Job Number: 03-248-521

Calculation Package Revision Level: /

DESIGN CALCULATIONS INDEX

Calculation Description	Applicable		Pages	Rev. Level
	Yes	No		
Primary Membrane Stress Calcs. (Computer Design Pgm.)	✓		1-14	/
Lifting Lug Calculations		✓		
Horizontal Vessel Saddle Calculations		✓		
Vertical Vessel Skirt Calculations		✓		
Other UG-22 Specified Loadings		✓		
Vessel Impact Testing Exemption Summary	✓		1-14	/

DESIGN CALCULATIONS REVISION CONTROL AND APPROVAL

[1]Drawing No. & Rev. Level	Calc. Package Rev. Level	Revised Calcs. Required	Approval	Date

New design

[1] Whenever new drawings are issued that pertain to the calculation package, or whenever drawings are revised, the current calculations shall be verified and approved as applicable or revised as necessary and approved.

Bidell Equipment, Inc.
6900 - 112th Avenue SE Calgary, AB T2C 4Z1 CANADA

Date Printed: 5/6/2004

VESSEL DESCRIPTION

18" O.D. x 66" S/S

Vessel designed per the ASME Boiler & Pressure Vessel Code,
Section VIII Division 1,2001 Edition, 2003 Addenda
with Advanced Pressure Vessel, Version: 8.2.1
Vessel is ASME Code Stamped

Job No: 03-248
Vessel Number: 03-248-521

NAMEPLATE INFORMATION

MAWP:	655.00 PSI
MDMT:	-20 °F at 655.00 PSI
Serial Number(s):	03-248-521
Year Built:	2004
Radiography:	RT 1
Postweld Heat Treated:	HT
Construction Types:	W

Notes

All applicable UG-22 loadings have been considered in this design

Signatures

Engineering: M Fudge Date: MAY 06 2004
Mike Fudge

Revision No.: 0 Date: MAY 06 2004

Table of Contents

Bidell Equipment, Inc.

Shell 1

Job No: 03-248
Number: 1

Vessel Number: 03-248-521
Mark Number: S1

Date Printed: 5/6/2004

Cylindrical Shell Design Information

Design Pressure:	655.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	PSI	Joint Efficiency:	100	%
Shell Material:	SA-106 Gr B		Factor B Chart:	CS-2	
			Material Stress (hot):	17100	PSI
Shell Length:	66.0000	in.	Material Stress (cold):	17100	PSI
Corrosion Allowance:	0.1250	in.	Actual Circumferential Stress:	15814	PSI
External Corrosion Allowance:	0.0000	in.	Actual Longitudinal Stress:	7517	PSI
Outside Diameter (new):	18.0000	in.			
Outside Diameter (corroded):	18.0000	in.	Specific Gravity:	1.00	
Shell Surface Area:	25.92	Sq. Ft.	Weight of Fluid:	533.96	lb.
Shell Estimated Volume:	63.92	Gal.	Total Flooded Shell Weight:	1109.02	lb.
			Shell Weight:	575.06	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Design Thickness Calculations

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

$$t = \frac{PR}{2SE + 0.4P} = \frac{655.00 * 8.5630}{2 * 17100 * 1.00 + 0.4 * 655.00} = 0.1628 + 0.1250_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0411_{\text{(12 1/2\% for pipe)}}$$

= minimum of **0.3289** in.

Circumferential Stress Calculations per Appendix 1-1(a)(1)

$$t = \frac{PR_o}{SE + 0.4P} = \frac{655.00 * 9.0000}{17100 * 1.00 + 0.4 * 655.00} = 0.3396 + 0.1250_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0664_{\text{(12 1/2\% for pipe)}}$$

= minimum of **0.5310** in.

MAWP for this Shell Section Only

$$P = \frac{SEt}{R_o - 0.4t} = \frac{17100 * 1.00 * 0.3667}{9.0000 - 0.4 * 0.3667}$$

= maximum design pressure of **708.27** PSI

External loads do not control design.

Pipe Selected: Size = **18 in.**, Schedule = **40**, Diameter = **18.0000** in., Wall = **0.5620** in.

Bidell Equipment, Inc.
Head 1

Job No: 03-248
Number: 1

Vessel Number: 03-248-521
Mark Number: H1

Date Printed: 5/6/2004

Ellipsoidal Head Design Information

Design Pressure:	655.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	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:	0.1250	in.	Material Stress (cold):	20000	PSI
External Corrosion Allowance:	0.0000	in.	Actual Head Stress:	18275	PSI
Head Location:	Right		Straight Flange :	2.0000	in.
Outside Diameter :	18.0000	in.	Head Depth (ho) :	4.7500	in.
Thin Out :	0.0625	in.			
K = 1/6[2 + (D/2h)²] :	1.00				
Head Surface Area:	3.08	Sq. Ft.	Specific Gravity:	1.00	
Head Estimated Volume:	4.75	Gal.	Weight of Fluid:	39.61	lb.
Head Weight:	62.79	lb.	Total Flooded Head Weight:	102.41	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Design Thickness Calculations

Design Thickness Calculations per Appendix 1-4(c)

$$\frac{PD_oK}{2SE + 2P(K - 0.1)} = \frac{655.00 * 18.0000 * 1.00}{2 * 20000 * 1.00 + 2 * 655.00 * (1.00 - 0.1)} = 0.2864 + 0.1250_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0625_{\text{(thin out)}}$$

= minimum of **0.4739** in.

Extreme Fiber Elongation Calculation per Paragraph UCS-79

$$\textbf{elongation} = \frac{75t}{R_f} = \frac{75 * 0.5000}{2.9750}$$

= elongation of **12.60** %

MAWP per UG-32 for this Head Only

$$P = \frac{2SEt}{KD_o - 2t(K - 0.1)} = \frac{2 * 20000 * 1.00 * 0.3125}{1.00 * 18.0000 - 2 * 0.3125 * (1.00 - 0.1)}$$

= **716.85** PSI

External loads do not control design.

Nominal Head Thickness Selected = **0.5000** in.
Minimum Thickness after forming = **0.4375** in.

Bidell Equipment, Inc.
Nozzle 1

Job No: 03-248
Number: 1
D Number: 1

Vessel Number: 03-248-521
Mark Number: N1

Date Printed: 5/6/2004

Nozzle Design Information

Design Pressure:	655.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	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:	0.1250	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Passes through a Category A Joint:	No	
Nozzle Pipe Size:	10		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	8.5000	in.	Nozzle Wall Thickness(new):	1.1250	in.
Nozzle ID (corroded):	8.7500	in.	Nozzle Wall Thickness(corroded):	1.0000	in.
Outer "h" Limit:	0.9168	in.	Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal "h" Limit:	0.9168	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
OD, Limit of Reinforcement:	17.5000	in.	Appendix 1-7 OD, Limit of Reinforcement(d_{LDR}):	13.1250	in.
Outside Groove Weld Depth:	0.5620	in.			

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Reinforcing Pad Information

Reinforcing Material:	SA-106 Gr B		Allowable Stress at Design Temperature(S_p):	17100	PSI
			Allowable Stress at Ambient Temperature:	17100	PSI
Reinforcing Plate Thickness(t_e):	0.3750	in.	Repad to Vessel Weld Leg Size(Weld 42):	0.3125	in.
OD, Reinforcing Plate(D_p):	14.8750	in.	Repad to Nozzle Groove Weld Depth:	0.3750	in.

Host Component: Shell 1 - Shell 1

Material:	SA-106 Gr B		Shell wall thickness(new):	0.5620	in.
Material Stress(S_v):	17100	PSI	Shell wall thickness - 12½% for pipe (corroded):	0.3668	in.

Nozzle Detail Information

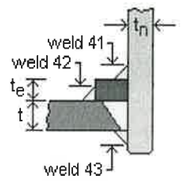


Fig. UW-16.1 (c)

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

Internal Weld Leg Size(Weld 43): 0.0000 in.

Nozzle Wall Thickness(t_n): 1.1250 in.

Outside Groove Weld Depth: 0.5620 in.

Repad to Vessel Weld Leg Size(Weld 42): 0.3125 in.

Repad Thickness(t_e): 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 10 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Large opening meets Appendix 1-7 stress calculation requirements
Weld Strength Paths are adequate.

Bidell Equipment, Inc.
Nozzle 1

Job No: 03-248
Number: 1
ID Number: 1

Vessel Number: 03-248-521
Mark Number: N1

Date Printed: 5/6/2004

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{655.00 * 9.0000}{17100 * 1 + 0.4 * 655.00}$$ **= 0.3395** in.

Nozzle Required Thickness Calculations

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

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{655.00 * 4.3750}{17100 * 1 - 0.6 * 655.00}$$ **= 0.1715** in.

Strength Reduction Factors

$$\mathbf{fr1} = \frac{Sn}{Sv} = \frac{17100}{17100} = 1.0000$$

$$\mathbf{fr2} = \frac{Sn}{Sv} = \frac{17100}{17100} = 1.0000$$

$$\mathbf{fr3} = \frac{Sn}{Sv} = \frac{17100}{17100} = 1.0000$$

$$\mathbf{fr4} = \frac{Sp}{Sv} = \frac{17100}{17100} = 1.0000$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion) per Paragraph UG-45(a)

$$t = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{655.00 * 4.3750}{17100 * 1.00 - 0.6 * 655.00} + 0.1250 + 0.0000$$ **= 0.2965** in.

Nozzle Thickness for Internal Pressure (plus corrosion) per Paragraph UG-45(b)(1)

$$t = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{655.00 * 9.0000}{17100 * 1 + 0.4 * 655.00} + 0.1250 + 0.0000$$ = **0.4645** in.

Minimum Thickness of Standard Wall Pipe (plus corrosion) per Paragraph UG-45(b)(4)

t = minimum thickness of standard wall pipe + Ca + ext. Ca = **0.4444** in.

Nozzle Minimum Thickness per Paragraph UG-45(b)

t = Smallest of UG-45(b)(1) or UG-45(b)(4) **= 0.4444** in.

Bidell Equipment, Inc.
Nozzle 1

Job No: 03-248
Number: 1
ID Number: 1

Vessel Number: 03-248-521
Mark Number: N1

Date Printed: 5/6/2004

Nozzle Reinforcement Calculations

Area Required for Internal Pressure

A = d tr F + 2 tn tr F (1 - fr1) = (8.7500 * 0.3395 * 1.00) + (2 * 1.0000 * 0.3395 * 1.00 * (1 - 1.0000)) = **2.9706** sq. in.

Area Available - Internal Pressure

A1 Formula 1 = d(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
8.7500 * (1.00 * 0.3667 - 1.00 * 0.3395) - 2 * 1.0000 * (1.00 * 0.3667 - 1.00 * 0.3395) * (1 - 1.0000) = *0.2380* sq. in.

A1 Formula 2 = 2(t + tn)(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
2 * (0.3667 + 1.0000)(1.00 * 0.3667 - 1.00 * 0.3395) - 2 * 1.0000 * (1.00 * 0.3667 - 1.00 * 0.3395) * (1 - 1.0000) = *0.0743* sq. in.

A1 = Larger value of *A1 Formula 1* and *A1 Formula 2* = **0.2380** sq. in.

A2 Formula 1 = 5(tn - trn) fr2 t = 5(1.0000 - 0.1715) * 1.0000 * 0.3667 = *1.5191* sq. in.

A2 Formula 2 = 2(tn - trn) fr2 (2.5 tn + te) = 2(1.0000 - 0.1715) * 1.0000 * (2.5 * 1.0000 + 0.3750) = *4.7639* sq. in.

A2 = Smaller value of *A2 Formula 1* and *A2 Formula 2* = **1.5191** sq. in.

A3 = Smaller value of the following :
5 * t * t_i * f_{r2} = 5 * 0.3667 * 0.8750 * 1.0000 = 1.6043 sq. in.
5 * t_i * t_i * f_{r2} = 5 * 0.8750 * 0.8750 * 1.0000 = 3.8281 sq. in.
2 * h * t_i * f_{r2} = 2 * 0.0000 * 0.8750 * 1.0000= 0.0000 sq. in.
= **0.0000** sq. in.

A41 = (leg)² * fr3 = (0.3750)² * 1.0000 = **0.1406** sq. in.

A42 = (leg)² * fr4 = (0.3125)² * 1.0000 = **0.0977** sq. in.

A43 = (leg)² * fr2 = 0 * 1.0000 = **0.0000** sq. in.

A5 = (Dp - d - 2tn) te fr4 = (14.8750 - 8.7500 - 2 * 1.0000) * 0.3750 * 1.0000 = **1.5469** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 3.5423 sq. in., which is **greater** than A (2.9706)

Appendix 1-7(a) (Large Opening in Shell) Calculations

Area Required for Internal Pressure

A = 2/3 * (d tr F + 2 tn tr F (1 - fr1)) = 2/3 * ((8.7500 * 0.3395 * 1.00) + (2 * 1.0000 * 0.3395 * 1.00 * (1 - 1.0000))) = **1.9804** sq. in.

Area Available - Internal Pressure

A1 = $(d_{LDR} - d)(E1\ t - F\ tr) - 2tn(E1\ t - F\ tr)(1 - fr1)$ =
(13.1250 - 8.7500) * (1.00 * 0.3667 - 1.00 * 0.3395) - 2 * 1.0000 * (1.00 * 0.3667 - 1.00 * 0.3395) * (1 - 1.0000) = **0.1190** sq. in.

A2 Formula 1 = 5(tn - trn) fr2 t = 5(1.0000 - 0.1715) * 1.0000 * 0.3667 = *1.5191* sq. in.
A2 Formula 2 = 2(tn - trn) fr2 (2.5 tn + te) = 2(1.0000 - 0.1715) * 1.0000 * (2.5 * 1.0000 + 0.3750) = *4.7639* sq. in.
A2 = Smaller value of *A2 Formula 1* and *A2 Formula 2* = **1.5191** sq. in.

A3 = Smaller value of the following :
5 * t * t_i * f_{r2} = 5 * 0.3667 * 0.8750 * 1.0000 = 1.6043 sq. in.
5 * t_j * t_i * f_{r2} = 5 * 0.8750 * 0.8750 * 1.0000 = 3.8281 sq. in.
2 * h * t_i * f_{r2} = 2 * 0.0000 * 0.8750 * 1.0000= 0.0000 sq. in.
= **0.0000** sq. in.

A41 = (leg)² * fr3 = (0.3750)² * 1.0000 = **0.1406** sq. in.

A42 = Allowable Weld 42 area * fr4 = 0.0000 * 1.0000 = **0.0000** sq. in.

A43 = (leg)² * fr2 = 0 * 1.0000 = **0.0000** sq. in.

A5 = (Dp - d - 2tn) te fr4 = (13.1250 - 8.7500 - 2 * 1.0000) * 0.3750 * 1.0000 = **0.8906** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 2.6693 sq. in., which is **greater** than A (1.9804)

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16

Weld 41 tmin = smaller of 0.75, te, or tn = smaller of 0.75, 0.3750, or 1.0000 = **0.3750** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{0.2500}{0.7}$ = **0.3571** in.

Weld 41, actual weld leg = **0.3750** in.

Weld 42 tmin = smaller of 0.75, t, or te = smaller of 0.75, 0.3667, or 0.3750 = **0.3667** in.

Weld 42 Leg min. = $\frac{0.5 * \text{tmin} + \text{ext. CA}}{0.7} = \frac{0.5 * 0.3667 + 0.0000}{0.7}$ = **0.2619** in.

Weld 42, actual weld leg = **0.3125** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Outer fillet, Weld 42, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Repad groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress = ½ * π * 9.7500 * 1.0000 * 11970 = **183200** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 10.7500 * 0.3750 * 8379 = **53000** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress = ½ * π * 10.7500 * 0.3667 * 12654 = **78300** lb.
Outer fillet in shear = ½ * π * Plate OD * weld leg * outer fillet in shear unit stress = ½ * π * 14.8750 * 0.3125 * 8379 = **61200** lb.
Repad groove weld = ½ * π * Nozzle OD * Groove Depth * repad groove weld in tension unit stress = ½ * π * 10.7500 * 0.3750 * 12654 = **80100** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [2.9706 - 0.2380 + 2 * 1.0000 * 1.0000 * (1.00 * 0.3667 - 1.0000 * 0.3395)] * 17100 = **47700** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (1.5191 + 1.5469 + 0.1406 + 0.0977) * 17100 = **56500** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (1.5191 + 0.0000 + 0.1406 + 0.0000 + 2 * 1.0000 * 0.3667 * 1.0000) * 17100 = **40900** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv = (1.5191 + 0.0000 + 1.5469 + 0.1406 + 0.0977 + 0.0000 + 2 * 1.0000 * 0.3667 * 1.0000) * 17100 = **69000** lb.

Check Strength Paths

Path 1-1 = Outer fillet in shear + Nozzle wall in shear = 61200 + 183200 = **244400** lb.
Path 2-2 = Upper fillet in shear + Repad groove weld + Groove weld in tension + Inner fillet in shear = 53000 + 80100 + 78300 + 0 = **211400** lb.
Path 3-3 = Outer fillet in shear + Inner fillet in shear + Groove weld in tension = 61200 + 0 + 78300 = **139500** lb.

Plate Strength = A5 * Sp = 1.5469 * 17100 = **26452** lb.

Outer fillet weld strength(61200) is greater than plate strength(26452).

Bidell Equipment, Inc.
Nozzle 2

Job No: 03-248
Number: 2
Number: 2

Vessel Number: 03-248-521
Mark Number: N2

Date Printed: 5/6/2004

Nozzle Design Information

Design Pressure:	655.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	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:	0.1250	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Passes through a Category A Joint:	No	
Nozzle Pipe Size:	6		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	5.1890	in.	Nozzle Wall Thickness(new):	0.7180	in.
Nozzle ID (corroded):	5.4390	in.	Nozzle Wall Thickness(corroded):	0.5930	in.
Outer "h" Limit:	0.7813	in.	Upper Weld Leg Size(Weld 41):	0.5000	in.
Internal "h" Limit:	0.7813	in.	Internal Weld Leg Size(Weld 43):	0.5000	in.
OD, Limit of Reinforcement:	10.8780	in.	Outside Groove Weld Depth:	0.5000	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Head 1 - Head 1

Material:	SA-516 Gr 70		Head wall thickness(new):	0.5000	in.
Material Stress(S_V):	20000	PSI	Head wall thickness - thin out (corroded):	0.3125	in.

Nozzle Detail Information

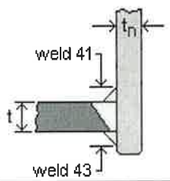


Fig. UW-16.1 (c)

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

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

Nozzle Wall Thickness(t_n): 0.7180 in.

Outside Groove Weld Depth: 0.5000 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 6 Schedule: 160
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)

$$\mathbf{tr} = \frac{P\ K1\ Do}{(2SE + 0.8P)} = \frac{655.00 * 0.9000 * 18.0000}{(2 * 20000 * 1 + 0.8 * 655.00)}$$ = **0.2618** in.

Nozzle Required Thickness Calculations

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

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{655.00 * 2.7195}{17100 * 1 - 0.6 * 655.00}$$ = **0.1066** in.

Strength Reduction Factors

$$\mathbf{fr1} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$ $$\mathbf{fr2} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$ $$\mathbf{fr3} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion) per Paragraph UG-45(a)

$$\mathbf{t} = \frac{PRn}{SE - 0.6P} + Ca + ext.\ Ca = \frac{655.00 * 2.7195}{17100 * 1.00 - 0.6 * 655.00} + 0.1250 + 0.0000$$ = **0.2316** in.

Nozzle Thickness for Internal Pressure (plus corrosion) per Paragraph UG-45(b)(1)

$$\mathbf{t} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{655.00 * 1.0000 * 18.0000}{(2 * 20000 * 1 + 2 * 655.00 * (1.0000 - 0.1))} + 0.1250 + 0.0000$$ = **0.4113** in.

Minimum Thickness of Standard Wall Pipe (plus corrosion) per Paragraph UG-45(b)(4)

t = minimum thickness of standard wall pipe + Ca + ext. Ca = **0.3700** in.

Nozzle Minimum Thickness per Paragraph UG-45(b)

t = Smallest of UG-45(b)(1) or UG-45(b)(4) = **0.3700** in.

Bidell Equipment, Inc.
Nozzle 2

Job No: 03-248
Number: 2
D Number: 2

Vessel Number: 03-248-521
Mark Number: N2

Date Printed: 5/6/2004

Nozzle Reinforcement Calculations

Area Required for Internal Pressure

A = d tr F + 2 tn tr F (1 - fr1) = (5.4390 * 0.2618 * 1.00) + (2 * 0.5930 * 0.2618 * 1.00 * (1 - 0.8550)) = **1.4690** sq. in.

Area Available - Internal Pressure

A1 Formula 1 = d(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
5.4390 * (1.00 * 0.3125 - 1.00 * 0.2618) - 2 * 0.5930 * (1.00 * 0.3125 - 1.00 * 0.2618) * (1 - 0.8550) = *0.2670* sq. in.

A1 Formula 2 = 2(t + tn)(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
2 * (0.3125 + 0.5930)(1.00 * 0.3125 - 1.00 * 0.2618) - 2 * 0.5930 * (1.00 * 0.3125 - 1.00 * 0.2618) * (1 - 0.8550) = *0.0831* sq. in.

A1 = Larger value of *A1 Formula 1* and *A1 Formula 2* = **0.2670** sq. in.

A2 Formula 1 = 5(tn - trn) fr2 t = 5(0.5930 - 0.1066) * 0.8550 * 0.3125 = *0.6498* sq. in.
A2 Formula 2 = 5(tn - trn) fr2 tn = 5(0.5930 - 0.1066) * 0.8550 * 0.5930 = *1.2331* sq. in.
A2 = Smaller value of *A2 Formula 1* and *A2 Formula 2* = **0.6498** sq. in.

A3 = Smaller value of the following :
5 * t * t_i * f_{r2} = 5 * 0.3125 * 0.4680 * 0.8550 = 0.6252 sq. in.
5 * t_i * t_i * f_{r2} = 5 * 0.4680 * 0.4680 * 0.8550 = 0.9363 sq. in.
2 * h * t_i * f_{r2} = 2 * 0.3750 * 0.4680 * 0.8550= 0.3001 sq. in.
= **0.3001** sq. in.

A41 = (leg)² * fr2 = (0.5000)² * 0.8550 = **0.2138** sq. in.

A43 = (leg)² * fr2 = (0.3214)² * 0.8550 = **0.0883** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A43 = 1.5190 sq. in., which is **greater** than A (1.4690)

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.3125, or 0.5930 **= 0.3125** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{0.2188}{0.7}$ **= 0.3125** in.

Weld 41, actual weld leg = **0.5000** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.3125, or 0.5930 **= 0.3125** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.3125 * 0.7)) + 0.1250}}{0.7} = \frac{0.3438}{0.7}$ **= 0.4911** in.

Weld 43, actual weld leg = **0.5000** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 6.0320 * 0.5930 * 11970 **= 67200** lb.

Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 6.6250 * 0.5000 * 8379 **= 43600** lb.

Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 6.6250 * 0.5000 * 12654 **= 65800** lb.

Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 6.6250 * 0.3214 * 8379 **= 28000** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [1.4690 - 0.2670 + 2 * 0.5930 * 0.8550 * (1.00 * 0.3125 - 1.0000 * 0.2618)] * 20000 **= 25100** lb.

W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.6498 + 0.0000 + 0.2138 + 0.0000) * 20000 **= 17300** lb.

W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.6498 + 0.3001 + 0.2138 + 0.0883 + 2 * 0.5930 * 0.3125 * 0.8550) * 20000 **= 31400** lb.

W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.6498 + 0.3001 + 0.0000 + 0.2138 + 0.0000 + 0.0883 + 2 * 0.5930 * 0.3125 * 0.8550) * 20000 **= 31400** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 43600 + 67200 **= 110800** lb.

Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
43600 + 65800 + 28000 **= 137400** lb.

Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 43600 + 28000 + 65800 **= 137400** lb.

Bidell Equipment, Inc.

Job No: 03-248

Vessel Number: 03-248-521

Date Printed: 5/6/2004

MDMT Report by Components

Design MDMT is -20 °F

Component	Material	Curve	Pressure	MDMT
Shell 1	SA-106 Gr B			Exempt per UG-20(f), 1-5
Nozzle 1	SA-106 Gr B			Exempt per UG-20(f), 1-5
Head 1	SA-516 Gr 70			Exempt per UG-20(f), 1-5
Nozzle 2	SA-106 Gr B			Exempt per UG-20(f), 1-5

The required design MDMT of -20 °F has been met or exceeded for the calculated MDMT values.

ANSI Flanges Are Not Included in MDMT Calculations.

Bidell Equipment, Inc.
18" O.D. x 66" S/S

Job No: 03-248

Vessel Number: 03-248-521

Date Printed: 5/6/2004

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)
Shell 1	655.00 PSI	0.00 PSI	929.99 PSI	708.27 PSI	708.27 PSI
Nozzle 1	655.00 PSI	0.00 PSI	929.99 PSI	708.37 PSI	708.37 PSI
Head 1	655.00 PSI	0.00 PSI	1016.70 PSI	665.91 PSI	665.91 PSI
Nozzle 2	655.00 PSI	0.00 PSI	1034.16 PSI	665.91 PSI	665.91 PSI

NC = Not Calculated Inc = Incomplete

Summary

Component with the lowest vessel MAWP(New & Cold) : **Shell 1**
The lowest vessel MAWP(New & Cold) : **929.99** PSI

Component with the lowest vessel MAWP(Hot & Corroded) : **Head 1**
The lowest vessel MAWP(Hot & Corroded) : **665.91** PSI

Pressures are exclusive of any external loads.

Bidell Equipment, Inc.

Job No: 03-248

Vessel Number: 03-248-521

Date Printed: 5/6/2004

Summary Information

	Dry Weight	Flooded Weight
Shell	575.06 lb.	1109.02 lb.
Head	62.79 lb.	102.41 lb.
Nozzle	98.38 lb.	98.38 lb.
Totals	736.23 lb.	1309.80 lb.

	Volume
Shell	63.92 Gal.
Head	4.75 Gal.
Nozzle	3.08 Gal.
Totals	71.74 Gal.

	Area
Shell	25.92 Sq. Ft.
Head	3.08 Sq. Ft.
Nozzle	3.85 Sq. Ft.
Totals	32.85 Sq. Ft.

Hydrostatic Test Information (UG-99)

Gauge at Top

Component with controlling ratio is : Shell 1
Component with controlling pressure is : Shell 1

Calculated Test Pressure = $P * 1.3 * \frac{\text{Cold Stress}}{\text{Hot Stress}} = 655.00 * 1.3 * \frac{17100}{17100} =$ **851.50 PSI**

Job Number: 03-248-523

Calculation Package Revision Level: 0

DESIGN CALCULATIONS INDEX

Calculation Description	Applicable		Pages	Rev. Level
	Yes	No		
Primary Membrane Stress Calcs. (Computer Design Pgm.)	✓		1-10	0
Lifting Lug Calculations		✓		
Horizontal Vessel Saddle Calculations		✓		
Vertical Vessel Skirt Calculations		✓		
Other UG-22 Specified Loadings		✓		
Vessel Impact Testing Exemption Summary	✓		1-10	0

DESIGN CALCULATIONS REVISION CONTROL AND APPROVAL

[1]Drawing No. & Rev. Level	Calc. Package Rev. Level	Revised Calcs. Required	Approval	Date

New design

[1] Whenever new drawings are issued that pertain to the calculation package, or whenever drawings are revised, the current calculations shall be verified and approved as applicable or revised as necessary and approved.

Bidell Equipment, Inc.
6900 - 112th Avenue SE Calgary, AB T2C 4Z1 CANADA

Date Printed: 5/6/2004

VESSEL DESCRIPTION

16" O.D. x 30" S/S

Vessel designed per the ASME Boiler & Pressure Vessel Code,
Section VIII Division 1,2001 Edition, 2003 Addenda
with Advanced Pressure Vessel, Version: 8.2.1
Vessel is ASME Code Stamped

Job No: 03-248
Vessel Number: 03-248-523

NAMEPLATE INFORMATION

MAWP:	1970.00 PSI
MDMT:	-20 °F at 1970.00 PSI
Serial Number(s):	03-248-523
Year Built:	2004
Radiography:	RT 1
Postweld Heat Treated:	HT
Construction Types:	W

Notes

All applicable UG-22 loadings have been considered in this design

Signatures

Engineering: M Fudge Date: MAY 06 2004
Mike Fudge

Revision No.: _____ Date: MAY 06 2004

Table of Contents

Bidell Equipment, Inc.

Shell 1

Job No: 03-248
Number: 1

Vessel Number: 03-248-523
Mark Number: S1

Date Printed: 5/6/2004

Cylindrical Shell Design Information

Design Pressure:	1970.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	PSI	Joint Efficiency:	100	%
Shell Material:	SA-106 Gr C		Factor B Chart:	CS-2	
			Material Stress (hot):	20000	PSI
Shell Length:	30.0000	in.	Material Stress (cold):	20000	PSI
Corrosion Allowance:	0.1250	in.	Actual Circumferential Stress:	19493	PSI
External Corrosion Allowance:	0.0000	in.	Actual Longitudinal Stress:	8598	PSI
Outside Diameter (new):	16.0000	in.			
Outside Diameter (corroded):	16.0000	in.	Specific Gravity:	1.00	
Shell Surface Area:	10.47	Sq. Ft.	Weight of Fluid:	165.56	lb.
Shell Estimated Volume:	19.82	Gal.	Total Flooded Shell Weight:	577.19	lb.
			Shell Weight:	411.63	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Design Thickness Calculations

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

$$t = \frac{PR}{2SE + 0.4P} = \frac{1970.00 * 7.0940}{2 * 20000 * 1.00 + 0.4 * 1970.00} = 0.3426 + 0.1250_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0668_{\text{(12 1/2\% for pipe)}}$$

= minimum of **0.5344** in.

Circumferential Stress Calculations per Appendix 1-1(a)(1)

$$t = \frac{PR_o}{SE + 0.4P} = \frac{1970.00 * 8.0000}{20000 * 1.00 + 0.4 * 1970.00} = 0.7582 + 0.1250_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.1262_{\text{(12 1/2\% for pipe)}}$$

= minimum of **1.0094** in.

MAWP for this Shell Section Only

$$P = \frac{SEt}{R_o - 0.4t} = \frac{20000 * 1.00 * 0.7771}{8.0000 - 0.4 * 0.7771}$$

= maximum design pressure of **2021.29** PSI

External loads do not control design.

Pipe Selected: Size = **16 in.**, Schedule = **100**, Diameter = **16.0000** in., Wall = **1.0310** in.

Bidell Equipment, Inc.
Head 1

Job No: 03-248
Number: 1

Vessel Number: 03-248-523
Mark Number: H1

Date Printed: 5/6/2004

Ellipsoidal Head Design Information

Design Pressure:	1970.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	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:	0.1250	in.	Material Stress (cold):	20000	PSI
External Corrosion Allowance:	0.0000	in.	Actual Head Stress:	19240	PSI
Head Location:	Right		Straight Flange :	2.0000	in.
Outside Diameter :	16.0000	in.	Head Depth (ho) :	4.5000	in.
Thin Out :	0.1250	in.			
$K = \frac{1}{6}[2 + (D/2h)^2]$:	1.00				
Head Surface Area:	2.36	Sq. Ft.	Specific Gravity:	1.00	
Head Estimated Volume:	2.89	Gal.	Weight of Fluid:	24.09	lb.
Head Weight:	96.08	lb.	Total Flooded Head Weight:	120.16	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Design Thickness Calculations

Design Thickness Calculations per Appendix 1-4(c)

$$\frac{PD_oK}{2SE + 2P(K - 0.1)} = \frac{1970.00 * 16.0000 * 1.00}{2 * 20000 * 1.00 + 2 * 1970.00 * (1.00 - 0.1)} = 0.7239 + 0.1250_{(corrosion)} + 0.0000_{(ext.\ corrosion)} + 0.1250_{(thin\ out)}$$

= minimum of **0.9739** in.

Extreme Fiber Elongation Calculation per Paragraph UCS-79

$$\textbf{elongation} = \frac{75t}{R_f} = \frac{75 * 1.0000}{2.5500}$$

= elongation of **29.40** %

MAWP per UG-32 for this Head Only

$$P = \frac{2SEt}{KD_o - 2t(K - 0.1)} = \frac{2 * 20000 * 1.00 * 0.7500}{1.00 * 16.0000 - 2 * 0.7500 * (1.00 - 0.1)}$$

= **2047.78** PSI

External loads do not control design.

Nominal Head Thickness Selected = **1.0000** in.
Minimum Thickness after forming = **0.8750** in.

Bidell Equipment, Inc.

Nozzle 1

Job No: 03-248
Number: 1
ID Number: 1

Vessel Number: 03-248-523
Mark Number: N1

Date Printed: 5/6/2004

Nozzle Design Information

Design Pressure:	1970.00 PSI		Design Temperature:	300	°F
Static Head:	0.00 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:	0.1250 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Passes through a Category A Joint:	No	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	XXH	
Nozzle ID (new):	2.3000 in.		Nozzle Wall Thickness(new):	0.6000	in.
Nozzle ID (corroded):	2.5500 in.		Nozzle Wall Thickness(corroded):	0.4750	in.
Outer "h" Limit:	1.5625 in.		Upper Weld Leg Size(Weld 41):	0.6250	in.
Internal "h" Limit:	0.8750 in.		Internal Weld Leg Size(Weld 43):	0.5000	in.
OD, Limit of Reinforcement:	5.1000 in.		Outside Groove Weld Depth:	1.0310	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Reinforcing Pad Information

Reinforcing Material:	SA-106 Gr B		Allowable Stress at Design Temperature(S_p):	17100	PSI
			Allowable Stress at Ambient Temperature:	17100	PSI
Reinforcing Plate Thickness(t_e):	0.3750 in.		Repad to Vessel Weld Leg Size(Weld 42):	0.3125	in.
OD, Reinforcing Plate(D_p):	7.6250 in.		Repad to Nozzle Groove Weld Depth:	0.3750	in.

Host Component: Shell 1 - Shell 1

Material:	SA-106 Gr C		Shell wall thickness(new):	1.0310	in.
Material Stress(S_v):	20000 PSI		Shell wall thickness - 12½% for pipe (corroded):	0.7771	in.

Nozzle Detail Information

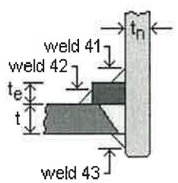


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.6250 in.

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

Nozzle Wall Thickness(t_n): 0.6000 in.

Outside Groove Weld Depth: 1.0310 in.

Repad to Vessel Weld Leg Size(Weld 42): 0.3125 in.

Repad Thickness(t_e): 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: XXH
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)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{1970.00 * 8.0000}{20000 * 1 + 0.4 * 1970.00}$$ = **0.7581** in.

Nozzle Required Thickness Calculations

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

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{1970.00 * 1.2750}{17100 * 1 - 0.6 * 1970.00}$$ = **0.1578** in.

Strength Reduction Factors

$$\mathbf{fr1} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

$$\mathbf{fr2} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

$$\mathbf{fr3} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

$$\mathbf{fr4} = \frac{Sp}{Sv} = \frac{17100}{20000} = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion) per Paragraph UG-45(a)

$$\frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{1970.00 * 1.2750}{17100 * 1.00 - 0.6 * 1970.00} + 0.1250 + 0.0000$$ = **0.2828** in.

Nozzle Thickness for Internal Pressure (plus corrosion) per Paragraph UG-45(b)(1)

$$\mathbf{t} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{1970.00 * 8.0000}{20000 * 1 + 0.4 * 1970.00} + 0.1250 + 0.0000$$ = **0.8831** in.

Minimum Thickness of Standard Wall Pipe (plus corrosion) per Paragraph UG-45(b)(4)

t = minimum thickness of standard wall pipe + Ca + ext. Ca = **0.3140** in.

Nozzle Minimum Thickness per Paragraph UG-45(b)

t = Smallest of UG-45(b)(1) or UG-45(b)(4) = **0.3140** in.

Bidell Equipment, Inc.
Nozzle 1

Job No: 03-248
Number: 1
D Number: 1

Vessel Number: 03-248-523
Mark Number: N1

Date Printed: 5/6/2004

Nozzle Reinforcement Calculations

Area Required for Internal Pressure

A = d tr F + 2 tn tr F (1 - fr1) = (2.5500 * 0.7581 * 1.00) + (2 * 0.4750 * 0.7581 * 1.00 * (1 - 0.8550)) = **2.0376** sq. in.

Area Available - Internal Pressure

A1 Formula 1 = d(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
2.5500 * (1.00 * 0.7771 - 1.00 * 0.7581) - 2 * 0.4750 * (1.00 * 0.7771 - 1.00 * 0.7581) * (1 - 0.8550) = *0.0458* sq. in.

A1 Formula 2 = 2(t + tn)(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
2 * (0.7771 + 0.4750)(1.00 * 0.7771 - 1.00 * 0.7581) - 2 * 0.4750 * (1.00 * 0.7771 - 1.00 * 0.7581) * (1 - 0.8550) = *0.0450* sq. in.

A1 = Larger value of *A1 Formula 1* and *A1 Formula 2* = **0.0458** sq. in.

A2 Formula 1 = 5(tn - trn) fr2 t = 5(0.4750 - 0.1578) * 0.8550 * 0.7771 = *1.0538* sq. in.

A2 Formula 2 = 2(tn - trn) fr2 (2.5 tn + te) = 2(0.4750 - 0.1578) * 0.8550 * (2.5 * 0.4750 + 0.3750) = *0.8475* sq. in.

A2 = Smaller value of *A2 Formula 1* and *A2 Formula 2* = **0.8475** sq. in.

A3 = Smaller value of the following :
$5 * t * t_i * f_{r2}$ = 5 * 0.7771 * 0.3500 * 0.8550 = 1.1627 sq. in.
$5 * t_i * t_i * f_{r2}$ = 5 * 0.3500 * 0.3500 * 0.8550 = 0.5237 sq. in.
$2 * h * t_i * f_{r2}$ = 2 * 0.3750 * 0.3500 * 0.8550= 0.2244 sq. in.

= **0.2244** sq. in.

A41 = $(leg)^2 * fr3 = (0.6250)^2 * 0.8550$ = **0.3340** sq. in.

A42 = Allowable Weld 42 area * fr4 = 0.0000 * 0.8550 = **0.0000** sq. in.

A43 = $(leg)^2 * fr2 = (0.3214)^2 * 0.8550$ = **0.0883** sq. in.

A5 = (Dp - d - 2tn) te fr4 = (5.1000 - 2.5500 - 2 * 0.4750) * 0.3750 * 0.8550 = **0.5130** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 2.0530 sq. in., which is **greater** than A (2.0376)

Bidell Equipment, Inc.
Nozzle 1

Job No: 03-248
Number: 1
ID Number: 1

Vessel Number: 03-248-523
Mark Number: N1

Date Printed: 5/6/2004

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16

Weld 41 tmin = smaller of 0.75, te, or tn = smaller of 0.75, 0.3750, or 0.4750 = **0.3750** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{0.2500}{0.7}$ = **0.3571** in.

Weld 41, actual weld leg = **0.6250** in.

Weld 42 tmin = smaller of 0.75, t, or te = smaller of 0.75, 0.7771, or 0.3750 = **0.3750** in.

Weld 42 Leg min. = $\frac{0.5 * \text{tmin} + \text{ext. CA}}{0.7} = \frac{0.5 * 0.3750 + 0.0000}{0.7}$ = **0.2679** in.

Weld 42, actual weld leg = **0.3125** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.7771, or 0.4750 = **0.4750** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.4750 * 0.7)) + 0.1250}}{0.7} = \frac{0.3750}{0.7}$ = **0.5357** in.

Weld 43, actual weld leg = **0.5000** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Outer fillet, Weld 42, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Repad groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 3.0250 * 0.4750 * 11970 = **27000** lb.

Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 3.5000 * 0.6250 * 8379 = **28800** lb.

Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 3.5000 * 1.0310 * 12654 = **71700** lb.

Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 3.5000 * 0.3214 * 8379 = **14800** lb.

Outer fillet in shear = ½ * π * Plate OD * weld leg * outer fillet in shear unit stress = ½ * π * 7.6250 * 0.3125 * 8379 = **31300** lb.

Repad groove weld = ½ * π * Nozzle OD * Groove Depth * repad groove weld in tension unit stress =
½ * π * 3.5000 * 0.3750 * 12654 = **26100** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [2.0376 - 0.0458 + 2 * 0.4750 * 0.8550 * (1.00 * 0.7771 - 1.0000 * 0.7581)] * 20000 = **40100** lb.

W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.8475 + 0.5130 + 0.3340 + 0.0000) * 20000 = **33900** lb.

W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.8475 + 0.2244 + 0.3340 + 0.0883 + 2 * 0.4750 * 0.7771 * 0.8550) * 20000 = **42500** lb.

W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.8475 + 0.2244 + 0.5130 + 0.3340 + 0.0000 + 0.0883 + 2 * 0.4750 * 0.7771 * 0.8550) * 20000 = **52800** lb.

Check Strength Paths

Path 1-1 = Outer fillet in shear + Nozzle wall in shear = 31300 + 27000 = **58300** lb.

Path 2-2 = Upper fillet in shear + Repad groove weld + Groove weld in tension + Inner fillet in shear =
28800 + 26100 + 71700 + 14800 = **141400** lb.

Path 3-3 = Outer fillet in shear + Inner fillet in shear + Groove weld in tension = 31300 + 14800 + 71700 = **117800** lb.

Bidell Equipment, Inc.
Nozzle 1

Job No: 03-248
Number: 1
Number: 1

Vessel Number: 03-248-523
Mark Number: N1

Date Printed: 5/6/2004

Plate Strength = A5 * Sp = 0.5130 * 17100 = **8772** lb.

Outer fillet weld strength(31300) is greater than plate strength(8772).

Bidell Equipment, Inc.
Nozzle 2

Job No: 03-248
Number: 2
D Number: 2

Vessel Number: 03-248-523
Mark Number: N2

Date Printed: 5/6/2004

Nozzle Design Information

Design Pressure:	1970.00	PSI	Design Temperature:	300	°F
Static Head:	0.00	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:	0.6250	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.1250	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Passes through a Category A Joint:	No	
Nozzle Pipe Size:	6		Nozzle Pipe Schedule:	XXH	
Nozzle ID (new):	4.8970	in.	Nozzle Wall Thickness(new):	0.8640	in.
Nozzle ID (corroded):	5.1470	in.	Nozzle Wall Thickness(corroded):	0.7390	in.
Outer "h" Limit:	1.9428	in.	Upper Weld Leg Size(Weld 41):	0.6250	in.
Internal "h" Limit:	1.5350	in.	Internal Weld Leg Size(Weld 43):	0.6250	in.
OD, Limit of Reinforcement:	10.2940	in.	Outside Groove Weld Depth:	1.0310	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Reinforcing Pad Information

Reinforcing Material:	SA-106 Gr B		Allowable Stress at Design Temperature(S_p):	17100	PSI
			Allowable Stress at Ambient Temperature:	17100	PSI
Reinforcing Plate Thickness(t_e):	0.5000	in.	Repad to Vessel Weld Leg Size(Weld 42):	0.3750	in.
OD, Reinforcing Plate(D_p):	10.7500	in.	Repad to Nozzle Groove Weld Depth:	0.5000	in.

Host Component: Shell 1 - Shell 1

Material:	SA-106 Gr C		Shell wall thickness(new):	1.0310	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness - 12½% for pipe (corroded):	0.7771	in.

Nozzle Detail Information

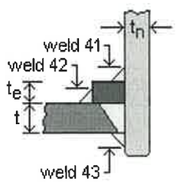


Fig. UW-16.1 (c)

Upper Weld Leg Size(Weld 41): 0.6250 in.

Internal Weld Leg Size(Weld 43): 0.6250 in.

Nozzle Wall Thickness(t_n): 0.8640 in.

Outside Groove Weld Depth: 1.0310 in.

Repad to Vessel Weld Leg Size(Weld 42): 0.3750 in.

Repad Thickness(t_e): 0.5000 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 6 Schedule: XXH
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Weld Strength Paths are adequate.

Bidell Equipment, Inc.
Nozzle 2

Job No: 03-248
Number: 2
ID Number: 2

Vessel Number: 03-248-523
Mark Number: N2

Date Printed: 5/6/2004

Required Shell Thickness per Paragraph UG-37(a)

$$\mathbf{tr} = \frac{PRo}{SE + 0.4P} = \frac{1970.00 * 8.0000}{20000 * 1 + 0.4 * 1970.00}$$ = **0.7581** in.

Nozzle Required Thickness Calculations

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

$$\mathbf{trn} = \frac{PRn}{SE - 0.6P} = \frac{1970.00 * 2.5735}{17100 * 1 - 0.6 * 1970.00}$$ = **0.3185** in.

Strength Reduction Factors

$$\mathbf{fr1} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

$$\mathbf{fr2} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

$$\mathbf{fr3} = \frac{Sn}{Sv} = \frac{17100}{20000} = 0.8550$$

$$\mathbf{fr4} = \frac{Sp}{Sv} = \frac{17100}{20000} = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion) per Paragraph UG-45(a)

$$\frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{1970.00 * 2.5735}{17100 * 1.00 - 0.6 * 1970.00} + 0.1250 + 0.0000$$ = **0.4435** in.

Nozzle Thickness for Internal Pressure (plus corrosion) per Paragraph UG-45(b)(1)

$$\mathbf{t} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{1970.00 * 8.0000}{20000 * 1 + 0.4 * 1970.00} + 0.1250 + 0.0000$$ = **0.8831** in.

Minimum Thickness of Standard Wall Pipe (plus corrosion) per Paragraph UG-45(b)(4)

t = minimum thickness of standard wall pipe + Ca + ext. Ca = **0.3700** in.

Nozzle Minimum Thickness per Paragraph UG-45(b)

t = Smallest of UG-45(b)(1) or UG-45(b)(4) = **0.3700** in.

Bidell Equipment, Inc.
Nozzle 2

Job No: 03-248
Number: 2
D Number: 2

Vessel Number: 03-248-523
Mark Number: N2

Date Printed: 5/6/2004

Nozzle Reinforcement Calculations

Area Required for Internal Pressure

A = d tr F + 2 tn tr F (1 - fr1) = (5.1470 * 0.7581 * 1.00) + (2 * 0.7390 * 0.7581 * 1.00 * (1 - 0.8550)) **= 4.0644** sq. in.

Area Available - Internal Pressure

A1 Formula 1 = d(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
5.1470 * (1.00 * 0.7771 - 1.00 * 0.7581) - 2 * 0.7390 * (1.00 * 0.7771 - 1.00 * 0.7581) * (1 - 0.8550) = *0.0937* sq. in.
A1 Formula 2 = 2(t + tn)(E1 t - F tr) - 2tn(E1 t - F tr)(1 - fr1) =
2 * (0.7771 + 0.7390)(1.00 * 0.7771 - 1.00 * 0.7581) - 2 * 0.7390 * (1.00 * 0.7771 - 1.00 * 0.7581) * (1 - 0.8550) = *0.0535* sq. in.
A1 = Larger value of *A1 Formula 1* and *A1 Formula 2* **= 0.0937** sq. in.

A2 Formula 1 = 5(tn - trn) fr2 t = 5(0.7390 - 0.3185) * 0.8550 * 0.7771 = *1.3969* sq. in.
A2 Formula 2 = 2(tn - trn) fr2 (2.5 tn + te) = 2(0.7390 - 0.3185) * 0.8550 * (2.5 * 0.7390 + 0.5000) = *1.6880* sq. in.
A2 = Smaller value of *A2 Formula 1* and *A2 Formula 2* **= 1.3969** sq. in.

A3 = Smaller value of the following :
5 * t * t_i * f_{r2} = 5 * 0.7771 * 0.6140 * 0.8550 = 2.0398 sq. in.
5 * t_i * t_i * f_{r2} = 5 * 0.6140 * 0.6140 * 0.8550 = 1.6117 sq. in.
2 * h * t_i * f_{r2} = 2 * 0.5000 * 0.6140 * 0.8550= 0.5250 sq. in.
= 0.5250 sq. in.

A41 = (leg)² * fr3 = (0.6250)² * 0.8550 **= 0.3340** sq. in.

A42 = Allowable Weld 42 area * fr4 = 0.0000 * 0.8550 **= 0.0000** sq. in.

A43 = (leg)² * fr2 = (0.4464)² * 0.8550 **= 0.1704** sq. in.

A5 = (Dp - d - 2tn) te fr4 = (10.2940 - 5.1470 - 2 * 0.7390) * 0.5000 * 0.8550 = **1.5685** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 4.0885 sq. in., which is **greater** than A (4.0644)

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16

Weld 41 tmin = smaller of 0.75, te, or tn = smaller of 0.75, 0.5000, or 0.7390 = **0.5000** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{0.2500}{0.7}$ = **0.3571** in.

Weld 41, actual weld leg = **0.6250** in.

Weld 42 tmin = smaller of 0.75, t, or te = smaller of 0.75, 0.7771, or 0.5000 = **0.5000** in.

Weld 42 Leg min. = $\frac{0.5 * \text{tmin} + \text{ext. CA}}{0.7} = \frac{0.5 * 0.5000 + 0.0000}{0.7}$ = **0.3571** in.

Weld 42, actual weld leg = **0.3750** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.7771, or 0.7390 = **0.7390** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.7390 * 0.7)) + 0.1250}}{0.7} = \frac{0.3750}{0.7}$ = **0.5357** in.

Weld 43, actual weld leg = **0.6250** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
er fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Outer fillet, Weld 42, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Repad groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 5.8860 * 0.7390 * 11970 = **81700** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 6.6250 * 0.6250 * 8379 = **54500** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 6.6250 * 1.0310 * 12654 = **135700** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 6.6250 * 0.4464 * 8379 = **38900** lb.
Outer fillet in shear = ½ * π * Plate OD * weld leg * outer fillet in shear unit stress = ½ * π * 10.7500 * 0.3750 * 8379 = **53000** lb.
Repad groove weld = ½ * π * Nozzle OD * Groove Depth * repad groove weld in tension unit stress =
½ * π * 6.6250 * 0.5000 * 12654 = **65800** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [4.0644 - 0.0937 + 2 * 0.7390 * 0.8550 * (1.00 * 0.7771 - 1.0000 * 0.7581)] * 20000 = **79900** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (1.3969 + 1.5685 + 0.3340 + 0.0000) * 20000 = **66000** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (1.3969 + 0.5250 + 0.3340 + 0.1704 + 2 * 0.7390 * 0.7771 * 0.8550) * 20000 = **68200** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(1.3969 + 0.5250 + 1.5685 + 0.3340 + 0.0000 + 0.1704 + 2 * 0.7390 * 0.7771 * 0.8550) * 20000 = **99500** lb.

Check Strength Paths

Path 1-1 = Outer fillet in shear + Nozzle wall in shear = 53000 + 81700 = **134700** lb.
Path 2-2 = Upper fillet in shear + Repad groove weld + Groove weld in tension + Inner fillet in shear =
54500 + 65800 + 135700 + 38900 = **294900** lb.
Path 3-3 = Outer fillet in shear + Inner fillet in shear + Groove weld in tension = 53000 + 38900 + 135700 = **227600** lb.

Bidell Equipment, Inc.
Nozzle 2

Job No: 03-248
Number: 2
D Number: 2

Vessel Number: 03-248-523
Mark Number: N2

Date Printed: 5/6/2004

Plate Strength = A5 * Sp = 1.5685 * 17100 = **26821** lb.

Outer fillet weld strength(53000) is greater than plate strength(26821).

Bidell Equipment, Inc.

Job No: 03-248

Vessel Number: 03-248-523

Date Printed: 5/6/2004

MDMT Report by Components

Design MDMT is -20 °F

Component	Material	Curve	Pressure	MDMT
Shell 1	SA-106 Gr C			Exempt per UG-20(f), 1-5
Head 1	SA-516 Gr 70			Exempt per UG-20(f), 1-5

The required design MDMT of -20 °F has been met or exceeded for the calculated MDMT values.

ANSI Flanges Are Not Included in MDMT Calculations.

Bidell Equipment, Inc.
16" O.D. x 30" S/S

Job No: 03-248

Vessel Number: 03-248-523

Date Printed: 5/6/2004

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)
Shell 1	1970.00 PSI	0.00 PSI	2361.85 PSI	2021.29 PSI	2021.29 PSI
Head 1	1970.00 PSI	0.00 PSI	2426.34 PSI	2047.78 PSI	2047.78 PSI

NC = Not Calculated Inc = Incomplete

Summary

Component with the lowest vessel MAWP(New & Cold) : **Shell 1**
The lowest vessel MAWP(New & Cold) : **2361.85** PSI

Component with the lowest vessel MAWP(Hot & Corroded) : **Shell 1**
The lowest vessel MAWP(Hot & Corroded) : **2021.29** PSI

Pressures are exclusive of any external loads.

Bidell Equipment, Inc.

Job No: 03-248

Vessel Number: 03-248-523

Date Printed: 5/6/2004

Summary Information

	Dry Weight	Flooded Weight
Shell	411.63 lb.	577.19 lb.
Head	96.08 lb.	120.16 lb.
Totals	507.71 lb.	697.35 lb.

	Volume
Shell	19.82 Gal.
Head	2.89 Gal.
Totals	22.71 Gal.

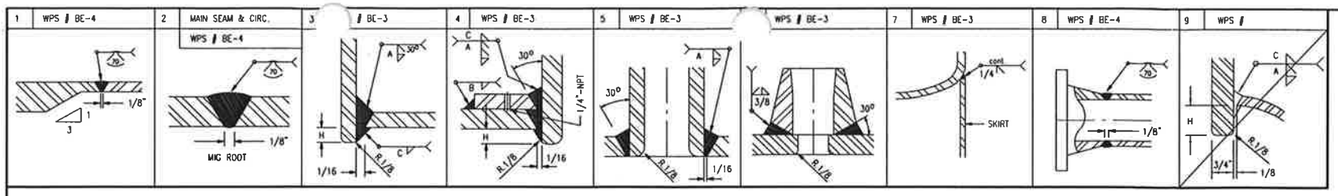
	Area
Shell	10.47 Sq. Ft.
Head	2.36 Sq. Ft.
Totals	12.83 Sq. Ft.

Hydrostatic Test Information (UG-99)

Gauge at Top

Component with controlling ratio is : Shell 1
Component with controlling pressure is : Shell 1

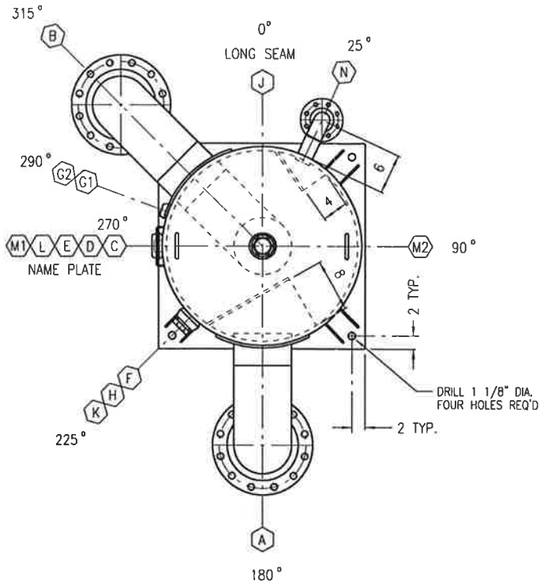
$$\text{Calculated Test Pressure} = P * 1.3 * \frac{\text{Cold Stress}}{\text{Hot Stress}} = 1970.00 * 1.3 * \frac{20000}{20000} =$$ **2561.00 PSI**



SOUR SERVICE MATERIAL

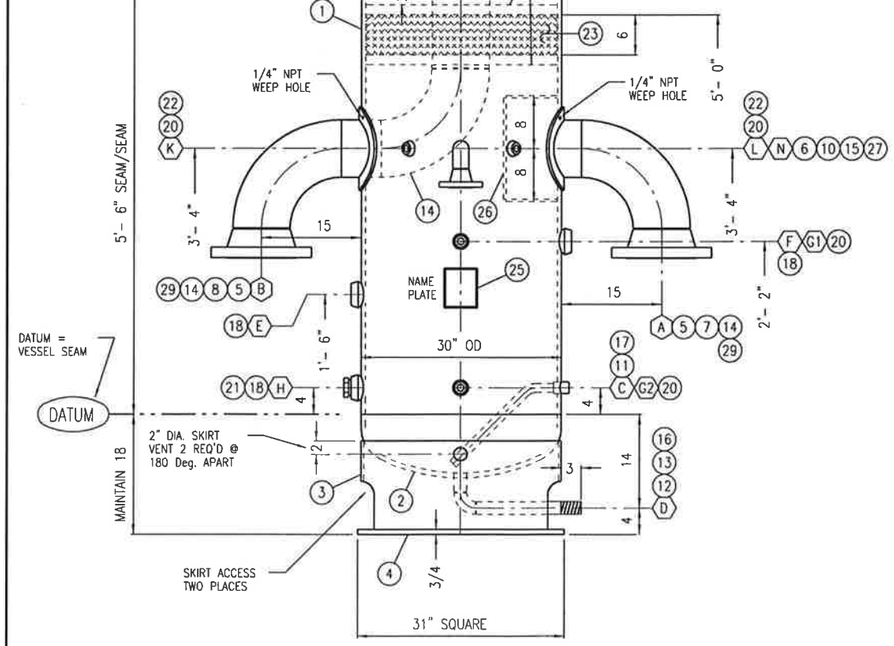
ALL Material on this Requisition/Purchase order shall meet the following Chemical and Physical Properties and shall be accompanied by Mill Test Certificates verifying this

1. Percent Manganese over Percent Carbon shall be greater than or equal to 2.5 $\left(\frac{\%MN}{\%C}\right)$
2. Percent Carbon plus one-quarter Percent Manganese $\left(\%C + \frac{\%MN}{4}\right)$ shall be less than or equal to .55
3. Hardness shall not exceed Brinell hardness No. 220



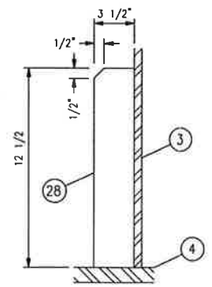
PLAN VIEW

TRUE ORIENTATION

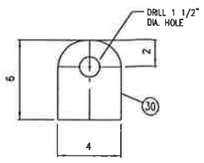


ELEVATION VIEW

NOT TRUE ORIENTATION



BASE PLATE GUSSET DETAIL



LIFTING LUG DETAIL

N.T.S. (CUT TO SUIT)

OF MATERIAL

Item	No. Req'd	Size	Description	Mat'l Spec.	HEAT No. or LOG No.
1	ONE	30"	OD x 5/8" Nom. t. ROLLED CAN x 5'-6" LG.	SA-516-70N	
2	2	30"	OD x 3/4" Nom. t. 2:1 SE HEAD c/w 2" SF	SA-516-70N	
3	ONE	30"	OD x 3/8" Nom. t. ROLLED CAN x 13.5" LG	SA-516-70N	
4	ONE	3/4"	t. BASE PLATE 31" x 31" SQUARE	SA-36	
5	2	8"	300# RFWN FLANGE XH BORE	SA-105 N	
6	ONE	2"	300# RFWN FLANGE XXH BORE	SA-105 N	
7	ONE	8"	SCH 160 SMLS PIPE x 5" LG BOE,POE	SA-106-B	
8	ONE	8"	SCH 160 SMLS PIPE x 6" LG BBE	SA-106-B	
9	ONE	8"	XH WALL SMLS PIPE x 11 1/2" LG BOE,POE	SA-106-B	
10	ONE	2"	XXH WALL SMLS PIPE x 4 1/4" LG BOE,POE	SA-106-B	
11	ONE	1"	SCH 160 SMLS PIPE x AS REQ'D TOE,POE	SA-106-B	
12	ONE	1.5"	SCH 160 SMLS PIPE x 3" LG BOE,POE	SA-106-B	
13	ONE	1.5"	SCH 160 SMLS PIPE x 15 3/4" BOE,TOE	SA-106-B	
14	3	8"	XH LR 90 Deg. BW ELBOW	SA-234-WPB	
15	ONE	2"	XXH WALL LR 90 Deg. BW ELBOW	SA-234-WPB	
16	ONE	1.5"	SCH 160 LR 90 Deg. BW ELBOW	SA-234-WPB	
17	ONE	1"	6000# F.S. THR'D FULL COUPLING	SA-105 N	
18	3	2"	3000# F.S. THREADOLET ON 30" RUN	SA-105 N	
19	ONE	2"	3000# F.S. THREADOLET ON FLAT RUN	SA-105 N	
20	4	3/4"	3000# F.S. THREADOLET ON 30" RUN	SA-105 N	
21	2	2"	6000# F.S. HEX HEAD PLUG	SA-105 N	
22	2	3/4"	6000# F.S. HEX HEAD PLUG	SA-105 N	
23	ONE	6"	t. 9# DENSITY x 28 3/4" OD MESH PAD	316 SS	
24	10	3/8"	t. x 1 1/2" BAR MESH SUPPORTS	SA-36	
25	ONE		ASME NAME PLATE c/w MNTG. BRKT.	SA-36	
26	ONE	3/8"	t. INLET BAFFLE 16" LG x AS REQ'D.	SA-516-70N	
27	ONE	3/8"	t. INLET BAFFLE 8" LG x AS REQ'D.	SA-516-70N	
28	8	3/8"	t. x 3 1/2" WIDE x 12 1/2" LG. GUSSETS	SA-36	
29	2	3/8"	t. REPADS 8 3/4" ID x 12 3/4" OD	SA-516-70N	
30	2	1/2"	t. PLATE x 4" WIDE x 6" LG.	SA-36	
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Vessel constructed in strict accordance with the 1998 edition of the ASME Code 2000 ADDENDA for Unfired Pressure Vessels Section VIII Div. 1

DESIGN				HYDROTEST
Internal Press.	655 PSIG			852 PSIG
External Press.	ATMOS.			ATMOS.
Temperature	300 Deg.F			AMBIENT
Min. Design Metal Temp.	– 20 Deg.F AT 655 PSIG			
Corr. Allowance	0.125 in 3.18 mm	Radiography	RT-1	
Mat'l Tests	NIL PER ASME UG-20f	FULL PER UW 11a		
Postweld Heat Tr.	SEE NOTE # 4	Volume	31.0 ft³ 0.878 m³	
Wt. full of water	lb kg	Shipping Wt.	2500 lb 1134 kg	

MATERIAL		Thk. Calc	Thk. Min.	Thk. Nom.	TYPE
Shell	SA-516-70N	0.610	0.625	0.625	ROLLED PLATE
Head.....End/Top	SA-516-70N	0.602	0.688	0.750	2:1 SE HEAD
Head.....End/Bottom	SA-516-70N	0.602	0.688	0.750	2:1 SE HEAD

Flange	Nozzle Neck	Coupling	Weld Filling
SA-105 N	SA-106-B	SA-105 N	SA-234-WPB
Bolts/Studs	Nuts	Gaskets	
SA-193-B7M	SA-194-2HM	316 SS FLEXITALLIC	

Special Procedures:

Service:	SOUR GAS SERVICE		
Registered Welding Procedures:	WPS 2111.2	AQP 1338	
C R N :	–		
Serial No.	01-104-501	Customer P.O.#	
Surface Prep.	SEE NOTE #2		
Finish	ONE COAT OF SHOP PRIMER		
Insulation	NONE		

NOTES:

1. TACK WELDS USED = WPS # BE-3 / BE-4
2. INTERNALLY @ EXTERNALLY CLEANED, PICKLED & OILED
3. 2" THREADOLET TO HAVE MAX. HOLE OF NO GREATER THAN 2 1/8" O.D.
4. PWHT @ 1150 Deg.F FOR ONE HOUR

ASME Eng. Per: MIKE FUDGE Date: AUG 07/01

APPROVED
FOR CONSTRUCTION

CUSTOMER PER DATE
ENGINEERING PER DATE
SHOP PROD. PER DATE

NOZZLE SCHEDULE

Ref.	Size	Rating	Type	Service	FILLET WELD SIZE W.D.	FILLET WELD SIZE A (W41)	FILLET WELD SIZE B (W42)	FILLET WELD SIZE C (W43)	PROJECTION H	PROJECTION EXT. PROJ.
A	8"	300#	RFWN	GAS INLET	1,4,8	1/2"	5/16"	1/2"	1/2"	AS SHOWN
B	8"	300#	RFWN	GAS OUTLET	1,4,8	1/2"	5/16"	1/2"	1/2"	AS SHOWN
C	1"	6000#	CPLG	DUMP	3	3/8"		3/8"	3/8"	
D	1.5"		PIPE	MANUAL DRAIN	2,5	3/8"				
E	2"	3000#	TOL	LIQUID LEVEL CONTROLLER	6	3/8"				
F	2"	3000#	TOL	HIGH LEVEL SHUTDOWN	6	3/8"				
$G_{1,2}$	3/4"	3000#	TOL	GAUGE GLASS	6	3/8"				
H	2"	3000#	TOL	INSPECTION OPENING	6	3/8"				
J	2"	3000#	TOL	INSPECTION OPENING	6	3/8"				
K	3/4"	3000#	TOL	PRESSURE INDICATOR (PLUGGED)	6	3/8"				
L	3/4"	3000#	TOL	TEMPERATURE INDICATOR (PLUGGED)	6	3/8"				
$M_{1,2}$	6"			SKIRT ACCESS						
N	2"	300#	RFWN	BYPASS INLET	3,8	3/8"		3/8"	3/8"	AS SHOWN
P										
Q										
R										

DATE	REV	ISSUED TO
AUG07	0	ISSUED TO SHOP / ABSA

DRAWING ISSUE RECORD

REV	DATE	BY	DESCRIPTION

REVISIONS

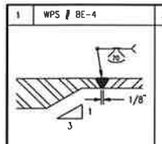
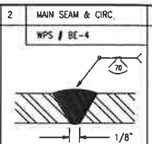
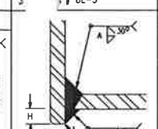
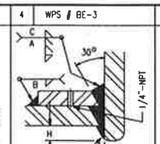
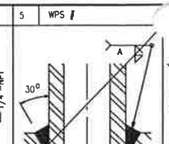
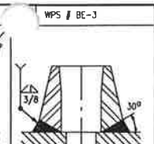
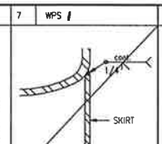
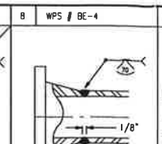
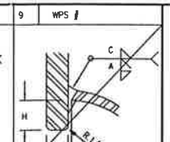
DRAWN	A.PROCHAZKA
DATE	AUG 07/01
SCALE	3/4"= 1'- 0"
CHK'D	

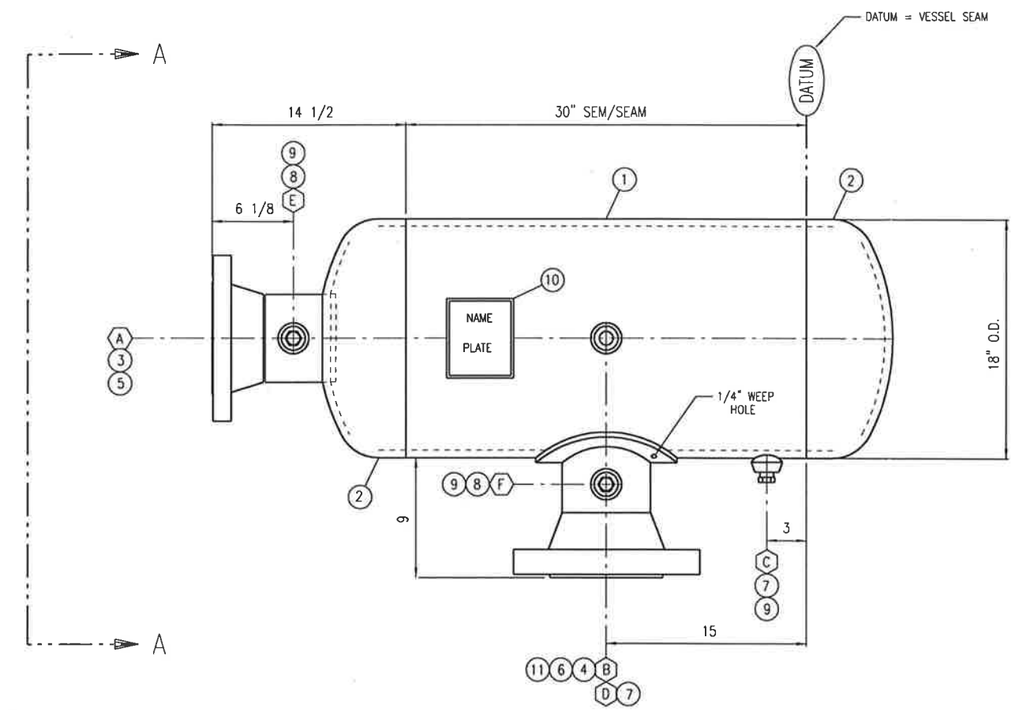
1st STAGE SCRUBBER 30" O.D.x 5'- 6"S/S

BIDELL EQUIPMENT
GAS COMPRESSION

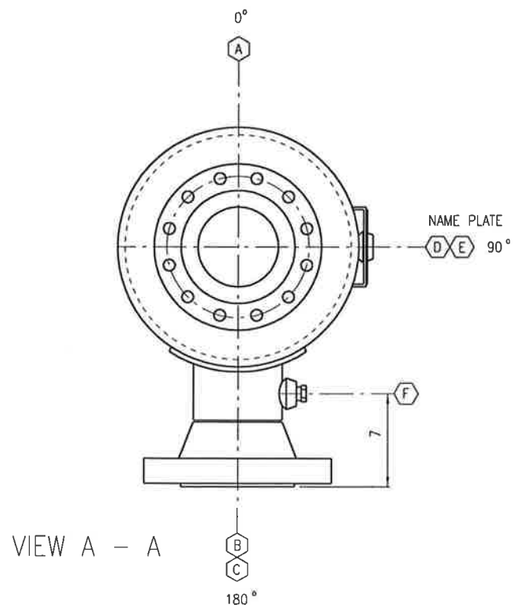
3236 – 50th AVENUE S.E.
CALGARY, ALTA. T2B-3A3
PHONE: (403) 235-5877
FAX: (403) 272-7749

CUSTOMER:	BIDELL EQUIPMENT INC.
PROJECT:	STOCK UNIT
SHOP ORDER:	01-104
DWG.No:	01-104-501
REVISION:	0

1	WPS # BE-4	2	MAIN SEAM & CIRC. WPS # BE-4	3	WPS # BE-3	4	WPS # BE-3	5	WPS #	WPS # BE-3	7	WPS #	8	WPS # BE-4	9	WPS #
																	



ELEVATION VIEW



VIEW A – A

SOUR SERVICE MATERIAL

ALL Material on this Requisition/Purchase order shall meet the following Chemical and Physical Properties and shall be accompanied by Mill Test Certificates verifying this

1. Percent Manganese over Percent Carbon shall be greater than or equal to 2.5 $\left(\frac{\%MN}{\%C}\right)$
2. Percent Carbon plus one-quarter Percent Manganese $\left(\%C + \frac{\%MN}{4}\right)$ shall be less than or equal to .55
3. Hardness shall not exceed Brinell hardness No. 220

LIST OF MATERIAL

Item	No. Req'd	Size	Description	Mat'l Spec.	HEAT No. or LOC No.
1	ONE	18"	SCH 40 SMLS PIPE x 30" LG.	SA-106-B	
2	2	18"	OD x 5/8" Nom. t. 2:1 SE HEAD c/w 2" SF	SA-516-70N	
3	ONE	6"	300# RFWN FLANGE SCH 160 BORE	SA-105 N	
4	ONE	6"	600# RFWN FLANGE XXH BORE	SA-105 N	
5	ONE	6"	SCH 160 SMLS PIPE x 5 3/4" LG BOE,POE	SA-106-B	
6	ONE	6"	XXH WALL SMLS PIPE x 5 1/2" LG BOE,POE	SA-106-B	
7	2	3/4"	3000# F.S. THREADOLET ON 18" RUN	SA-105 N	
8	2	3/4"	3000# F.S. THREADOLET ON 6" RUN	SA-105 N	
9	3	3/4"	6000# F.S. HEX HEAD PLUG	SA-105 N	
10	ONE		ASME NAME PLATE c/w MNTG. BRKT.	SA-36	
11	ONE	3/8"	t. REPAD x 6 3/4" ID x 10 3/4" OD	SA-106-B	
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U

Vessel to be constructed in strict accordance with the 1998 edition of the ASME Code 2000 ADDENDA for Unfired Pressure Vessels Section VIII Div. 1

		DESIGN			HYDROTEST
DESIGN	Internal Press.	655 PSIG			852 PSIG
	External Press.	ATMOS.			ATMOS.
	Temperature	300 Deg.F			AMBIENT
	Min. Design Metal Temp.	– 20 Deg.F AT 655 PSIG			
	Corr. Allowance	0.125 in 3.18 mm	Radiography		RT-1
	Mat'l Tests	NIL PER ASME UG-20f			ASME UW 11a
	Postweld Heat Tr.	SEE NOTE #3	Volume	4.71 ft³	0.13 m³
	Wt. full of water	lb kg	Shipping Wt.	550 lb	250 kg

MATERIAL			Thk. Calc.	Thk. Min.	Thk. Nom.	TYPE
Shell	SA-106-B		0.465	0.492	0.562	SMLS PIPE
Head,.....End/Top	SA-516-70N		0.411	0.563	0.625	2:1 SE HEAD
Head,.....End/Bottom	SA-516-70N		0.411	0.563	0.625	2:1 SE HEAD
Flange	Nozzle Neck	Coupling				Weld Fitting
SA-105 N	SA-106-B	SA-105 N				SA-234-WPB
Bolts/Studs	Nuts	Gaskets				
SA-193-B7M	SA-194-2HM	316 SS FLEXITALLIC				

Special Procedures:

Service:	SOUR GAS SERVICE		
Registered Welding Procedures:	WPS 2111.2	AQP 1338	
C R N :	–		
Serial No.	01-104-512	Customer P.O.#	
Surface Prep.	SEE NOTE # 2		
Finish	ONE COAT OF SHOP PRIMER		
Insulation	NONE		

NOTES:

1. TACK WELDS USED = WPS # BE-3 / BE-4
2. INTERNALLY & EXTERNALLY CLEANED, PICKLED & OILED
3. PWHT @ 1150 Deg.F FOR ONE HOUR

ASME Eng. Per: MIKE FUDGE Date: AUGUST 07/01

APPROVED
FOR CONSTRUCTION

CUSTOMER PER DATE
ENGINEERING PER DATE
SHOP PROD. PER DATE

NOZZLE SCHEDULE

Ref.	Size	Rating	Type	Service	FILLET WELD SIZE W.D.	A (W41)	B (W42)	C (W43)	PROJECTION H	EXT. PROJ.
A	6"	300#	RFWN	GAS INLET / INSPECTION OPENING AS PER UG-46f(7)	3.8	3/8"		3/8"	3/8"	AS SHOWN
B	6"	600#	RFWN	GAS OUTLET / INSPECTION OPENINGS AS PER UG-46f(7)	4.8	3/8"	5/16"	0"	0"	9"
C	3/4"	3000#	TOL	DRAIN	6	3/8"				
D	3/4"	3000#	TOL	TEMPERATURE CONNECTION	6	3/8"				
E	3/4"	3000#	TOL	TEST CONNECTION	6	3/8"				
F	3/4"	3000#	TOL	TEST CONNECTION	6	3/8"				
G										
H										
J										
K										
L										
M										
N										
P										
Q										
R										

REV	DATE	BY	DESCRIPTION
0	AUG07		ISSUED TO SHOP / ABSA

DRAWING ISSUE RECORD — REVISIONS

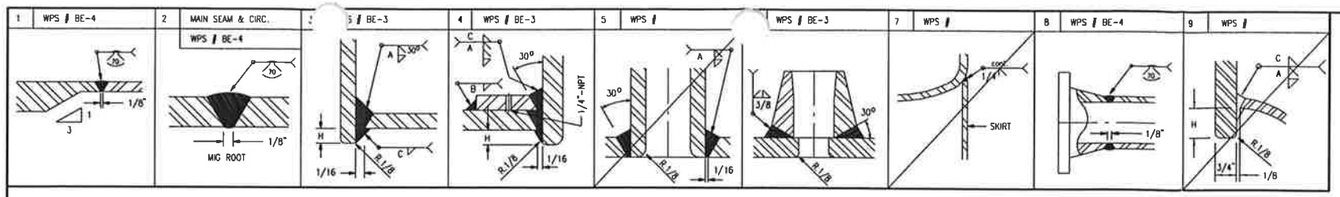
DRAWN	A.PROCHAZKA
DATE	AUGUST 07/01
SCALE	1.5" = 1'– 0"
CHK'D	

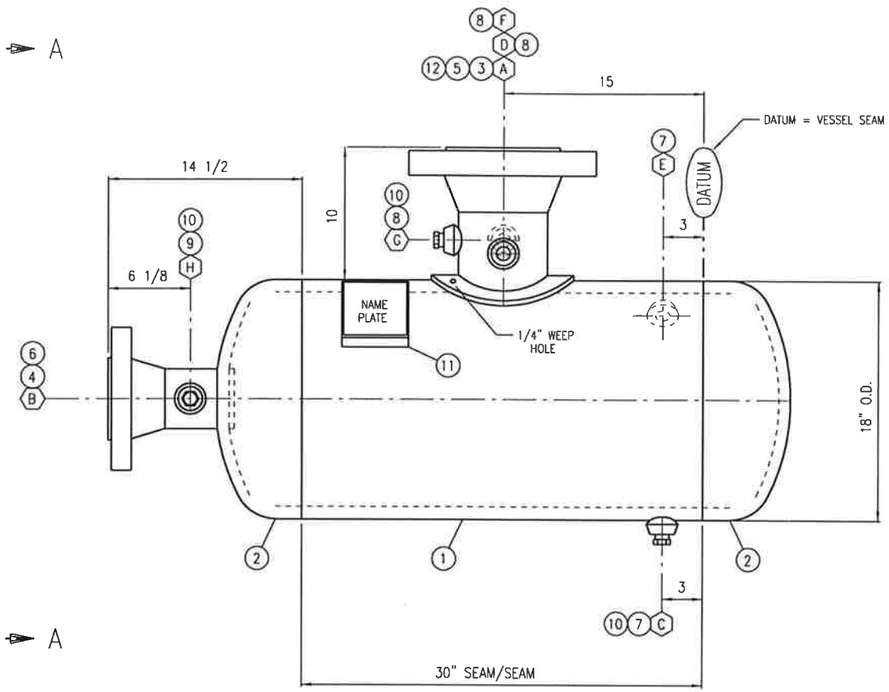
2nd STAGE SUCTION BOTTLE
18" O.D. x 2'– 6" S/S

BIDELL EQUIPMENT
GAS COMPRESSION
3236 – 50th AVENUE S.E.
CALGARY, ALTA. T2B-3A3
PHONE: (403) 235-5877
FAX: (403) 272-7749

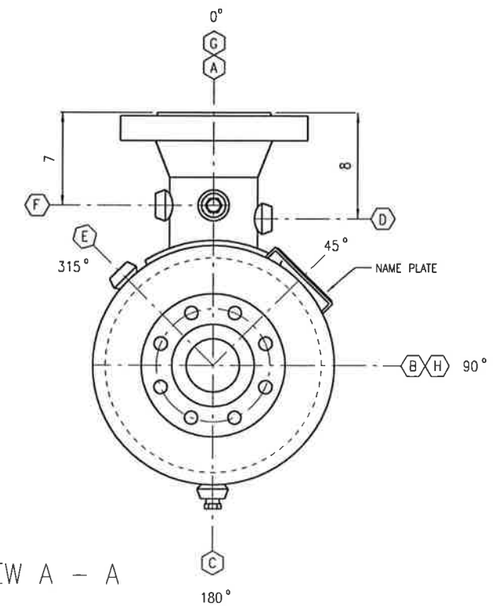
CUSTOMER:	BIDELL EQUIPMENT INC.
PROJECT:	STOCK UNIT
SHOP ORDER:	01-104
DWG.No:	01-104-512
REVISION:	0

1	WPS # BE-4	2	MAIN SEAM & CIRC. WPS # BE-4	3	WPS # BE-3	4	WPS # BE-3	5	WPS #		WPS # BE-3	7	WPS #	8	WPS # BE-4	9	WPS #





ELEVATION VIEW



VIEW A – A

SOUR SERVICE MATERIAL

ALL Material on this Requisition/Purchase order shall meet the following Chemical and Physical Properties and shall be accompanied by Mill Test Certificates verifying this

1. Percent Manganese over Percent Carbon shall be greater than or equal to 2.5 $\left(\frac{\%MN}{\%C}\right)$
2. Percent Carbon plus one-quarter Percent Manganese $\left(\%C + \frac{\%MN}{4}\right)$ shall be less than or equal to .55
3. Hardness shall not exceed Brinell hardness No. 220

BILL OF MATERIAL

Item	No. Req'd	Size	Description	Mat'l Spec.	HEAT No. or LOC No.
1	ONE	18"	SCH 80 SMLS PIPE x 30" LG.	SA-106-B	
2	2	18"	OD x 7/8" Nom. t. 2:1 SE HEAD c/w 2" SF	SA-516-70N	
3	ONE	6"	600# RFWN FLANGE XXH BORE	SA-105 N	
4	ONE	4"	600# RFWN FLANGE XXH BORE	SA-105 N	
5	ONE	6"	XXH WALL SMLS PIPE x 7" LG BOE,POE	SA-106-B	
6	ONE	4"	XXH WALL SMLS PIPE x 5 3/8" LG BOE,POE	SA-106-B	
7	3	3/4"	3000# F.S. THREADOLET ON 18" RUN	SA-105 N	
8	3	3/4"	3000# F.S. THREADOLET ON 6" RUN	SA-105 N	
9	ONE	3/4"	3000# F.S. THREADOLET ON 4" RUN	SA-105 N	
10	3	3/4"	6000# F.S. HEX HEAD PLUG	SA-105 N	
11	ONE		ASME NAME PLATE c/w MNTG. BRKT.	SA-36	
12	ONE	3/8"	t. REPAD x 6 3/4" ID x 10 3/4" OD	SA-106-B	
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U — be constructed in strict accordance w. 1998 edition of the ASME Code 2000 ADDENDA for Unfired Pressure Vessels Section VIII Div. 1

DESIGN				HYDROTEST
Internal Press.	1315 PSIG			1710 PSIG
External Press.	ATMOS.			ATMOS.
Temperature	300 Deg.F			AMBIENT

Min. Design Metal Temp. – 20 Deg.F AT 1315 PSIG

Corr. Allowance 0.125 in 3.18 mm Radiography RT-1

Mat'l Tests NIL PER ASME UG-20(f) ASME UW 11a

Postweld Heat Tr. NONE Volume 4.71 ft³ 0.13 m³

Wt. full of water lb kg Shipping Wt. 750 lb 341 kg

MATERIAL		Thk. Calc.	Thk. Min.	Thk. Nom.	TYPE
Shell	SA-106-B	0.797	0.820	0.937	SMLS PIPE
Head.....End/Top	SA-516-70N	0.684	0.750	0.875	2:1 SE HEAD
Head.....End/Bottom	SA-516-70N	0.684	0.750	0.875	2:1 SE HEAD

Flange	Nozzle Neck	Coupling	Weld Fitting
SA-105 N	SA-106-B	SA-105 N	SA-234-WPB
Bolts/Studs	Nuts	Gaskets	
SA-193-B7M	SA-194-2HM	316 SS FLEXITALLIC	

Special Procedures:

Service: SOUR GAS SERVICE

Registered Welding Procedures: WPS 2111.2 AQP 1338

C R N : –

Serial No. 01-104-522 Customer P.O.#

Surface Prep. SEE NOTE #2

Finish ONE COAT OF SHOP PRIMER

Insulation NONE

NOTES:

1. TACK WELDS USED = WPS # BE-3 / BE-4
2. INTERNALLY & EXTERNALLY CLEANED, PICKLED & OILED
3. PWHT @ 1150 Deg.F FOR ONE HOUR

ASME Eng. Per: MIKE FUDGE Date: AUGUST 15/01

APPROVED
FOR CONSTRUCTION

CUSTOMER PER DATE

ENGINEERING PER DATE

SHOP PROD. PER DATE

NOZZLE SCHEDULE

Ref.	Size	Rating	Type	Service	FILLET WELD SIZE W.O.	A (W41)	B (W42)	C (W43)	PROJECTION H	EXT. PROJ.
A	6"	600#	RFWN	GAS INLET / INSPECTION OPENING AS PER UG-46(f)(7)	4,8	3/8"	5/16"	0"	0"	10"
B	4"	600#	RFWN	GAS OUTLET / INSPECTION OPENINGS AS PER UG-46(f)(7)	3,8	5/8"		5/8"	5/8"	AS SHOWN
C	3/4"	3000#	TOL	DRAIN	6	3/8"				
D	3/4"	3000#	TOL	TEMPERATURE CONNECTION	6	3/8"				
E	3/4"	3000#	TOL	PRESSURE CONNECTION	6	3/8"				
F	3/4"	3000#	TOL	HIGH TEMPERATURE SHUT-DOWN	6	3/8"				
G	3/4"	3000#	TOL	TEST CONNECTION	6	3/8"				
H	3/4"	3000#	TOL	TEST CONNECTION	6	3/8"				
J										
K										
L										
M										
N										
P										
Q										
R										

DRAWING ISSUE RECORD			REVISIONS			
AUG15	0	ISSUED TO SHOP / ABSA				
DATE	REV	ISSUED TO	REV	DATE	BY	DESCRIPTION

DRAWN A.PROCHAZKA
DATE AUG 15/01
SCALE 1.5" = 1'-0"
CHK'D

2nd STAGE DISCHARGE BOTTLE
18" O.D. x 2'- 6" S/S

BIDELL EQUIPMENT
GAS COMPRESSION
3236 – 50th AVENUE S.E.
CALGARY, ALTA. T2B-3A3
PHONE: (403) 235-5877
FAX: (403) 272-7749

CUSTOMER: BIDELL EQUIPMENT INC.
PROJECT: STOCK UNIT
SHOP ORDER: 01-104

DWG.No:01-104-522 REVISION: 0