.0000}{83.7880}$$ = **1581** lb.

$$Q_W = \frac{W\ C_{de}}{2} = \frac{111892 * 0.60}{2}$$ = **33568** lb.

$Q_N = Q_W = 33568$ = **33568** lb.

$Q_C = Q_N + \text{Max}(Q_L, Q_T) = 33568 + \text{Max}(116,1581)$ = **35149** lb.

Saddle Load for Vessel Stress Analysis

$Q = Q_C = 35149$ = **35149** lb.

Saddle Load for Support Stress Analysis

$Q_S = Q_C = 35149$ = **35149** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

$$S_p = \frac{P\,R}{2\,t} = \frac{77.10 * 47.8438}{2 * 0.3125}$$ = **5902** PSI

Longitudinal Compressive Stress Due to External Pressure

$$S_{pe} = \frac{-P_e\,R}{2\,t} = \frac{-0.00 * 47.8438}{2 * 0.3125}$$ = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1\,Q\,L}{4\,Z_1} = \frac{0.57596 * 35149 * 363.0000}{4 * 2247}$$ = **818** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1'\,Q\,L}{4\,Z_1} = \frac{0.28585 * 35149 * 363.0000}{4 * 2247}$$ = **406** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2\,Q}{R\,t_e}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{1.17074 * 35149}{47.8438 * 0.6875}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **946** PSI

$$S_{2w} = \left[\frac{K_{2w}\,Q}{R\,t}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{0.99845 * 35149}{47.8438 * 0.3125}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **1776** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4\,t_e\,(b + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_3\,Q\,R}{L\,t_e^2}\right]$$

$$= -\left[\frac{35149}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 35149 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-8176** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4\,t\,(b_w + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_{3w}\,Q\,R}{L\,t^2}\right]$$

$$= -\left[\frac{35149}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 35149 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-16504** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 35149}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **5951** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 35149$ = **7154** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{818 + 5902}{20000 * 1.00}$$ = **0.3360**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-818}{-\mathrm{Min}(20000,10942)}$$ = **0.0748**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{406 + 5902}{20000 * 1.00}$$ = **0.3154**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-406}{-\mathrm{Min}(20000,10942)}$$ = **0.0371**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{946}{0.8 * 20000}$$ = **0.0591**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{1776}{0.8 * 20000}$$ = **0.1110**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-8176}{-\,(1.25 * 20000)}$$ = **0.3270**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-16504}{-\,(1.25 * 20000)}$$ = **0.6602**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{5951}{0.5 * 33050}$$ = **0.3601**

Operating Pressurized Condition - Sustained Loads

Saddle Support Loads

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{0 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **0** lb.

$$\mathbf{Q}_T = \frac{1.5\, F_T\, h}{d} = \frac{1.5\ * 0 * 61.0000}{83.7880}$$ = **0** lb.

$$\mathbf{Q}_W = \frac{W}{2} = \frac{111892}{2}$$ = **55946** lb.

$\mathbf{Q}_N = Q_W = 55946$ = **55946** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_N = 55946$ = **55946** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_N = 55946$ = **55946** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

$$S_p = \frac{P\,R}{2\,t} = \frac{78.50 * 47.8438}{2 * 0.3125}$$ = **6009** PSI

Longitudinal Compressive Stress Due to External Pressure

$$S_{pe} = \frac{-P_e\,R}{2\,t} = \frac{-0.00 * 47.8438}{2 * 0.3125}$$ = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1\,Q\,L}{4\,Z_1} = \frac{0.57596 * 55946 * 363.0000}{4 * 2247}$$ = **1301** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1'\,Q\,L}{4\,Z_1} = \frac{0.28585 * 55946 * 363.0000}{4 * 2247}$$ = **646** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2\,Q}{R\,t_e}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{1.17074 * 55946}{47.8438 * 0.6875}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **1506** PSI

$$S_{2w} = \left[\frac{K_{2w}\,Q}{R\,t}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{0.99845 * 55946}{47.8438 * 0.3125}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **2826** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4\,t_e\,(b + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_3\,Q\,R}{L\,t_e^2}\right]$$

$$= -\left[\frac{55946}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 55946 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-13014** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4\,t\,(b_w + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_{3w}\,Q\,R}{L\,t^2}\right]$$

$$= -\left[\frac{55946}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 55946 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-26269** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 55946}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **9471** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 55946$ = **11386** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{1301 + 6009}{20000 * 1.00}$$ = **0.3655**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-1301}{-\mathrm{Min}(20000,10942)}$$ = **0.1189**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{646 + 6009}{20000 * 1.00}$$ = **0.3328**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-646}{-\mathrm{Min}(20000,10942)}$$ = **0.0590**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{1506}{0.8 * 20000}$$ = **0.0941**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{2826}{0.8 * 20000}$$ = **0.1766**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-13014}{-\,(1.25 * 20000)}$$ = **0.5206**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-26269}{-\,(1.25 * 20000)}$$ = **1.0508**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{9471}{0.5 * 33050}$$ = **0.5731**

Operating Unpressurized Condition - Sustained Loads

Saddle Support Loads

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{0 * 61.0000}{363.0000 - 2 * 36.0000} = \mathbf{0}\ \text{lb.}$$

$$\mathbf{Q}_T = \frac{1.5\ F_T\ h}{d} = \frac{1.5\ * 0 * 61.0000}{83.7880} = \mathbf{0}\ \text{lb.}$$

$$\mathbf{Q}_W = \frac{W}{2} = \frac{111892}{2} = \mathbf{55946}\ \text{lb.}$$

$\mathbf{Q}_N = Q_W = 55946$ = **55946** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_N = 55946$ = **55946** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_N = 55946$ = **55946** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

$$S_p = \frac{P\,R}{2\,t} = \frac{3.50 * 47.8438}{2 * 0.3125}$$ = **268** PSI

Longitudinal Compressive Stress Due to External Pressure

S_{pe} = = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1\,Q\,L}{4\,Z_1} = \frac{0.57596 * 55946 * 363.0000}{4 * 2247}$$ = **1301** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1'\,Q\,L}{4\,Z_1} = \frac{0.28585 * 55946 * 363.0000}{4 * 2247}$$ = **646** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2\,Q}{R\,t_e}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{1.17074 * 55946}{47.8438 * 0.6875}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **1506** PSI

$$S_{2w} = \left[\frac{K_{2w}\,Q}{R\,t}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{0.99845 * 55946}{47.8438 * 0.3125}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **2826** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4\,t_e\,(b + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_3\,Q\,R}{L\,t_e^2}\right]$$

$$= -\left[\frac{55946}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 55946 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-13014** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4\,t\,(b_w + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_{3w}\,Q\,R}{L\,t^2}\right]$$

$$= -\left[\frac{55946}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 55946 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-26269** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 55946}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **9471** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 55946$ = **11386** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{1301 + 268}{20000 * 1.00}$$ = **0.0784**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-1301}{-\mathrm{Min}(20000,10942)}$$ = **0.1189**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{646 + 268}{20000 * 1.00}$$ = **0.0457**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-646}{-\mathrm{Min}(20000,10942)}$$ = **0.0590**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{1506}{0.8 * 20000}$$ = **0.0941**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{2826}{0.8 * 20000}$$ = **0.1766**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-13014}{-\,(1.25 * 20000)}$$ = **0.5206**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-26269}{-\,(1.25 * 20000)}$$ = **1.0508**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{9471}{0.5 * 33050}$$ = **0.5731**

Empty Pressurized Condition - Sustained Loads

Saddle Support Loads

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{0 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **0** lb.

$$\mathbf{Q}_T = \frac{1.5\, F_T\, h}{d} = \frac{1.5\ * 0 * 61.0000}{83.7880}$$ = **0** lb.

$$\mathbf{Q}_W = \frac{W}{2} = \frac{13790}{2}$$ = **6895** lb.

$\mathbf{Q}_N = Q_W = 6895$ = **6895** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_N = 6895$ = **6895** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_N = 6895$ = **6895** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

$$S_p = \frac{P\,R}{2\,t} = \frac{75.00 * 47.8438}{2 * 0.3125}$$ = **5741** PSI

Longitudinal Compressive Stress Due to External Pressure

$$S_{pe} = \frac{-P_e\,R}{2\,t} = \frac{-0.00 * 47.8438}{2 * 0.3125}$$ = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1\,Q\,L}{4\,Z_1} = \frac{0.57596 * 6895 * 363.0000}{4 * 2247}$$ = **160** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1'\,Q\,L}{4\,Z_1} = \frac{0.28585 * 6895 * 363.0000}{4 * 2247}$$ = **80** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2\,Q}{R\,t_e}\right] \left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{1.17074 * 6895}{47.8438 * 0.6875}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **186** PSI

$$S_{2w} = \left[\frac{K_{2w}\,Q}{R\,t}\right] \left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{0.99845 * 6895}{47.8438 * 0.3125}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **348** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4\,t_e\,(b + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_3\,Q\,R}{L\,t_e^2}\right]$$

$$= -\left[\frac{6895}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 6895 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-1604** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4\,t\,(b_w + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_{3w}\,Q\,R}{L\,t^2}\right]$$

$$= -\left[\frac{6895}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 6895 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-3237** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 6895}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **1167** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 6895$ = **1403** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{160 + 5741}{20000 * 1.00}$$ = **0.2951**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-160}{-\mathrm{Min}(20000,10942)}$$ = **0.0146**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{80 + 5741}{20000 * 1.00}$$ = **0.2911**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-80}{-\mathrm{Min}(20000,10942)}$$ = **0.0073**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{186}{0.8 * 20000}$$ = **0.0116**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{348}{0.8 * 20000}$$ = **0.0218**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-1604}{-\,(1.25 * 20000)}$$ = **0.0642**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-3237}{-\,(1.25 * 20000)}$$ = **0.1295**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{1167}{0.5 * 33050}$$ = **0.0706**

Empty Unpressurized Condition - Occasional Loads - Seismic Case 8

Seismic Information

$V = C_s W = 0.2400 * 13790.00$ = **3310** lb.

$F_{LS} = VC_{eh} = 3309.6000 * 0.70$ = **2317** lb.

$$\mathbf{F}_{TS} = \frac{F_{LS}}{2} = \frac{2317}{2}$$ = **1158** lb.

Saddle Support Loads

$\mathbf{F}_L = F_{LS} = 2317$ = **2317** lb.

$\mathbf{F}_T = F_{TS} = 1158$ = **1158** lb.

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{2317 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **486** lb.

$$\mathbf{Q}_T = \frac{1.5\, F_T\, h}{d} = \frac{1.5\ * 1158 * 61.0000}{83.7880}$$ = **1265** lb.

$$\mathbf{Q}_W = \frac{W(C_{de} + 0.2 S_{DS} C_{ev})}{2} = \frac{13790(0.60 + 0.2 * 0.2667 * -0.70)}{2}$$ = **3880** lb.

$\mathbf{Q}_N = Q_W = 3880$ = **3880** lb.

$\mathbf{Q}_C = Q_N + \text{Max}(Q_L, Q_T) = 3880 + \text{Max}(486,1265)$ = **5145** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_C = 5145$ = **5145** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_C = 5145$ = **5145** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

S_p = = **0** PSI

Longitudinal Compressive Stress Due to External Pressure

S_{pe} = = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1 Q L}{4 Z_1} = \frac{0.57596 * 5145 * 363.0000}{4 * 2247}$$ = **120** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1' Q L}{4 Z_1} = \frac{0.28585 * 5145 * 363.0000}{4 * 2247}$$ = **59** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2 Q}{R t_e}\right] \left[\frac{L - 2A}{L + \frac{4}{3} H}\right] = \left[\frac{1.17074 * 5145}{47.8438 * 0.6875}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **139** PSI

$$S_{2w} = \left[\frac{K_{2w} Q}{R t}\right] \left[\frac{L - 2A}{L + \frac{4}{3} H}\right] = \left[\frac{0.99845 * 5145}{47.8438 * 0.3125}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **260** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4 t_e (b + 1.56 \sqrt{R t})}\right] - \left[\frac{12 K_3 Q R}{L t_e^2}\right]$$

$$= -\left[\frac{5145}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 5145 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-1197** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4 t (b_w + 1.56 \sqrt{R t})}\right] - \left[\frac{12 K_{3w} Q R}{L t^2}\right]$$

$$= -\left[\frac{5145}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 5145 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-2416** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 5145}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **871** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 5145$ = **1047** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{120 + 0}{20000 * 1.00}$$ = **0.0060**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-120}{-\mathrm{Min}(20000,10942)}$$ = **0.0110**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{59 + 0}{20000 * 1.00}$$ = **0.0030**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-59}{-\mathrm{Min}(20000,10942)}$$ = **0.0054**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{139}{0.8 * 20000}$$ = **0.0087**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{260}{0.8 * 20000}$$ = **0.0163**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-1197}{-\,(1.25 * 20000)}$$ = **0.0479**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-2416}{-\,(1.25 * 20000)}$$ = **0.0966**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{871}{0.5 * 33050}$$ = **0.0527**

Empty Unpressurized Condition - Occasional Loads - Wind Case 7

Wind Calculations

$q_z = 0.00256\ K_z\ K_{zt} K_d\ V^2\ I = 0.00256 * 0.85 * 1.000 * 1.00 * 90^2 * 1.0000$ **= 17.626**

$P = q_z\ G\ C_f = 17.626 * 0.89 * 0.70$ = **11.0** lb./Ft.²

$F_{LW} = P\ A_L\ C_{wi} = 11.0 * 50.2655 * 1.00$ = **552** lb.

$$F_{TW} = \frac{P\ A_T\ C_{wi}}{2} = \frac{11.0 * 263.6752 * 1.0000}{2}$$ = **1448** lb.

Saddle Support Loads

$F_L = F_{LW} = 552$ = **552** lb.

$F_T = F_{TW} = 1448$ = **1448** lb.

$$Q_L = \frac{F_L h}{L - 2A} = \frac{552 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **116** lb.

$$Q_T = \frac{1.5\ F_T\ h}{d} = \frac{1.5\ * 1448 * 61.0000}{83.7880}$$ = **1581** lb.

$$Q_W = \frac{W\ C_{de}}{2} = \frac{13790 * 0.60}{2}$$ = **4137** lb.

$Q_N = Q_W = 4137$ = **4137** lb.

$Q_C = Q_N + \text{Max}(Q_L, Q_T) = 4137 + \text{Max}(116,1581)$ = **5718** lb.

Saddle Load for Vessel Stress Analysis

$Q = Q_C = 5718$ = **5718** lb.

Saddle Load for Support Stress Analysis

$Q_S = Q_C = 5718$ = **5718** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

S_p = = **0** PSI

Longitudinal Compressive Stress Due to External Pressure

S_{pe} = = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1 Q L}{4 Z_1} = \frac{0.57596 * 5718 * 363.0000}{4 * 2247}$$ = **133** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1' Q L}{4 Z_1} = \frac{0.28585 * 5718 * 363.0000}{4 * 2247}$$ = **66** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2 Q}{R t_e}\right] \left[\frac{L - 2A}{L + \frac{4}{3} H}\right] = \left[\frac{1.17074 * 5718}{47.8438 * 0.6875}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **154** PSI

$$S_{2w} = \left[\frac{K_{2w} Q}{R t}\right] \left[\frac{L - 2A}{L + \frac{4}{3} H}\right] = \left[\frac{0.99845 * 5718}{47.8438 * 0.3125}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **289** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4 t_e (b + 1.56 \sqrt{R t})}\right] - \left[\frac{12 K_3 Q R}{L t_e^2}\right]$$

$$= -\left[\frac{5718}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 5718 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-1330** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4 t (b_w + 1.56 \sqrt{R t})}\right] - \left[\frac{12 K_{3w} Q R}{L t^2}\right]$$

$$= -\left[\frac{5718}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 5718 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-2685** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 5718}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **968** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 5718$ = **1164** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{133 + 0}{20000 * 1.00}$$ = **0.0067**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-133}{-\mathrm{Min}(20000,10942)}$$ = **0.0122**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{66 + 0}{20000 * 1.00}$$ = **0.0033**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-66}{-\mathrm{Min}(20000,10942)}$$ = **0.0060**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{154}{0.8 * 20000}$$ = **0.0096**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{289}{0.8 * 20000}$$ = **0.0181**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-1330}{-\,(1.25 * 20000)}$$ = **0.0532**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-2685}{-\,(1.25 * 20000)}$$ = **0.1074**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{968}{0.5 * 33050}$$ = **0.0586**

Empty Unpressurized Condition - Sustained Loads

Saddle Support Loads

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{0 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **0** lb.

$$\mathbf{Q}_T = \frac{1.5\ F_T\ h}{d} = \frac{1.5\ * 0 * 61.0000}{83.7880}$$ = **0** lb.

$$\mathbf{Q}_W = \frac{W}{2} = \frac{13790}{2}$$ = **6895** lb.

$\mathbf{Q}_N = Q_W = 6895$ = **6895** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_N = 6895$ = **6895** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_N = 6895$ = **6895** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

S_p = = **0** PSI

Longitudinal Compressive Stress Due to External Pressure

S_{pe} = = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8438^2 * 0.3125$ = **2247** in.³

$$S_1 = \frac{K_1 Q L}{4 Z_1} = \frac{0.57596 * 6895 * 363.0000}{4 * 2247}$$ = **160** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1' Q L}{4 Z_1} = \frac{0.28585 * 6895 * 363.0000}{4 * 2247}$$ = **80** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_2 = \left[\frac{K_2 Q}{R t_e}\right] \left[\frac{L - 2A}{L + \frac{4}{3} H}\right] = \left[\frac{1.17074 * 6895}{47.8438 * 0.6875}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **186** PSI

$$S_{2w} = \left[\frac{K_{2w} Q}{R t}\right] \left[\frac{L - 2A}{L + \frac{4}{3} H}\right] = \left[\frac{0.99845 * 6895}{47.8438 * 0.3125}\right] \left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **348** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3125^2 + 0.3750^2$ = **0.2383** sq. in.

$$S_3 = -\left[\frac{Q}{4 t_e (b + 1.56 \sqrt{R t})}\right] - \left[\frac{12 K_3 Q R}{L t_e^2}\right]$$

$$= -\left[\frac{6895}{4 * 0.6875 * (24.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.03322 * 6895 * 47.8438}{363.0000 * 0.2383}\right]$$

= **-1604** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4 t (b_w + 1.56 \sqrt{R t})}\right] - \left[\frac{12 K_{3w} Q R}{L t^2}\right]$$

$$= -\left[\frac{6895}{4 * 0.3125 * (25.0000 + 1.56 * \sqrt{47.8438 * 0.3125})}\right] - \left[\frac{12 * 0.02740 * 6895 * 47.8438}{363.0000 * 0.3125^2}\right]$$

= **-3237** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3125 + 0.3750$ = **0.6875** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 6895}{0.6875 * (0.5000 + 1.56 * \sqrt{47.8438 * 0.3125})}$$ = **1167** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 6895$ = **1403** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{160 + 0}{20000 * 1.00}$$ = **0.0080**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-160}{-\mathrm{Min}(20000,10942)}$$ = **0.0146**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{80 + 0}{20000 * 1.00}$$ = **0.0040**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-80}{-\mathrm{Min}(20000,10942)}$$ = **0.0073**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{186}{0.8 * 20000}$$ = **0.0116**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{348}{0.8 * 20000}$$ = **0.0218**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-1604}{-\,(1.25 * 20000)}$$ = **0.0642**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-3237}{-\,(1.25 * 20000)}$$ = **0.1295**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{1167}{0.5 * 33050}$$ = **0.0706**

Test Condition

Saddle Support Loads

$$\mathbf{Q}_L = \frac{F_L h}{L - 2A} = \frac{0 * 61.0000}{363.0000 - 2 * 36.0000}$$ = **0** lb.

$$\mathbf{Q}_T = \frac{1.5\ F_T\ h}{d} = \frac{1.5\ * 0 * 61.0000}{83.7880}$$ = **0** lb.

$$\mathbf{Q}_W = \frac{W}{2} = \frac{112716}{2}$$ = **56358** lb.

$\mathbf{Q}_N = Q_W = 56358$ = **56358** lb.

Saddle Load for Vessel Stress Analysis

$\mathbf{Q} = Q_N = 56358$ = **56358** lb.

Saddle Load for Support Stress Analysis

$\mathbf{Q}_S = Q_N = 56358$ = **56358** lb.

Zick Calculations

Longitudinal Stress Due to Internal Pressure

$$S_p = \frac{P\,R}{2\,t} = \frac{75.00 * 47.8125}{2 * 0.3750}$$ = **4781** PSI

Longitudinal Compressive Stress Due to External Pressure

S_{pe} = = **0** PSI

Longitudinal Bending Stress in the Shell at the Midpoint

$Z_1 = \pi R^2 t = 3.1416 * 47.8125^2 * 0.3750$ = **2693** in.³

$$S_1 = \frac{K_1\,Q\,L}{4\,Z_1} = \frac{0.57592 * 56358 * 363.0000}{4 * 2693}$$ = **1094** PSI

Longitudinal Bending Stress in the Shell in the Plane of the Saddle

$$S_1' = \frac{K_1'\,Q\,L}{4\,Z_1} = \frac{0.28625 * 56358 * 363.0000}{4 * 2693}$$ = **544** PSI

Saddle Plane Tangential Shear Stress

$t_e = t + t_{wp} = 0.3750 + 0.3750$ = **0.7500** in.

$$S_2 = \left[\frac{K_2\,Q}{R\,t_e}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{1.17074 * 56358}{47.8125 * 0.7500}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **1392** PSI

$$S_{2w} = \left[\frac{K_{2w}\,Q}{R\,t}\right]\left[\frac{L - 2A}{L + \frac{4}{3}H}\right] = \left[\frac{0.99845 * 56358}{47.8125 * 0.3750}\right]\left[\frac{363.0000 - 2 * 36.0000}{363.0000 + \frac{4}{3} * 16.2564}\right]$$ = **2374** PSI

Circumferential Stress at the Horn of the Saddle

$t_e^2 = t^2 + t_{wp}^2 = 0.3750^2 + 0.3750^2$ = **0.2813** sq. in.

$$S_3 = -\left[\frac{Q}{4\,t_e\,(b + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_3\,Q\,R}{L\,t_e^2}\right]$$

$$= -\left[\frac{56358}{4 * 0.7500 * (24.0000 + 1.56 * \sqrt{47.8125 * 0.3750})}\right] - \left[\frac{12 * 0.03326 * 56358 * 47.8125}{363.0000 * 0.2813}\right]$$

= **-11148** PSI

Circumferential Stress at End of the Wear Plate

$$S_{3w} = -\left[\frac{Q}{4\,t\,(b_w + 1.56\sqrt{R\,t})}\right] - \left[\frac{12\,K_{3w}\,Q\,R}{L\,t^2}\right]$$

$$= -\left[\frac{56358}{4 * 0.3750 * (25.0000 + 1.56 * \sqrt{47.8125 * 0.3750})}\right] - \left[\frac{12 * 0.02743 * 56358 * 47.8125}{363.0000 * 0.3750^2}\right]$$

= **-18564** PSI

Ring Compression in the Shell Over the Saddle

$t_e = t + t_{wp} = 0.3750 + 0.3750$ = **0.7500** in.

$$S_5 = \frac{K_5 Q}{t_e (b + 1.56 \sqrt{R t})} = \frac{0.76027 * 56358}{0.7500 * (0.5000 + 1.56 * \sqrt{47.8125 * 0.3750})}$$ = **8040** PSI

Maximum Splitting Force

$F_s = K_8 Q_s = 0.20352 * 56358$ = **11470** lb.

Vessel Stress Ratio Calculations

Any ratio greater than 1 represents an overstressed condition

$$R_{1t} = \frac{S_1 + S_p}{S_{Shell}\, E} = \frac{1094 + 4781}{20000 * 1.00}$$ = **0.2938**

$$R_{1C} = \frac{-S_1}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-1094}{-\mathrm{Min}(20000,10942)}$$ = **0.1000**

$$R_{1t}' = \frac{S_1' + S_p}{S_{Shell}\, E} = \frac{544 + 4781}{20000 * 1.00}$$ = **0.2663**

$$R_{1C}' = \frac{-S_1'}{-\,\mathrm{Min}(S_{Shell}, B_{Shell})} = \frac{-544}{-\mathrm{Min}(20000,10942)}$$ = **0.0497**

$$R_2 = \frac{S_2}{0.8\, S_{Shell}} = \frac{1392}{0.8 * 20000}$$ = **0.0870**

$$R_{2W} = \frac{S_{2W}}{0.8\, S_{Shell}} = \frac{2374}{0.8 * 20000}$$ = **0.1484**

$$R_3 = \frac{S_3}{-\,(1.25\, S_{Shell})} = \frac{-11148}{-\,(1.25 * 20000)}$$ = **0.4459**

$$R_{3w} = \frac{S_{3W}}{-\,(1.25\, S_{Shell})} = \frac{-18564}{-\,(1.25 * 20000)}$$ = **0.7426**

$$R_5 = \frac{S_5}{0.5\, Y_{Shell}} = \frac{8040}{0.5 * 33050}$$ = **0.4865**

MDMT Report by Components

Design MDMT is -20 °F

Component	Material	Curve	Pressure	MDMT
8'-0" OD x 30'-0" LONG SHELL	SA-516 Gr. 70	D	75.00 PSI	-55 °F
3" 150# RFWN (N6B)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N8)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFWN (N6C)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N9)	SA-106 Gr. B	B	75.00 PSI	-155 °F
4" 150# RFSO (N7C)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFSO (N17)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFSO (N18)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFWN (N4)	SA-106 Gr. B	B	75.00 PSI	-155 °F
4" 150# RFSO (N7B)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFSO (N16)	SA-106 Gr. B	B	75.00 PSI	-155 °F
4" 150# RFSO (N1)	SA-106 Gr. B	B	75.00 PSI	-155 °F
2" 6000# CPLG (C1)	SA-105	B	75.00 PSI	-155 °F
3" 150# RFWN (N6A)	SA-106 Gr. B	B	75.00 PSI	-155 °F
4" 150# RFSO (N7A)	SA-106 Gr. B	B	75.00 PSI	-155 °F
18" 150# RFSO (M2)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N13)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFWN (N6D)	SA-106 Gr. B	B	75.00 PSI	-155 °F
96" OD FLANGED & DISHED HEAD C/W 1.5"	SA-516 Gr. 70	D	75.00 PSI	-55 °F
1" 150# RFSO (N11A)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N15C)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFSO (N19)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N11D)	SA-106 Gr. B	B	75.00 PSI	-155 °F
2" 150# RFSO (N10A)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFSO (N3)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N15A)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N11B)	SA-106 Gr. B	B	75.00 PSI	-155 °F
8" 150# RFSO (N5)	SA-106 Gr. B	B	75.00 PSI	-153 °F
1" 150# RFSO (N15B)	SA-106 Gr. B	B	75.00 PSI	-155 °F
18" 150# RFSO (M1)	SA-106 Gr. B	B	75.00 PSI	-153 °F
1" 150# RFSO (N14)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N15E)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N11C)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N15D)	SA-106 Gr. B	B	75.00 PSI	-155 °F
1" 150# RFSO (N12)	SA-106 Gr. B	B	75.00 PSI	-155 °F
3" 150# RFSO (N2)	SA-106 Gr. B	B	75.00 PSI	-155 °F
8'-0" OD FLANGED & DISHED HEAD C/W 1.5"	SA-516 Gr. 70	D	75.00 PSI	-55 °F
2" 150# RFSO (N10B)	SA-106 Gr. B	B	75.00 PSI	-155 °F

Component with highest MDMT: 8'-0" OD x 30'-0" LONG SHELL.

Computed MDMT = -55 °F

The required design MDMT of -20 °F has been met or exceeded for the calculated MDMT values.

ASME Flanges Are Not Included in MDMT Calculations.

MAWP Report by Components

Component	Design Pressure	Static Head	Vessel MAWP New & Cold UG-98(a)	Component MAWP Hot & Corroded UG-98(b)	Vessel MAWP Hot & Corroded UG-98(a)
8'-0" OD x 30'-0" LONG SHELL	75.00 PSI	3.50 PSI	100.57 PSI	83.73 PSI	80.23 PSI
4" 150# RFSO (N1)	75.00 PSI	3.50 PSI	127.02 PSI	98.67 PSI	95.17 PSI
ASME Flange Class: 150 Gr:1.1	75.00 PSI	3.50 PSI	281.50 PSI	215.00 PSI	211.50 PSI
3" 150# RFWN (N4)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFWN (N6A)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFWN (N6B)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFWN (N6C)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFWN (N6D)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
4" 150# RFSO (N7A)	75.00 PSI	3.50 PSI	119.99 PSI	94.15 PSI	90.65 PSI
4" 150# RFSO (N7B)	75.00 PSI	3.50 PSI	119.99 PSI	94.15 PSI	90.65 PSI
4" 150# RFSO (N7C)	75.00 PSI	3.50 PSI	119.99 PSI	94.15 PSI	90.65 PSI
1" 150# RFSO (N8)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
1" 150# RFSO (N9)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
1" 150# RFSO (N13)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFSO (N16)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFSO (N17)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
3" 150# RFSO (N18)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
18" 150# RFSO (M2)	75.00 PSI	3.50 PSI	100.57 PSI	83.73 PSI	80.23 PSI
ASME Flange Class: 150 Gr:1.1	75.00 PSI	3.50 PSI	281.50 PSI	215.00 PSI	211.50 PSI
ASME Flange Class: 150 Gr:1.1	75.00 PSI	3.50 PSI	281.50 PSI	215.00 PSI	211.50 PSI
2" 6000# CPLG (C1)	75.00 PSI	3.50 PSI	153.26 PSI	130.56 PSI	127.06 PSI
96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT	75.00 PSI		85.18 PSI	88.93 PSI	85.43 PSI
3" 150# RFSO (N2)	75.00 PSI	3.50 PSI	117.68 PSI	98.92 PSI	95.42 PSI
3" 150# RFSO (N3)	75.00 PSI	3.50 PSI	120.53 PSI	100.80 PSI	97.30 PSI
8" 150# RFSO (N5)	75.00 PSI	3.50 PSI	113.46 PSI	98.00 PSI	94.50 PSI
2" 150# RFSO (N10A)	75.00 PSI	3.50 PSI	179.47 PSI	156.76 PSI	153.26 PSI
1" 150# RFSO (N11A)	75.00 PSI	3.50 PSI	179.47 PSI	156.76 PSI	153.26 PSI
1" 150# RFSO (N11B)	75.00 PSI	3.50 PSI	179.47 PSI	156.76 PSI	153.26 PSI
1" 150# RFSO (N11C)	75.00 PSI	3.50 PSI	179.47 PSI	156.76 PSI	153.26 PSI
1" 150# RFSO (N11D)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
1" 150# RFSO (N12)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
1" 150# RFSO (N14)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
1" 150# RFSO (N15A)	75.00 PSI	3.50 PSI	179.47 PSI	156.76 PSI	153.26 PSI
1" 150# RFSO (N15B)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
1" 150# RFSO (N15C)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
1" 150# RFSO (N15D)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
1" 150# RFSO (N15E)	75.00 PSI	3.50 PSI	100.01 PSI	88.94 PSI	85.44 PSI
3" 150# RFSO (N19)	75.00 PSI	3.50 PSI	85.18 PSI	88.94 PSI	85.44 PSI
18" 150# RFSO (M1)	75.00 PSI	3.50 PSI	105.34 PSI	91.14 PSI	87.64 PSI
ASME Flange Class: 150 Gr:1.1	75.00 PSI	3.50 PSI	281.50 PSI	215.00 PSI	211.50 PSI
ASME Flange Class: 150 Gr:1.1	75.00 PSI	3.50 PSI	281.50 PSI	215.00 PSI	211.50 PSI
8'-0" OD FLANGED & DISHED HEAD C/W 1.5" SF (LEFT	75.00 PSI	I	114.88 PSI	88.95 PSI	85.45 PSI
2" 150# RFSO (N10B)	75.00 PSI	3.50 PSI	114.89 PSI	88.95 PSI	85.45 PSI

NC = Not Calculated Inc = Incomplete

Component	Design Pressure	Static Head	Vessel MAWP New & Cold UG-98(a)	Component MAWP Hot & Corroded UG-98(b)	Vessel MAWP Hot & Corroded UG-98(a)

PLATINUM ENERGY SERVICES ULC
TWO (2) 8'-0" OD x 30'-0" LONG TREATERS
Job No: 30137 & 30138 Vessel Number: 01
Date Printed: 2/12/2016

Summary

Component with the lowest vessel MAWP(New & Cold) :**96" OD FLANGED & DISHED HEAD C/W 1.5" SF (RIGHT SIDE)**
The lowest vessel MAWP(New & Cold) : **85.18** PSI

Component with the lowest vessel MAWP(Hot & Corroded) :**8'-0" OD x 30'-0" LONG SHELL**
The lowest vessel MAWP(Hot & Corroded) : **80.23** PSI

Pressures are exclusive of any external loads.

Flange pressures listed here do not consider external loadings

Summary Information

	Dry Weight	Flooded Weight
Shell	11355.68 lb.	104136.38 lb.
Head	2317.26 lb.	8577.41 lb.
Nozzle	317.88 lb.	317.88 lb.
ASME Flange	748.00 lb.	748.00 lb.
Totals	14738.83 lb.	113779.67 lb.

	Volume
Shell	11106.06 Gal.
Head	750.62 Gal.
Nozzle	28.10 Gal.
Totals	11884.78 Gal.

	Area
Shell	753.98 Sq. Ft.
Head	122.61 Sq. Ft.
Nozzle	29.56 Sq. Ft.
Totals	906.15 Sq. Ft.

Hydrostatic Test Information Par. UG-99(b)
Gauge at Top

Component	Const.	x	STest	/	SDesign	x	Pressure	=	Component Hydro Test Pressure
1" 150# RFSO (N11A)	1.3	x	17100	/	17100	x	75.00	=	**97.50**
1" 150# RFSO (N11B)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N11C)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N11D)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N12)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N13)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N14)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N15A)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N15B)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N15C)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N15D)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N15E)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N8)	1.3	x	17100	/	17100	x	75.00	=	97.50
1" 150# RFSO (N9)	1.3	x	17100	/	17100	x	75.00	=	97.50
18" 150# RFSO (M1)	1.3	x	17100	/	17100	x	75.00	=	97.50
18" 150# RFSO (M2)	1.3	x	17100	/	17100	x	75.00	=	97.50
2" 150# RFSO (N10A)	1.3	x	17100	/	17100	x	75.00	=	97.50
2" 150# RFSO (N10B)	1.3	x	17100	/	17100	x	75.00	=	97.50
2" 6000# CPLG (C1)	1.3	x	20000	/	20000	x	75.00	=	97.50
3" 150# RFSO (N16)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFSO (N17)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFSO (N18)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFSO (N19)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFSO (N2)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFSO (N3)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFWN (N4)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFWN (N6A)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFWN (N6B)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFWN (N6C)	1.3	x	17100	/	17100	x	75.00	=	97.50
3" 150# RFWN (N6D)	1.3	x	17100	/	17100	x	75.00	=	97.50
4" 150# RFSO (N1)	1.3	x	17100	/	17100	x	75.00	=	97.50
4" 150# RFSO (N7A)	1.3	x	17100	/	17100	x	75.00	=	97.50
4" 150# RFSO (N7B)	1.3	x	17100	/	17100	x	75.00	=	97.50
4" 150# RFSO (N7C)	1.3	x	17100	/	17100	x	75.00	=	97.50
8" 150# RFSO (N5)	1.3	x	17100	/	17100	x	75.00	=	97.50
8'-0" OD FLANGED & DIS	1.3	x	20000	/	20000	x	75.00	=	97.50
8'-0" OD x 30'-0" LONG	1.3	x	20000	/	20000	x	75.00	=	97.50
96" OD FLANGED & DISHE	.3	x	20000	/	20000	x	75.00	=	97.50

Calculated Test Pressure: 97.50 PSI

Special Notes:

This calculation assumes one chamber.

This calculation is limited by the lowest component pressure per chamber.