T-2816-1

Report Date: 11/21/95

Alabama Heat Exchangers, Inc.
5751 La Rue Steiner Rd.
Theodore, Al. 36582

CUSTOMER
HULS AMERICA INC.
P. O. BOX 889
THEODORE, AL. 36590

VESSEL DESCRIPTION
ESTER WASH WATER STRIPPING COLUMN
Vessel Number: T-2816-1
Drawing Number: 3356B951
ASME Code stamped: Yes
Vessel designed per the ASME Boiler & Pressure Vessel Code,
Section VIII, Division 1. 1992 Edition, 1993 addenda
with Advanced Pressure Vessel, Version 5.61d

JOB NUMBER
3356-B

NAMEPLATE INFORMATION
MAWP: 50.00 PSI and Full Vacuum at 356 F
MDMT: -20 F at 50.00 PSI

Serial Number(s): _____
National Board Number(s): _____

Year built: 1995
Radiography: None
Postweld heat treated: No
Lethal service: No

Engineering Manager _____ date: ___/___/___

Q.C. Manager _____ date: ___/___/___

Authorized Inspector _____ date: ___/___/___

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Alabama Heat Exchangers, Inc.
November 28, 1995
ASME Section VIII, Div. 1, 1992 Edition, 1994 Addenda

Job/Quote No : 3356-B Customer: HULS AMERICA INC.
Shell Desc. : MAIN SHELL
Designed: Neville J. Alloo Design Date: June 23, 1995
Checked : Approved:

Cylindrical Shell - Internal Pressure

Design Pressure :	50.00 PSI	Static Head:	0.00 PSI
Shell Material :	SA-312, Type TP316L, WLD	Joint Efficiency:	85 Pct.
Matl Condition :	S31603, HIGH	Design Temperature:	356 F
Matl stress(hot):	13432 PSI	Material stress (cold):	14200 PSI
Shell Length :	158.125 In.	Corrosion Allowance :	0.0000 In.
Shell Area :	22.9 Sq. Ft.	Outside diameter :	6.6250 In.
Shell Weight :	125.3 Lbs.		
Specific Gravity:	1.0000	Shell Estimated Volume:	21.73 Gal.
Weight of Fluid :	182 Lbs.	Total Flooded Shell Weight:	306.8 Lbs.
Actual Stress :	1639 PSI	Actual Longitudinal Stress:	786 PSI
MAWP(new & cold):	433.4 PSI	MAWP (at design):	409.75 PSI

Material is exempt from impact testing per UHA-51(d)
Minimum Design Metal Temperature: -20 F

Longitudinal Stress Calculations - UG-27(c)(2):
t = PR /(2SE +0.4P) =50 * 3.1785 /(2 * 13432 * 0.85 + 0.4 * 50)
t = 0.0070 +0.0000 (corrosion) +0.0010 (12 1/2% for pipe)= 0.0080 In. min

Design Thickness per Appendix 1-1(a)(1)
Circumferential Stress Calculations:
t = PRo /(SE +0.4P) = 50 * 3.3125 / (13432 * 0.85 + 0.4 * 50)
t = 0.0145 +0.0000 (corrosion) +0.0021 (12 1/2% for pipe)= 0.0166 In. min

PIPE SELECTED: diameter= 6 In schedule= 10S wall= 0.1340 Inches

Cylindrical Shell - External Pressure

Design Pa :	15.00 PSI	Dimension L :	120.0000 In.
		Factor B chart :	HA-4
Ext. minimum t :	0.0682 In.	Ext. nominal t :	0.1340 In.
minimum L / Do :	18.11	nominal L / Do :	18.11
minimum Do / t :	110.97	nominal Do / t :	56.53
min. Factor A :	0.000095	nom. Factor A :	0.000356
min. Factor B :	1252	nom. Factor B :	4702

minimum Pa = 4B / 3(Do/t) = 4 * 1252 / 3 (6.6250 / 0.0597)
nominal Pa = 4B / 3(Do/t) = 4 * 4702 / 3 (6.6250 / 0.1172)

MINIMUM EXTERNAL PRESSURE, (using minimum t) Pa = 15.04 PSI
MAXIMUM EXTERNAL PRESSURE, (using nominal t) Pa = 110.90 PSI

Nozzle in the shell

ASME Section VIII, Div. 1, 1992 Edition, 1994 Addenda

Job/Quote No : 3356-B Nozzle Number: A1

Description : 1-1/2" SCH 40 Quantity: 1

Configuration: Nozzle passing thru the vessel, attached by a groove weld.

: Nozzle does not pass thru a category A joint.

Required shell thickness per UG-37(a)

Shell material : SA-312, Type TP316L, WLD Material Stress: 13432

Shell wall, new: 0.1340 Shell wall (-12.5%), corroded: 0.1172

tr = PRo / (SE + 0.4P)

tr = 50 * 3.3125 / (13432 * 1 + 0.4 * 50) = 0.0123

Flange Class:150 Material Gr.: 2.3, 316L Maximum Pressure: 167

Nozzle Material: SA-312 TP316L WLD Condition: HIGH

Stress (hot) : 13432 PSI Stress (cold): 14200 PSI

Nozzle pipe size : 1.5 Nozzle pipe schedule: 40

Joint efficiency E1: 1.00 Nozzle corrosion allowance: 0.0000 In.

Nozzle ID, new : 1.6100 In. Nozzle wall, new: 0.1450 In.

Nozzle ID, corroded: 1.6100 In. Nozzle wall, corroded: 0.1450 In.

OD, limit of reinf : 3.2200 In. Correction factor F: 1.00

External projection: 6.0000 In. Internal projection: 0.9375 In.

Outer "h" limit : 0.2930 In. Internal "h" limit: 0.2930 In.

Upper weld, weld 41: 0.1340 In. Internal weld, weld 43: 0.1340 In.

Groove weld depth : 0.1340 In.

fr1= Sn/Sv = 13432 / 13432= 1.000 fr2= Sn/Sv = 13432 / 13432= 1.000

fr3= Sn/Sv = 13432 / 13432= 1.000

exempt per UHA-51(a)

Minimum Design Metal Temperature: -20 F

UG-45 Calculations

The wall thickness shall not be less than the greater of the following:

UG-45(a) - thickness for pressure loading plus corrosion.

t = (P Rn / (SE - 0.6 P)) + CA nozzle efficiency(E): 100 %

t = (50 * 0.8050 / (13432 * 1.00 - 0.6 * 50)) + 0.0000 = 0.0030 In.

UG-45(b) - the smaller of UG-45(b)(3) or UG-45(b)(4):

UG-45(b)(3) - the greater of UG-45(b)(1) or UG-45(b)(2):

UG-45(b)(1) - the thickness (plus CA) required for internal pressure.

t = PRo / (SE + 0.4P) + corrosion

t = 50 * 3.3125 / (13432 * 1 + 0.4 * 50) + 0.0000 : 0.0123 In.

UG-45(b)(2) - the thickness (plus CA) required for external pressure.

t = PRo / (SE + 0.4P) + corrosion

t = (15.00 * 3.3125 / (13432 * 1 + 0.4 * 15.00)) + 0.0000 : 0.0037 In.

UG-45(b)(4) - minimum thickness of standard wall pipe plus CA : 0.1269 In.

UG-45(b) = 0.0123 In.

Wall thickness for pipe = tn * 0.875

Wall thickness of 0.1269 is greater than or equal to UG-45 value of 0.0123

Reinforcement calculations are not required per UG-36(c)(3)(a)

Check the welds per UW-16

tmin, weld 41 = lesser of 0.75 or t or tn = 0.75 or 0.1172 or 0.1450 = 0.1172
Weld 41, leg min.=(lesser of 0.25 or (tmin * 0.7))/0.7 = 0.0820 / 0.7 = 0.1172
Weld 41, actual weld leg = 0.1340

tmin, weld 43 = lesser of 0.75 or t or tn = 0.75 or 0.1172 or 0.1450 = 0.1172
Weld 43, leg min.=(lesser of 0.25 or (tmin * 0.7))/0.7 = 0.0820 / 0.7 = 0.1172
Weld 43, actual weld leg = 0.1340

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

Nozzle wall in shear	= 0.70 * 13432	=	9402 PSI
Upper fillet, weld 41, in shear	= 0.49 * 13432	=	6582 PSI
Vessel groove weld in tension	= 0.74 * 13432	=	9940 PSI
Inner fillet, weld 43, in shear	= 0.49 * 13432	=	6582 PSI

Strength of connection elements

Nozzle wall in shear	= Pi/2 * mean nozzle diameter * tn * 9402		
	= 1.57 * 1.7550 * 0.1450 * 9402	=	3800 Lbs.
Upper fillet in shear	= Pi/2 * nozzle O.D. * weld leg * 6582		
	= 1.57 * 1.9000 * 0.1340 * 6582	=	2600 Lbs.
Groove weld tension	= Pi/2 * nozzle O.D. * weld leg * 9940		
	= 1.57 * 1.9000 * 0.1340 * 9940	=	4000 Lbs.
Inner fillet in shear	= Pi/2 * nozzle O.D. * weld leg * 6582		
	= 1.57 * 1.9000 * 0.1340 * 6582	=	2600 Lbs.

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

W = [A -(d - 2tn)(Elt - Ftr)]s = [0.0198-(1.6100 -2 *0.1450)
(1.00 * 0.1172 - 1.00 * 0.0123)] * 13432 = -1500 Lbs.

W1-1 = (A2 + A5 + A41 + A42) * S
= (0.0832 + 0.0000 + 0.0180 + 0.0000) * 13432 = 1400 Lbs.

W2-2 = (A2 + A3 + A41 + A43 + 2tn *t *fr1) S = (0.0832 + 0.0850
+0.0180 +0.0180 +2 * 0.1450 * 0.1172 * 1.000) 13432 = 3200 Lbs.

W3-3 = (A2 +A3 +A5 +A41 +A42 +A43 + 2tn * t * fr1) S
(0.0832 + 0.0850 + 0.0000 +0.0180 +0.0000 +0.0180
+ 2 * 0.1450 * 0.1172 * 1.000) * 13432 = 3200 Lbs.

Check strength paths

Path 1-1 =	2600 +	3800		=	6400 Lbs.
Path 2-2 =	2600 +	4000 +	2600	=	9200 Lbs.
Path 3-3 =	2600 +	2600 +	4000	=	9200 Lbs.

Nozzle in the shell

Job/Quote No : 3356-B Nozzle Number: P1, P2 & A2
Description : 2" SCH 40 Quantity: 3
Configuration: Nozzle passing thru the vessel, attached by a groove weld.
: Nozzle does not pass thru a category A joint.

Required shell thickness per UG-37(a)

Shell material : SA-312, Type TP316L, WLD Material Stress: 13432
Shell wall, new: 0.1340 Shell wall (-12.5%), corroded: 0.1172
tr = PRo / (SE + 0.4P)
tr = 50 * 3.3125 / (13432 * 1 + 0.4 * 50) = 0.0123

Flange Class:150 Material Gr.: 2.3, 316L Maximum Pressure: 167
Nozzle Material: SA-312 TP316L WLD Condition: HIGH
Stress (hot) : 13432 PSI Stress (cold): 14200 PSI
Nozzle pipe size : 2 In Nozzle pipe schedule: 40
Joint efficiency E1: 1.00 Nozzle corrosion allowance: 0.0000 In.
Nozzle ID, new : 2.0670 In. Nozzle wall, new: 0.1540 In.
Nozzle ID, corroded: 2.0670 In. Nozzle wall, corroded: 0.1540 In.
OD, limit of reinf : 4.1340 In. Correction factor F: 1.00
External projection: 6.0000 In. Internal projection: 0.0000 In.
Outer "h" limit : 0.2930 In. Internal "h" limit: 0.2930 In.
Upper weld, weld 41: 0.1340 In. Internal weld, weld 43: 0.0000 In.
Groove weld depth : 0.1340 In.

fr1= Sn/Sv = 13432 / 13432= 1.000 fr2= Sn/Sv = 13432 / 13432= 1.000
fr3= Sn/Sv = 13432 / 13432= 1.000
exempt per UHA-51(a)

Minimum Design Metal Temperature: -20 F

UG-45 Calculations

The wall thickness shall not be less than the greater of the following:

UG-45(a) - thickness for pressure loading plus corrosion.
t = (P Rn / (SE - 0.6 P)) + CA nozzle efficiency(E): 100 %
t = (50 * 1.0335 / (13432 * 1.00 - 0.6 * 50)) + 0.0000 = 0.0039 In.

UG-45(b) - the smaller of UG-45(b)(3) or UG-45(b)(4):
UG-45(b)(3) - the greater of UG-45(b)(1) or UG-45(b)(2):
UG-45(b)(1) - the thickness (plus CA) required for internal pressure.
t = PRo / (SE + 0.4P) + corrosion
t = 50 * 3.3125 / (13432 * 1 + 0.4 * 50) + 0.0000 : 0.0123 In.
UG-45(b)(2) - the thickness (plus CA) required for external pressure.
t = PRo / (SE + 0.4P) + corrosion
t = (15.00 * 3.3125 / (13432 * 1 + 0.4 * 15.00)) + 0.0000 : 0.0037 In.

UG-45(b)(4) - minimum thickness of standard wall pipe plus CA : 0.1347 In.
UG-45(b) = 0.0123 In.
Wall thickness for pipe = tn * 0.875
Wall thickness of 0.1347 is greater than or equal to UG-45 value of 0.0123

Reinforcement calculations are not required per UG-36(c)(3)(a)

Check the welds per UW-16

tmin, weld 41 = lesser of 0.75 or t or tn = 0.75 or 0.1172 or 0.1540 = 0.1172
Weld 41, leg min.=(lesser of 0.25 or (tmin * 0.7))/0.7 = 0.0820 / 0.7 = 0.1172
Weld 41, actual weld leg = 0.1340

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

Nozzle wall in shear	= 0.70 * 13432	=	9402 PSI
Upper fillet, weld 41, in shear	= 0.49 * 13432	=	6582 PSI
Vessel groove weld in tension	= 0.74 * 13432	=	9940 PSI

Strength of connection elements

Nozzle wall in shear	= Pi/2 * mean nozzle diameter * tn * 9402		
	= 1.57 * 2.2210 * 0.1540 * 9402	=	5000 Lbs.
Upper fillet in shear	= Pi/2 * nozzle O.D. * weld leg * 6582		
	= 1.57 * 2.3750 * 0.1340 * 6582	=	3300 Lbs.
Groove weld tension	= Pi/2 * nozzle O.D. * weld leg * 9940		
	= 1.57 * 2.3750 * 0.1172 * 9940	=	4300 Lbs.

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

W = [A -(d - 2tn)(E1t - Ftr)]s = [0.0254-(2.0670 -2 *0.1540)
(1.00 * 0.1172 - 1.00 * 0.0123)] * 13432 = -2100 Lbs.

W1-1 = (A2 + A5 + A41 + A42) * S
= (0.0880 + 0.0000 + 0.0180 + 0.0000) * 13432 = 1400 Lbs.

W2-2 = (A2 + A3 + A41 + A43 + 2tn *t *fr1) S = (0.0880 + 0.0000
+0.0180 +0.0000 +2 * 0.1540 * 0.1172 * 1.000) 13432 = 1900 Lbs.

W3-3 = (A2 +A3 +A5 +A41 +A42 +A43 + 2tn * t * fr1) S
(0.0880 + 0.0000 + 0.0000 +0.0180 +0.0000 +0.0000
+ 2 * 0.1540 * 0.1172 * 1.000) * 13432 = 1900 Lbs.

Check strength paths

Path 1-1 =	3300 + 5000	=	8300 Lbs.
Path 2-2 =	3300 + 4300	=	7600 Lbs.
Path 3-3 =	3300 + 0 + 4300	=	7600 Lbs.

Job/Quote No : 3356-B Customer: HULS AMERICA INC.
Head Desc. : END CAP
Designed: Neville J. Alloo Design Date: June 23, 1995
Checked : Approved:
External loads do not control design.

Ellipsoidal Head - Internal Pressure

Design Pressure :	50.00 PSI	Static Head:	0.00 PSI
Head Material :	SA-403, Type 316L WP-W	Joint efficiency:	85 Pct.
Matl Condition :	S31603	Design Temperature:	356 F
Matl stress(hot):	13432 PSI	Material stress (cold):	14200 PSI
Actual Stress :	1610 PSI	Corrosion Allowance:	0.0000 In.
Head Location :	Bottom & Top	Outside diameter :	6.6250 In.
Head Quantity :	2		
Total Head Area :	1.1 Sq. Ft.	Total Head Est. Volume:	0.76 Gal.
Total Head Wt. :	6.3 Lbs.	Weight of Fluid :	6 Lbs.
Specific Gravity:	1.0000	Total Flooded Head Weight:	12.6 Lbs.
MAWP(new & cold):	441.1 PSI	MAWP (at design):	417.24 PSI
Straight Flange :	1.7000 In.	Thin Out :	0.0168 In.

Head Depth (ho) : 1.7233 In. K = 1/6 [2 + Sq (D/2h)]: 1.00
Material is exempt from impact testing per UHA-51(d)
Minimum Design Metal Temperature: -20 F

Design Thickness per Appendix 1-4(c)

$t = PDoK / (2SE + 2P(K - 0.1))$
$t = 50 * 6.6250 * 1.00 / (2 * 13432 * 0.85 + 2 * 50 (1.00 - 0.1))$
$t = 0.0145 + 0.0000$ (corrosion) $+ 0.0168$ (thin out) $= 0.0313$ In. min.

NOMINAL HEAD THICKNESS SELECTED = 0.1340 Inches

External Pressure

Design Pa :	15.00 PSI	Factor B chart :	HA-4
Ext. minimum t :	0.0339 In.	Ext. nominal t :	0.1340 In.
min. Factor A :	0.000375	nom. Factor A :	0.002571
min. Factor B :	5028	nom. Factor B :	8033
t -Ca -thin out:	0.0171 In.	t -Ca -thin out:	0.1172 In.

minimum Pa = B / (Ro/t) = 5028 / (5.6975 / 0.0171)
nominal Pa = B / (Ro/t) = 8033 / (5.6975 / 0.1172)

MINIMUM EXTERNAL PRESSURE, (using minimum t) Pa = 15.09 PSI
MAXIMUM EXTERNAL PRESSURE, (using nominal t) Pa = 165.24 PSI

Configuration: Nozzle passing thru the vessel, attached by a groove weld.
: Nozzle does not pass thru a category A joint.

Required head thickness per UG-37(a)

Head material : SA-403, Type 316L WP-W Material Stress: 13432
Head wall, nom.: 0.1340 Head wall, corroded and thinned: 0.1172
tr = P K1 Do / (2 SE + 0.8 P)
tr =50 *0.90 *6.6250/(2 *13432 *1 + 0.8 *50)= 0.0111

Flange Class:150 Material Gr.: 2.3, 316L Maximum Pressure: 167
Nozzle Material: SA-312 TP316L WLD Condition: HIGH
Stress (hot) : 13432 PSI Stress (cold): 14200 PSI
Nozzle pipe size : 2 In Nozzle pipe schedule: 40
Joint efficiency E1: 1.00 Nozzle corrosion allowance: 0.0000 In.
Nozzle ID, new : 2.0670 In. Nozzle wall, new: 0.1540 In.
Nozzle ID, corroded: 2.0670 In. Nozzle wall, corroded: 0.1540 In.
OD, limit of reinf : 4.1340 In. Correction factor F: 1.00
External projection: 6.0000 In. Internal projection: 0.0000 In.
Outer "h" limit : 0.2930 In. Internal "h" limit: 0.2930 In.
Upper weld, weld 41: 0.1340 In. Internal weld, weld 43: 0.0000 In.
Groove weld depth : 0.1340 In.

fr1= Sn/Sv = 13432 / 13432= 1.000 fr2= Sn/Sv = 13432 / 13432= 1.000
fr3= Sn/Sv = 13432 / 13432= 1.000
exempt per UHA-51(a)

Minimum Design Metal Temperature: -20 F

UG-45 Calculations

The wall thickness shall not be less than the greater of the following:

UG-45(a) - thickness for pressure loading plus corrosion.
t = (P Rn / (SE - 0.6 P)) + CA nozzle efficiency(E): 100 %
t = (50 * 1.0335 / (13432 * 1.00 - 0.6 * 50)) + 0.0000 = 0.0039 In.

UG-45(b) - the smaller of UG-45(b)(3) or UG-45(b)(4):
UG-45(b)(3) - the greater of UG-45(b)(1) or UG-45(b)(2):
UG-45(b)(1) - the thickness (plus CA) required for internal pressure.
t = P K Do / (2 SE + 2P (K - 0.1)) + corrosion
t =50*1.00*6.6250/(2*13432*1+2*50(1.00-0.1))+0.0000 : 0.0123 In.
UG-45(b)(2) - the thickness (plus CA) required for external pressure.
t = P K Do / (2 SE + 2P (K - 0.1)) + corrosion
t =15*1.00*6.6250/(2*13432*1 +2*15(1.00-0.1))+0.0000 : 0.0037 In.

UG-45(b)(4) - minimum thickness of standard wall pipe plus CA : 0.1347 In.
UG-45(b) = 0.0123 In.

Wall thickness for pipe = tn * 0.875
Wall thickness of 0.1347 is greater than or equal to UG-45 value of 0.0123

Reinforcement calculations are not required per UG-36(c)(3)(a)

Check the welds per UW-16

tmin, weld 41 = lesser of 0.75 or t or tn = 0.75 or 0.1172 or 0.1540 = 0.1172
Weld 41, leg min.=(lesser of 0.25 or (tmin * 0.7))/0.7 = 0.0820 / 0.7 = 0.1172
Weld 41, actual weld leg = 0.1340

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

Nozzle wall in shear	= 0.70 * 13432	=	9402 PSI
Upper fillet, weld 41, in shear	= 0.49 * 13432	=	6582 PSI
Vessel groove weld in tension	= 0.74 * 13432	=	9940 PSI

Strength of connection elements

Nozzle wall in shear	= Pi/2 * mean nozzle diameter * tn * 9402		
	= 1.57 * 2.2210 * 0.1540 * 9402	=	5000 Lbs.
Upper fillet in shear	= Pi/2 * nozzle O.D. * weld leg * 6582		
	= 1.57 * 2.3750 * 0.1340 * 6582	=	3300 Lbs.
Groove weld tension	= Pi/2 * nozzle O.D. * weld leg * 9940		
	= 1.57 * 2.3750 * 0.1172 * 9940	=	4300 Lbs.

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

W = [A -(d - 2tn)(E1t - Ftr)]s = [0.0229-(2.0670 -2 *0.1540)
(1.00 * 0.1172 - 1.00 * 0.0111)] * 13432 = -2100 Lbs.

W1-1 = (A2 + A5 + A41 + A42) * S
= (0.0880 + 0.0000 + 0.0180 + 0.0000) * 13432 = 1400 Lbs.

W2-2 = (A2 + A3 + A41 + A43 + 2tn *t *fr1) S = (0.0880 + 0.0000
+0.0180 +0.0000 +2 * 0.1540 * 0.1172 * 1.000) 13432 = 1900 Lbs.

W3-3 = (A2 +A3 +A5 +A41 +A42 +A43 + 2tn * t * fr1) S
(0.0880 + 0.0000 + 0.0000 +0.0180 +0.0000 +0.0000
+ 2 * 0.1540 * 0.1172 * 1.000) * 13432 = 1900 Lbs.

Check strength paths

Path 1-1 =	3300 +	5000			=	8300 Lbs.
Path 2-2 =	3300 +	4300			=	7600 Lbs.
Path 3-3 =	3300 +	0 +	4300		=	7600 Lbs.

Flange description: 2" 150# BLIND FLANGE

Design Pressure : 50.00 PSI	Corrosion Allowance:0.0000 in.
Static Head: 0.00 PSI	Design Temperature: 356 F
Flange Material : SA-182 F316L	Condition: HIGH
Hot Stress (Sfo): 14632 PSI	Cold Stress (Sfa): 16300 PSI
Flange Weight : 6.0 lb	Flange MAWP (at design): 561.14 PSI
exempt per UHA-51(a)	

Minimum Design Metal Temperature: -20 F

Bolting Material: SA-193 Gr B8M	Condition: 1
Hot Stress (Sb) : 14872 PSI	Cold Stress (Sa) : 18800 PSI

Gasket and Facing Details

Gasket Material : GARLOCK 3100	
Gasket Type :	Gasket Factor m: 2.80
Configuration : Ring type	Seating stress y: 3150 PSI
Seating column : Column I	Facing sketch: 1a
Gasket width (N): 0.5000 in.	O.D. contact face: 3.6250 in.

Bolting Details

Number of bolts : 4	Nominal bolt diameter (a): 0.6250 in.
Bolt root area : 0.2020 in^2	Bolt hole diameter: 0.7500 in.

Flange Dimensions

End diameter(ID): 0.0000 in.	
Bolt circle (C) : 4.3750 in.	Outside diameter (A): 6.0000 in.
Head factor C : 0.300	Weld Efficiency (%) : 100

Gasket Seating Calculations (Table 2-5.2)

b0 = N / 2 = 0.5000 / 2 = 0.2500 in.
Since b0 <= 1/4 in., b = b0 = 0.2500 in.
G = (O.D. contact face) - N = 3.1250 in.

Load and Bolting Calculations

Min. Wm2 = (Pi)bGy = Pi * 0.2500 * 3.1250 * 3150 = 7731 lb
H = (Pi/4)(G^2)P = (Pi / 4) * Sqr(3.1250) * 50.00 = 383 lb
Hp = 2b(Pi)GmP = 2 * 0.2500 * Pi * 3.1250 * 2.80 * 50.00 = 687 lb
Min. Wm1 = H + Hp = 383 + 687 = 1070 lb
Am1 = Wm1 / Sb = 1070 / 14872 = 0.0719 in^2
Am2 = Wm2 / Sa = 7731 / 18800 = 0.4112 in^2
Am = greater of Am1 or Am2 = greater of 0.0719 or 0.4112 = 0.4112 in^2
Ab = No. of bolts * Bolt root area = 4 * 0.2020 = 0.8080 in^2
W = (Am + Ab)Sa/2 = (0.4112 + 0.8080) * 18800 / 2 = 11460 lb

Thickness Calculations

hG = (C - G) / 2 = (4.3750 - 3.1250) / 2 = 0.6250 in.
Min. t (Operating) = G * SqRt(CP / SE + 1.9 Wm1 hG / SE G^3) =
3.1250 * SqRt(0.300 * 50.00 / 14632 * 1.00 +
1.9 * 1070 * 0.6250 / 14632 * 1.00 * 3.1250^3) = 0.1944 in.
Min. t (Seating) = G * SqRt(1.9 W hG / SE G^3) = 3.1250 *
SqRt(1.9 * 11460 * 0.6250 / 14632 * 1.00 * 3.1250^3) = 0.5169 in.
Min. t = max(0.1944, 0.5169) + CA = 0.5169 + 0.0000 = 0.5169 in.
Minimum thickness = 0.5169 in. Nominal thickness = 0.7500 in.

Ab >= Am, bolting is adequate for flange design.

Nominal t >= Minimum t, flange thickness is adequate for flange design.

Item	Design Pressure	Static Head	MAWP New & Cold	MAWP Hot & Corr.
MAIN SHELL	50.00	0.00	433.37	409.75
Nozzle No. A1	50.00	0.00	509.84	482.27
ANSI Flange Cl: 150 Gr:2.3,	50.00	0.00	230.00	167.00
Nozzle No. P1, P2 & A2	50.00	0.00	509.84	482.27
ANSI Flange Cl: 150 Gr:2.3,	50.00	0.00	230.00	167.00
END CAP	50.00	0.00	441.10	417.24
Nozzle No. V1 & B1	50.00	0.00	567.39	536.71
ANSI Flange Cl: 150 Gr:2.3,	50.00	0.00	230.00	167.00
2" 150# BLIND FLANGE	50.00	0.00	709.35	561.14

-- SUMMARY --

New and cold component with lowest MAWP: (MAWP = 230.00 PSI)
ANSI Flange Cl: 150 Gr:2.3, 31

Hot and corroded component with lowest MAWP: (MAWP = 167.00 PSI)
ANSI Flange Cl: 150 Gr:2.3, 31

Pressures are exclusive of any external loads.

Item	Material	Curve	Pressure	MDMT
MAIN SHELL	SA-312, Type TP316L, WLD	exempt per UHA-51(a)		
Nozzle No. A1	SA-312 TP316L WLD	exempt per UHA-51(a)		
Nozzle No. P1, P2 & A2	SA-312 TP316L WLD	exempt per UHA-51(a)		
END CAP	SA-403, Type 316L WP-W	exempt per UHA-51(a)		
Nozzle No. V1 & E1	SA-312 TP316L WLD	exempt per UHA-51(a)		
2" 150# BLIND FLANGE	SA-182 F316L	exempt per UHA-51(a)		

-- SUMMARY --

All components meet MDMT requirements.

WEIGHTS:

	dry	flooded
Shell weight	125 Lbs.	307 Lbs.
Head weight	8 Lbs.	13 Lbs.
Nozzle weight	65 Lbs.	65 Lbs.
Flange weight	6 Lbs.	6 Lbs.
Total Weights	203 Lbs.	390 Lbs.

VOLUME:

Shell volume	21.73 Gallons
Head volume	0.76 Gallons
Total Volume	22.49 Gallons

AREA:

Shell area	23 Sq. Ft.
Head area	1 Sq. Ft.
Total Area	24 Sq. Ft.

HYDROSTATIC TEST INFORMATION
Gauge at Top

Controlling Components

Ratio: MAIN SHELL
Pressure: MAIN SHELL

Design Pressure * 1.5 * (Cold Stress / Hot Stress) = Hydro Test Pressure
50.00 * 1.5 * (14200 / 13432) = 79.29 PSI

Supp. Lug Per Pressure Vessel Hand Book
8th Edition By ~~Megyesy~~ Megyesy.

Load Per Lug. 1,400 lbs.