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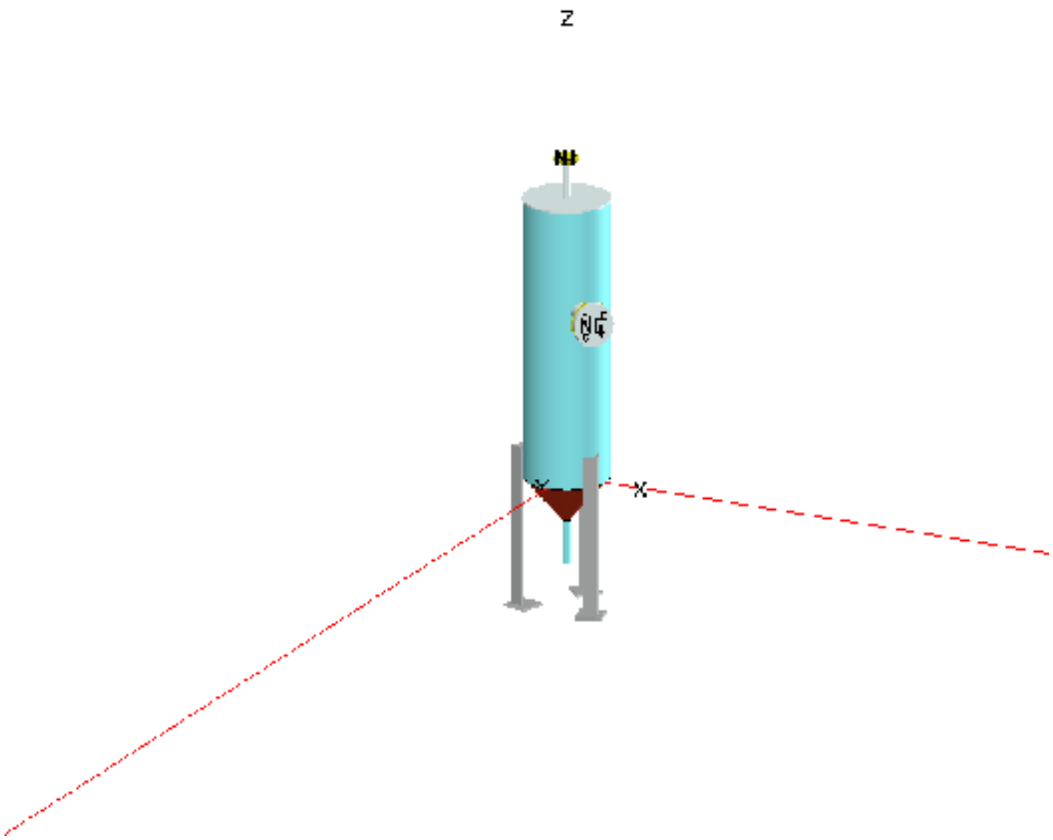
PLANTA CANNING



COMPRESS Pressure Vessel Design Calculations

Vessel No: V-06
Customer: FIUBA
Contract:
Designer: HRI/SEG
Date: lunes, agosto 09, 2004

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Deficiencies Summary

No deficiencies found.

Nozzle Schedule

Nozzle mark	Service	Size	Materials								
			Nozzle	Impact	Norm	Fine Grain	Pad	Impact	Norm	Fine Grain	Flange
N1	OIL INLET	0,750" Sch 160 DN 20	SA-106 B Smls pipe	No	No	No	N/A	N/A	N/A	N/A	SW A105 150#
N6	U.C.	2" Sch 80 (XS) DN 50	SA-106 B Smls pipe	No	No	No	N/A	N/A	N/A	N/A	WN A105 150#

Nozzle Summary

Nozzle mark	OD (mm)	t_n (mm)	Req t_n (mm)	A_1?	A_2?	Shell			Reinforcement Pad		Corr (mm)	A_a/A_r (%)
						Nom t (mm)	Design t (mm)	User t (mm)	Width (mm)	t_{pad} (mm)		
N1	26,67	5,56	5,51	Yes	Yes	6,35*	N/A		N/A	N/A	3,00	Exempt
N6	60,32	5,54	5,50	Yes	Yes	6,35	N/A		N/A	N/A	3,00	Exempt

t_n: Nozzle thickness

Req t_n: Nozzle thickness required per UG-45/UG-16

Nom t: Vessel wall thickness

Design t: Required vessel wall thickness due to pressure + corrosion allowance per UG-37

User t: Local vessel wall thickness (near opening)

A_a: Area available per UG-37, governing condition

A_r: Area required per UG-37, governing condition

Corr: Corrosion allowance on nozzle wall

* Head minimum thickness after forming

Pressure Summary

Pressure Summary for Chamber bounded by Welded Cover #1 and Welded Cover #1

Identifier	P Design (kg/cm²)	T Design (°C)	MAWP (kg/cm²)	MAP (kg/cm²)	MDMT Rating		Corrosion Allowance (mm)	Impact Test
					MDMT (°C)	Exemption		
Welded Cover #1	2,0	80,0	2,40	3,43	-28,9	Note 1	1,00	No
Cylinder #1	2,0	80,0	16,24	35,55	-37,2	Note 2	3,00	No
Transition #1	2,0	80,0	-22751,23	27,85	-103,9	Note 3	3,00	No
Cylinder #2	2,0	80,0	152,83	434,38	-103,9	Note 4	3,00	No
Legs #1	2,0	80,0	2,00	N/A	N/A	N/A	N/A	N/A
OIL INLET (N1)	2,0	80,0	2,40	3,42	-48,3	Note 5	3,00	No
U.C. (N6)	2,0	80,0	18,70	20,04	-32,6	Note 5	3,00	No

Chamber design MDMT is 0,00°C
Chamber rated MDMT is -28,89°C

Chamber MAWP hot & corroded is -22751,23 kg/cm^2 @ 80,0°C

Chamber MAP cold & new is 3,42 kg/cm^2 @ 21,1°C

This pressure chamber is not designed for external pressure.

Notes for MDMT Rating:

Note #	Exemption	Details
1.	Head is impact test exempt per UG-20(f)	UCS-66 governing thickness = 0,25 in (6,35 mm).
2.	Material impact test exemption temperature from Fig UCS-66 Curve B = -28,88889 °C Fig UCS-66.1 MDMT reduction = 8,333333 °C, (coincident ratio = 0,85)	UCS-66 governing thickness = 0,21875 in (5,56 mm)
3.	Material is impact test exempt to -103,8889 °C per UCS-66(b)(3) (coincident ratio = 0,10706)	
4.	Material is impact test exempt per UCS-66(d)(NPS 4 or smaller pipe)	
5.	UCS-66(b)(1)(b)	

Design notes are available on the Settings Summary page.

Revision History

No.	Date	Operator	Notes
0	10/30/2004	aep0130	New vessel created ASME Division 1 [Build 6231]

Settings Summary

COMPRESS Build 6231

Units: MKS

Datum Line Location: 304,00 mm from bottom seam

Design

ASME Section VIII Division 1, 2001 Edition, A03 Addenda

Design or Rating:	Get Thickness from Pressure
Minimum thickness:	1/16" per UG-16(b)
Design for cold shut down only:	No
Design for lethal service (full radiography required):	No
Design nozzles for:	Design P, find nozzle MAWP and MAP
Corrosion weight loss:	100% of theoretical loss
UG-23 Stress Increase:	1,20
Skirt/legs stress increase:	1,3
Minimum nozzle projection:	0,99 mm
Juncture calculations for $\alpha > 30$ only:	Yes
Preheat P-No 1 Materials > 1,25" and <= 1,50" thick:	No

Pipe under-tolerance is not applied to nozzle wall thicknesses.
Butt welds are tapered per Figure UCS-66.3(a).

Hydro/Pneumatic Test

Shop Hydrotest Pressure:	1,3 times vessel MAWP
Test liquid specific gravity:	1,00
Maximum stress during test:	90% of yield

Code Interpretations

Apply interpretation VIII-1-83-66:	Yes
Apply interpretation VIII-1-86-175:	Yes
Apply interpretation VIII-1-83-115:	Yes
Apply interpretation VIII-1-01-37:	Yes
Disallow UG-20(f) exemptions:	No

UG-22 Loadings

UG-22 (a) Internal or External Design Pressure :	Yes
UG-22 (b) Weight of the vessel and normal contents under operating or test conditions:	Yes
UG-22 (c) Superimposed static reactions from weight of attached equipment (external loads):	No
UG-22 (d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs:	Yes
UG-22 (f) Wind reactions:	No
UG-22 (f) Seismic reactions:	No

Note: UG-22 (b),(c) and (f) loads only considered when supports are present.

Thickness Summary

Component Identifier	Material	Diameter (mm)	Length (mm)	Nominal t (mm)	Design t (mm)	Joint E	Load
Welded Cover #1	SA-516 70	337,32 ID	6,35	6,35*	5,88	1,0000	Internal
Cylinder #1	SA-106 B Smls pipe	323,85 OD	970,00	6,35	3,32	0,8500	Internal
Transition #1	SA-516 70	21,34/323,85 OD	154,00	6,35	3,46	0,7000	Internal
Cylinder #2	SA-106 B Smls pipe	26,67 OD	150,00	5,56	3,03	0,8500	Internal

Nominal t: Vessel wall nominal thickness
Design t: Required vessel thickness due to governing loading + corrosion
Joint E: Longitudinal seam joint efficiency
* Head minimum thickness after forming

Load
internal: Circumferential stress due to internal pressure governs
external: External pressure governs
Wind: Combined longitudinal stress of pressure + weight + wind governs
Seismic: Combined longitudinal stress of pressure + weight + seismic governs

Weight Summary

Component	Weight (kg) Contributed by Vessel Elements						
	Metal New*	Metal Corroded*	Insulation & Supports	Lining	Piping + Liquid	Operating Liquid	Test Liquid
Welded Cover #1	3,77	3,18	0,00	0,00	0,00	0,00	0,03
Cylinder #1	47,98	25,56	0,00	0,00	0,00	0,00	73,86
Transition #1	5,52	3,73	0,00	0,00	0,00	0,00	3,82
Cylinder #2	0,43	0,23	0,00	0,00	0,00	0,00	0,03
Legs #1	13,85	13,85	0,00	0,00	0,00	0,00	0,00
TOTAL:	**71,56**	**46,54**	**0,00**	**0,00**	**0,00**	**0,00**	**77,73**

* Shells with attached nozzles have weight reduced by material cut out for opening.

Component	Weight (kg) Contributed by Attachments						
	Body Flanges (new)	Nozzles & Flanges (new)	Packed Beds	Ladders & Platforms	Trays & Supports	Rings & Clips	Vertical Loads
Welded Cover #1	0,00	1,32	0,00	0,00	0,00	0,00	0,00
Cylinder #1	0,00	6,14	0,00	0,00	0,00	0,00	0,00
Transition #1	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cylinder #2	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Legs #1	0,00	0,00	0,00	0,00	0,00	0,00	0,00
TOTAL:	**0,00**	**7,47**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**

Vessel operating weight, Corroded: 53 kg
Vessel empty weight, Corroded: 53 kg
Vessel empty weight, New: 79 kg
Vessel test weight, New: 157 kg

Vessel center of gravity location (from datum)

Vessel Lift Weight, New: 79 kg
Center of Gravity: 371,54 mm

Vessel Capacity

Vessel Capacity** (New): 78 liters
Vessel Capacity** (Corroded): 81 liters
**The vessel capacity does not include volume of nozzle, piping or other attachments.

Hydrostatic Test

Shop test pressure determination for Chamber bounded by Welded Cover #1 and Welded Cover #1 based on MAWP per UG-99(b)

Shop hydrostatic test gauge pressure is 0,00 kg/cm^2 at 21,11 °C (the chamber MAEP = 0,00 kg/cm^2). External pressure governs the test pressure per UG-99(f).

The shop test is performed with the vessel in the horizontal position.

Identifier	Local test pressure kg/cm^2	Test liquid static head kg/cm^2	UG-99 stress ratio	UG-99 pressure factor	Stress during test kg/cm^2	Allowable test stress kg/cm^2	Stress excessive?
Cylinder #1 (1)	0,04	0,04	1,0000	1,30	1,120	2.214,667	No
Transition #1	0,04	0,04	1,0000	1,30	1,319	2.404,496	No
Cylinder #2	0,02	0,02	1,0000	1,30	0,050	2.214,667	No
Welded Cover #1	0,04	0,04	1,0000	1,30	16,122	3.606,744	No
OIL INLET (N1)	0,02	0,02	1,0000	1,30	NI	NI	NI
U.C. (N6)	0,01	0,01	1,0000	1,30	0,529	3.322,001	No

Notes:
(1) Cylinder #1 limits the UG-99 stress ratio.
(2) NI indicates that test stress was not investigated.
(3) P_L stresses at nozzle openings have been estimated using the method described in PVP-Vol. 399, pages 77-82.
(4) VIII-2, AD-151.1(b) used as the basis for nozzle allowable test stress.

The field test condition has not been investigated.

The test temperature of 21,11 °C is warmer than the minimum recommended temperature of -12,22 °C so the brittle fracture provision of UG-99(h) has been met.

Welded Cover #1

ASME Section VIII Division 1, 2001 Edition, A03 Addenda

Component:	Welded Cover
Material specification:	SA-516 70 (ASME II-D p. 14, ln. 31)

Head is impact test exempt per UG-20(f)
UCS-66 governing thickness = 0,25 in (6,35 mm).

Internal design pressure: P = 2,0000 kg/cm^2 @ 80,00°C

Static liquid head:

P_{th}=0,0406 kg/cm^2(SG=1,0000, H_s=406,45 mm, Horizontal test head)

Corrosion allowance: Inner C = 1,00 mm Outer C = 0,00 mm

Design MDMT = 0,00°C
Rated MDMT = -28,89°C

No impact test performed
Material is not normalized
Material is not produced to Fine Grain Practice
PWHT is not performed

Radiography: Category A joints - Seamless No RT

Estimated weight: New = 3,8 kg corr = 3,2 kg

Head outside diameter = 337,32 mm
Cover thickness = 6,35 mm

Factor C from Fig. UG-34, sketch (b-1)

Factor C = 0,17

Design thickness, (at 80,00 °C) UG-34 (c)(2)

t = d*Sqr(C*P/(S*E)) + Corrosion
= 12,35931*Sqr(0,17*28,44669/(20.000,00*1)) + 0,0394
= 0,2316 in (5,88 mm)

Maximum allowable working pressure, (at 80,00 °C)

P = (S*E/C)*(t/d)^2 - P_s
= (20.000,00*1/0,17)*(0,2106/12,35931)^2 - 0
= 34,159 psi (2,40 kg/cm^2)

Maximum allowable pressure, (At 21,11 °C)

P = (S*E/C)*(t/d)^2
= (20.000,00*1/0,17)*(0,25/12,28051)^2
= 48,756 psi (3,43 kg/cm^2)

OIL INLET (N1)

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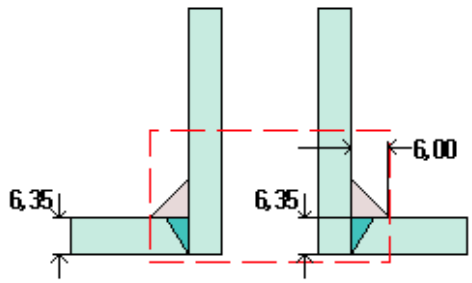
$t_{w(lower)}$ = 6,35 mm
Leg_{41} = 6,00 mm



Note: round inside edges per UG-76(c)

Located on:	Welded Cover #1
Liquid static head included:	0 psi (0,00 kg/cm^2)
Nozzle material specification:	SA-106 B Smls pipe (ASME II-D p. 10, ln. 15)
Nozzle description:	0,750" Sch 160 DN 20
Flange description:	0,75 inch 150# SW A105
Bolt Material:	SA-193 B7 Bolt <= 2 1/2
Flange rated MDMT: (UCS-66(b)(1)(b))	-55,00 °F (-48,33°C)
Liquid static head on flange:	0 psi (0,00 kg/cm^2)
ASME B16.5 flange rating MAWP:	266,00 psi @ 176,00°F (18,70 kg/cm^2 @ 80,00°C)
ASME B16.5 flange rating MAP:	285,00 psi @ 70,00°F (20,04 kg/cm^2 @ 21,11°C)
ASME B16.5 flange hydro test:	450,00 psi @ 70,00°F (31,64 kg/cm^2 @ 21,11°C)
Nozzle orientation:	0 °
Local vessel minimum thickness:	0,2500 in (6,35 mm)
Nozzle inside diameter, new:	0,6120 in (15,54 mm)
Nozzle nominal wall thickness:	0,2190 in (5,56 mm)
Nozzle corrosion allowance:	0,1181 in (3,00 mm)
Projection available outside vessel, Lpr:	5,6555 in (143,65 mm)
Distance to head center, R:	0,0000 in (0,00 mm)

Reinforcement Calculations for Internal Pressure

The vessel wall thickness governs the MAWP of this nozzle.

UG-39 Area Calculation Summary (cm^2) For P = 2,40 kg/cm^2 @ 80,00 °C							**UG-45 Nozzle Wall Thickness Summary (mm)** The nozzle passes UG-45	
A required	**A available**	**A_1**	**A_2**	**A_3**	**A_5**	**A welds**	**t_{req}**	**t_{min}**
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							5,51	5,56

Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	**Required weld**	**Actual weld**	**Status**

	throat size (mm)	throat size (mm)	
Nozzle to shell fillet (Leg_{41})	1,79	4,20	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-39 Area Calculation Summary (cm^2) For P = 3,42 kg/cm² @ 21,11 °C							UG-45 Nozzle Wall Thickness Summary (mm) The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							2,51	5,56

Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (mm)	Actual weld throat size (mm)	Status
Nozzle to shell fillet (Leg_{41})	3,89	4,20	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Cylinder #1

ASME Section VIII Division 1, 2001 Edition, A03 Addenda

Component:	Cylinder
Material specification:	SA-106 B Smls pipe (ASME II-D p. 10, ln. 15)
Pipe NPS and Schedule:	12" Sch 20 DN 300

Material impact test exemption temperature from Fig UCS-66 Curve B = -28,88889 °C
Fig UCS-66.1 MDMT reduction = 8,333333 °C, (coincident ratio = 0,85)
UCS-66 governing thickness = 0,21875 in (5,56 mm)

Internal design pressure: P = 2 kg/cm^2 @ 80°C

Static liquid head:

P_{th}=0,0393 kg/cm^2(SG=1,0000, H_s=393,37 mm, Horizontal test head)

Corrosion allowance: Inner C = 3,00 mm Outer C = 0,00 mm

Design MDMT = 0,00°C
Rated MDMT = -37,22°C

No impact test performed
Material is not normalized
Material is not produced to Fine Grain Practice
PWHT is not performed

Radiography:	Longitudinal joint -	Seamless No RT
	Top circumferential joint -	None UW-11(c) Type 1
	Bottom circumferential joint -	None UW-11(c) Type 1

Estimated weight: New = 48,1271 kg corr = 25,6318 kg
Capacity: New = 73,7567 liters corr = 76,6284 liters

OD = 323,85 mm
Length L_c = 970,00 mm
t = 6,35 mm

Design thickness, (at 80,00°C) Appendix 1-1

t = $P*R_o/(S*E + 0,40*P)$ + Corrosion
= 2,0000*161,93/(1202,2498*0,85 + 0,40*2,0000) + 3,00
= 3,3172 mm

Maximum allowable working pressure, (at 80,00°C) Appendix 1-1

P = $S*E*t/(R_o - 0,40*t) - P_s$
= 1202,2498*0,85*2,5565 / (161,93 - 0,40*2,5565) - 0,0000
= 16,2367 kg/cm^2

Maximum allowable pressure, (at 21,11°C) Appendix 1-1

P = $S*E*t/(R_o - 0,40*t)$
= 1202,2498*0,85*5,5563 / (161,93 - 0,40*5,5563)
= 35,5536 kg/cm^2

Design thickness = 3,32 mm

The governing condition is due to internal pressure.

The cylinder thickness of 6,35 mm is adequate.

Thickness Required Due to Pressure + External Loads

Condition	Pressure P (kg/cm²)	Allowable Stress Before UG-23 Stress Increase (kg/cm²)		Temperature (°C)	Corrosion C (mm)	Location	Load	Req'd Thk Due to Tension (mm)	Req'd Thk Due to Compression (mm)
		S_t	S_c						
Operating, Hot & Corroded	2,00	1202,25	1050,59	80,00	3,0000	top	Weight	0,1308	0,1271
						Bottom	Weight	0,1290	0,1290
Operating, Hot & New	2,00	1202,25	1189,88	80,00	0,0000	top	Weight	0,1265	0,1225
						Bottom	Weight	0,1245	0,1245
Hot Shut Down, Corroded	0,00	1202,25	1050,59	80,00	3,0000	top	Weight	0,0012	0,0054
						Bottom	Weight	0,0033	0,0033
Hot Shut Down, New	0,00	1202,25	1189,88	80,00	0,0000	top	Weight	0,0029	0,0069
						Bottom	Weight	0,0049	0,0049
Empty, Corroded	0,00	1202,25	1050,59	-17,78	3,0000	top	Weight	0,0012	0,0054
						Bottom	Weight	0,0033	0,0033
Empty, New	0,00	1202,25	1189,88	-17,78	0,0000	top	Weight	0,0029	0,0069
						Bottom	Weight	0,0049	0,0049
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0,00	1202,25	1050,59	80,00	3,0000	top	Weight	0,0018	0,0021
						Bottom	Weight	0,0000	0,0000

Legs #1

Leg material:		SA-36
Leg description:		2x2x3/8 Equal Angle (Leg in)
Number of legs:	N =	3
Overall length:		22,1654 in (563,00 mm)
Base to girth seam length:		17,7323 in (450,40 mm)
Bolt circle:		10,7244 in (272,40 mm)
Anchor bolt size:		0,375 inch series 8 threaded
Anchor bolt material:		SA-193 B7
Anchor bolts/leg:		1
Anchor bolt allowable stress:	S_b =	20.000,000 psi (1.406,14 kg/cm^2)
Anchor bolt corrosion allowance:		0,0000 in (0,00 mm)
Anchor bolt hole clearance:		0,0000 in (0,00 mm)
Base plate width:		3,9370 in (100,00 mm)
Base plate length:		3,9370 in (100,00 mm)
Base plate thickness:		0,3750 in (9,53 mm) (0,0405 in required)
Base plate allowable stress:		24.000,000 psi (1.687,37 kg/cm^2)
Foundation allowable bearing stress:		750,000 psi (52,73 kg/cm^2)
Effective length coefficient:	K =	1,2
Coefficient:	C_m =	0,85
Leg yield stress:	F_y =	36.000,000 psi (2.531,05 kg/cm^2)
Leg elastic modulus:	E =	29.000.000,000 psi (2.038.900,00 kg/cm^2)
Leg to shell fillet weld:		0,0831 in (2,11 mm) (0,0012 in required)

Note: The support attachment point is assumed to be 1 mm up from the cylinder circumferential seam.

Loading	Force attack angle °	Leg position °	Axial end load kg_f	Shear resisted kg_f	Axial f_a kg/cm^2	Bending f_{bx} kg/cm^2	Bending f_{by} kg/cm^2	Ratio H_{1-1}	Ratio H_{1-2}
Governing Condition		0	18,5	0,0	2,109	3,692	0,000	0,0036	0,0036
Weight operating new	**0**	120	34,2	0,0	3,896	6,822	0,000	0,0066	0,0066
Moment = 1,9 kg-m		240	34,2	0,0	3,896	6,822	0,000	0,0066	0,0066

Note: Formulae are taken from the AISC manual ninth edition.

$P_1 = W/N + 48*M_t/(N*D)$
$= 174,2272/ 3 + 48*13,77425/(3*12,75)$
$= 75,3611$ lb (34,18321 kg_f)

Allowable axial compressive stress, F_a (AISC chapter E)

Local buckling check (AISC 5-99)

$b/t = (2/0,375) < (76 / Sqr(36))$ so $Q_s = 1$

Flexural-torsional buckling (AISC 5-317)

Shear center distance $w_o = 0,6342745$
$r_o^2 = w_o^2 + (I_z + I_w)/A$
$= 0,6342745^2 + (0,2058227 + 0,7521589)/1,36$
$= 1,106702$

Torsional constant J = 0,06375
Shear modulus G = 11.165,00 $kips/in^2$

$F_{ej} = G*J / (A*r_o^2)$
$= 11.165,00*0,06375 / (1,36*1,106702)$
$= 472,8998$

$K*l/r_w = 1,2*18,73228/0,7436787 = 30,22641$

$F_{ew} = \pi^2*E/(Kl/r_w)^2$
$= \pi^2*29.000,00/(30,22641)^2$
$= 313,2741$

$H = 1 - (w_o^2 / r_o^2)$
$= 1 - (0,6342745^2 / 1,106702)$
$= 0,6364839$

$F_e = ((F_{ew} + F_{ej})/(2*H))*(1 - Sqr(1 - (4*F_{ew}*F_{ej}*H)/(F_{ew} + F_{ej})^2))$
$= ((313,2741 + 472,8998)/(2*0,6364839))*(1 - Sqr(1 - (4*313,2741*472,8998*0,6364839)/(313,2741 + 472,8998)^2))$
$= 232,0266$

Equivalent slenderness ratio

$Kl/r = \pi*Sqr(E/F_e)$
$= \pi*Sqr(29.000,00/232,0266)$
$= 35,12207$

$C_c = Sqr(2*\pi^2*E/(F_y*Q_s))$
$= Sqr(2*\pi^2*29.000.000/(36.000,00*1))$
$= 126,0993$

V-03

K*l/r= 1,2*18,73228/0,3890247 = 57,7823

$F_a = 1 * (1 - (Kl/r)^2/(2*C_c^2))*F_y / (5/3 + 3*(Kl/r)/(8*C_c)-(Kl/r)^3/(8*C_c^3))$
$= 1 * (1 - (57,7823)^2/(2*126,0993^2))*36.000,00 / (5/3 + 3*(57,7823)/(8*126,0993)-(57,7823)^3/(8*126,0993^3))$
= 17.640,79 psi (1.240,270 kg/cm^2)

Allowable axial compression and bending (AISC chapter H)

Note: r is divided by 1,35 - See AISC 6.1.4, pg. 5-314

$F'_{ex} = 1*12*\pi^2*E/(23*(Kl/r)^2)$
$= 1*12*\pi^2*29.000.000/(23*(78,0061)^2)$
= 24.541,10 psi (1.725,408 kg/cm^2)

$F'_{ey} = 1*12*\pi^2*E/(23*(Kl/r)^2)$
$= 1*12*\pi^2*29.000.000/(23*(40,80566)^2)$
= 89.683,05 psi (6.305,337 kg/cm^2)

$F_b = 1*0,66*F_y$
= 23.760,00 psi (1.670,492 kg/cm^2)

Compressive axial stress

$f_a = P_1/A$
= 75,36107/1,36
= 55,41255 psi (3,896 kg/cm^2)

Bending stresses

$f_{bx} = F*Cos(\alpha)*L/(I_x/C_x) + P_1*E_{cc}/(I_x/C_x)$
$= 0*Cos(120)*18,73228/(0,2058227/0,5147605) + 75,36107*0,5148/(0,2058227/0,5147605)$
= 97,02811 psi (6,822 kg/cm^2)

$f_{by} = F*Sin(\alpha)*L/(I_y/C_y)$
$= 0*Sin(120)*18,73228/(0,7521589/1,4142)$
= 0 psi (0,000 kg/cm^2)

AISC equation H_{1-1}

$H_{1-1} = f_a/F_a + C_{mx}*f_{bx}/((1 - f_a/F'_{ex})*F_{bx}) + C_{my}*f_{by}/((1 - f_a/F'_{ey})*F_{by})$
$= 55,41255/17.640,79 + 0,85*97,02811/((1 - 55,41255/24.541,10)*23.760,00) + 0,85*0/((1 - 55,41255/89.683,05)*23.760,00)$
= 6,620138E-03

AISC equation H_{1-2}

$H_{1-2} = f_a/(0,6*1*F_y) + f_{bx}/F_{bx} + f_{by}/F_{by}$
$= 55,41255/(0,6*1*36.000,00) + 97,02811/23.760,00 + 0/23.760,00$
= 6,64907E-03

3, 2x2x3/8 Equal Angle legs are adequate.

Anchor bolts - Weight operating corroded condition governs

Tensile loading per leg (1 bolt per leg)

$R = 48*M/(N*BC) - W/N$
$= 48*12,96328/(3*10,72441) - 117,8294/3$
= -19,93623 lb$_f$ (-9,042923 kg$_f$)
There is no net uplift (R is negative).

0,375 inch series 8 threaded bolts are satisfactory.

Check the leg to vessel fillet weld, Bednar 10.3, Weight operating new governs

Note: continuous welding is assumed for all support leg fillet welds.

The following leg attachment weld analysis assumes the fillet weld is present on three sides (leg top closure plate is used).

$Z_w = (2*b*d + d^2)/3$
$= (2*2,8284*3,433071 + 3,433071^2)/3$
$= 10,40206$

$J_w = (b + 2*d)^3/12 - d^2*(b + d)^2/(b + 2*d)$
$= (2,8284 + 2*3,433071)^3/12 - 3,433071^2*(2,8284 + 3,433071)^2/(2,8284 + 2*3,433071)$
$= 28,26371$

$E = d^2/(b + 2*d)$
$= 3,433071^2/(2,8284 + 2*3,433071)$
$= 1,215733$

Governing weld load $f_x = Cos(120)*0 = 0$ lb_f
Governing weld load $f_y = Sin(120)*0 = 0$ lb_f

$f_1 = P_1/L_{weld}$
$= 75,36107/9,694542$
$= 7,773556$ lb_f/in (1,388198 Kg_f/cm) (V_L direct shear)

$f_2 = f_y*L_{leg}*0,5*b/J_w$
$= 0*18,73228*0,5*2,8284/28,26371$
$= 0$ lb_f/in (0 Kg_f/cm) (V_L torsion shear)

$f_3 = f_y/L_{weld}$
$= 0/9,694542$
$= 0$ lb_f/in (0 Kg_f/cm) (V_c direct shear)

$f_4 = f_y*L_{leg}*E/J_w$
$= 0*18,73228*1,215733/28,26371$
$= 0$ lb_f/in (0 Kg_f/cm) (V_c torsion shear)

$f_5 = f_x*L_{leg}/Z_w$
$= 0*18,73228/10,40206$
$= 0$ lb_f/in (0 Kg_f/cm) (M_L bending)

$f_6 = f_x/L_{weld}$
$= 0/9,694542$
$= 0$ lb_f/in (0 Kg_f/cm) (Direct outward radial shear)

$f = Sqr((f_1 + f_2)^2 + (f_3 + f_4)^2 + (f_5 + f_6)^2)$
$= Sqr((7,773556 + 0)^2 + (0 + 0)^2 + (0 + 0)^2)$
$= 7,773556$ lb_f/in (1,388198 Kg_f/cm) (Resultant shear load)

Required leg to vessel fillet weld leg size (welded both sides + top)

$t_w = f / (0,707*0,55*S_a)$
$= 7,773556 / (0,707*0,55*17.100,00)$
$=$ 0,0012 in (0,0297 mm)

The 2,11 mm leg to vessel attachment fillet weld size is adequate.

Base plate thickness check, AISC 3-106

$f_p = P/(B*N)$
$= 78,62586/(3,937008*3,937008)$
$= 5,072626$ psi (0,357 kg/cm^2)

Required base plate thickness is the largest of the following: (0,0405 in)

$t_b = Sqr(0,5*P/S_b)$

= Sqr(0,5*78,62586/24.000,00)
= 0,0405 in (1,0280 mm)

t_b = 0,5*(N - d)*Sqr(3*f_p/S_b)
= 0,5*(3,937008 - 2)*Sqr(3*5,072626/24.000,00)
= 0,0244 in (0,6195 mm)

The base plate thickness is adequate.

Check the leg to vessel attachment stresses, WRC-107 (Weight operating corroded governs)

Applied Loads

Radial load:	P_r =	0,00 kg_f
Circumferential moment:	M_c =	0,00 kg-m
Circumferential shear:	V_c =	0,00 kg_f
Longitudinal moment:	M_L =	0,33 kg-m
Longitudinal shear:	V_L =	25,19 kg_f
Torsion moment:	M_t =	0,00 kg-m
Internal pressure:	P =	2,00 kg/cm^2
Mean shell radius:	R_m =	161,75 mm
Local shell thickness:	t =	3,35 mm
Shell yield stress:	S_y =	2.283,85 kg/cm^2

Maximum stresses due to the applied loads at the leg edge (includes pressure)

R_m/t =48,2798

C_1 = 35,92, C_2 = 43,60 mm

Local circumferential pressure stress = $P*R_i/t$ = 1.359,00 psi (95,54707 kg/cm^2)

Local longitudinal pressure stress = $P*R_i/2t$ = 680 psi (47,80869 kg/cm^2)

Maximum combined stress (P_L+P_b+Q) = 107,99 kg/cm^2
Allowable combined stress (P_L+P_b+Q) = +-3*S = +-3.606,74 kg/cm^2

The maximum combined stress (P_L+P_b+Q) is within allowable limits.

Maximum local primary membrane stress (P_L) = 100,82 kg/cm^2
Allowable local primary membrane (P_L) = +-1,5*S = +-1.803,37 kg/cm^2

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the leg edge per WRC Bulletin 107										
Figure	**value**	b	**A_u**	**A_l**	**B_u**	**B_l**	**C_u**	**C_l**	**D_u**	**D_l**
3C*	2,7362	0,2722	0	0	0	0	0	0	0	0
4C*	5,7395	0,2562	0	0	0	0	0	0	0	0
1C	0,0623	0,2378	0	0	0	0	0	0	0	0
2C-1	0,0225	0,2378	0	0	0	0	0	0	0	0
3A*	1,8923	0,2369	0	0	0	0	0	0	0	0
1A	0,0641	0,2623	0	0	0	0	0	0	0	0
3B*	4,0486	0,2527	-5,273	-5,273	5,273	5,273	0	0	0	0
1B-1	0,0164	0,2485	-7,171	7,171	7,171	-7,171	0	0	0	0
Pressure stress*			95,547	95,547	95,547	95,547	95,547	95,547	95,547	95,547
Total circumferential stress			83,103	97,445	107,991	93,649	95,547	95,547	95,547	95,547
Primary membrane circumferential stress*			90,274	90,274	100,820	100,820	95,547	95,547	95,547	95,547
3C*	2,9538	0,2562	0	0	0	0	0	0	0	0
4C*	5,5223	0,2722	0	0	0	0	0	0	0	0
1C-1	0,0426	0,2590	0	0	0	0	0	0	0	0
2C	0,0316	0,2590	0	0	0	0	0	0	0	0
4A*	4,3806	0,2369	0	0	0	0	0	0	0	0
2A	0,0264	0,2847	0	0	0	0	0	0	0	0
4B*	1,9246	0,2527	-2,953	-2,953	2,953	2,953	0	0	0	0
2B-1	0,0263	0,2722	-10,546	10,546	10,546	-10,546	0	0	0	0
Pressure stress*			47,809	47,809	47,809	47,809	47,809	47,809	47,809	47,809
Total longitudinal stress			34,310	55,402	61,308	40,216	47,809	47,809	47,809	47,809
Primary membrane longitudinal stress*			44,856	44,856	50,762	50,762	47,809	47,809	47,809	47,809
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	-4,289	-4,289	4,289	4,289
Total Shear stress			0	0	0	0	-4,289	-4,289	4,289	4,289
Combined stress (P_L+P_b+Q)			83,103	97,445	107,991	93,649	95,899	95,899	95,899	95,899

Note: * denotes primary stress.

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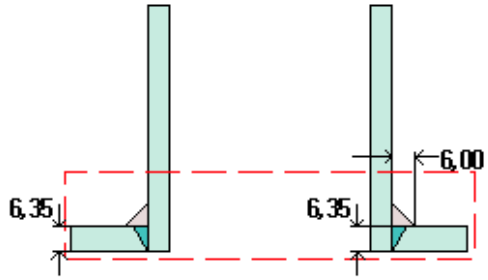
$t_{w(lower)}$ = 6,35 mm
Leg_{41} = 6,00 mm



Note: round inside edges per UG-76(c)

Located on:	Cylinder #1
Liquid static head included:	0 psi (0,00 kg/cm^2)
Nozzle material specification:	SA-106 B Smls pipe (ASME II-D p. 10, ln. 15)
Nozzle description:	2" Sch 80 (XS) DN 50
Flange description:	2 inch 150# WN A105
Bolt Material:	SA-193 B7 Bolt <= 2 1/2
Flange rated MDMT: (UCS-66(b)(1)(b))	-26,70 °F (-32,61°C)
Liquid static head on flange:	0 psi (0,00 kg/cm^2)
ASME B16.5 flange rating MAWP:	266,00 psi @ 176,00°F (18,70 kg/cm^2 @ 80,00°C)
ASME B16.5 flange rating MAP:	285,00 psi @ 70,00°F (20,04 kg/cm^2 @ 21,11°C)
ASME B16.5 flange hydro test:	450,00 psi @ 70,00°F (31,64 kg/cm^2 @ 21,11°C)
Nozzle orientation:	45 °
Local vessel minimum thickness:	0,2188 in (5,56 mm)
Nozzle center line offset to datum line:	24,4094 in (620,00 mm)
End of nozzle to shell center:	12,2047 in (310,00 mm)
Nozzle inside diameter, new:	1,9390 in (49,25 mm)
Nozzle nominal wall thickness:	0,2180 in (5,54 mm)
Nozzle corrosion allowance:	0,1181 in (3,00 mm)
Projection available outside vessel, Lpr:	5,8297 in (148,08 mm)

Reinforcement Calculations for Internal Pressure

The attached ASME B16.5 flange limits the nozzle MAWP.

UG-37 Area Calculation Summary (cm^2) For P = 18,70 kg/cm^2 @ 80,00 °C							**UG-45 Nozzle Wall Thickness Summary (mm)** The nozzle passes UG-45	
A required	**A available**	**A_1**	**A_2**	**A_3**	**A_5**	**A welds**	**t_{req}**	**t_{min}**
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							5,50	5,54

Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			

V-03

Weld description	Required weld throat size (mm)	Actual weld throat size (mm)	Status
Nozzle to shell fillet (Leg_{41})	1,78	4,20	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for MAP

The attached ASME B16.5 flange limits the nozzle MAP.

UG-37 Area Calculation Summary (cm^2) For P = 20,04 kg/cm^2 @ 21,11 °C							UG-45 Nozzle Wall Thickness Summary (mm) The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							2,68	5,54

Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (mm)	Actual weld throat size (mm)	Status
Nozzle to shell fillet (Leg_{41})	3,88	4,20	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Transition #1

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Component: Transition
Material specification: SA-516 70 (ASME II-D p. 14, ln. 31)
Material is impact test exempt to -103,8889 °C per UCS-66(b)(3) (coincident ratio = 0,10706)

Internal design pressure: P = 2,0000 kg/cm^2 @ 80,00°C

Static liquid head:

P_{th}=0,0239 kg/cm^2(SG=1,0000, H_s=239,56 mm, Horizontal test head at small end)
P_{th}=0,0390 kg/cm^2(SG=1,0000, H_s=390,82 mm, Horizontal test head at large end)

Corrosion allowance: Inner C = 3,00 mm Outer C = 0,00 mm

Design MDMT = 0,00°C
Rated MDMT = -103,89°C

No impact test performed
Material is not normalized
Material is not produced to Fine Grain Practice
PWHT is not performed

Radiography: Category A joints - None UW-11(c) Type 1
Circ. joint top/left - None UW-11(c) Type 1
Circ. joint right/bottom - None UW-11(c) Type 1

Estimated weight: New = 5,5 kg corr = 3,7 kg
Capacity: New = 3,8 liters corr = 4,0 liters

Axial length = 154,00 mm
Large End OD = 323,8500 mm
Small End OD = 21,3400 mm
Cone t_c = 6,35 mm

Design thickness, (at 80,00°C) App 1-4(e) (Large End)

t = $P*D_o / (2*Cos(\alpha)*(S*E + 0,40*P)) + C$
= 2,0000*323,8500 / (2*Cos(44,484783)*(1406,1400*0,70 + 0.4*2,0000)) + 2,9997
= 3,46 mm

Small End design thickness (t = 3,03 mm) does not govern.

MAWP, (Corroded at 80,00°C) App 1-4(e) (Large End)

P = $2*S*E*t*Cos(\alpha) / (D_o - 0,80*t*Cos(\alpha)) - P_s$
= 2*1406,1400*0,70*3,3503*Cos(44,484783) / (323,8500 - 0,80*3,3503*Cos(44,484783)) - 0,0000
= 14,6157 kg/cm^2

Small End MAWP (242,1954 kg/cm^2) does not govern.

MAP, (New at 21,11°C) App 1-4(e) (Large End)

P = $2*S*E*t*Cos(\alpha) / (D_o - 0,80*t*Cos(\alpha)) - P_s$
= 2*1406,1400*0,70*6,3500*Cos(44,484783) / (323,8500 - 0,80*6,3500*Cos(44,484783)) - 0,0000
= 27,8503 kg/cm^2

Small End MAP (503,4152 kg/cm^2) does not govern.

% Extreme fiber elongation - UCS-79

= (50 * t / Rf) * (1 - Rf / Ro)
= (50 * 8,9006 / 6,2197) * (1 - 6,2197 / ∞)
= 71,5514

Transition design thickness = 3,46 mm

The governing condition is due to internal pressure.

The transition thickness of 6,35 mm is adequate.

Thickness Required Due to Pressure + External Loads

Condition	Pressure P (kg/cm²)	Allowable Stress Before UG-23 Stress Increase (kg/cm²)		Temperature (°C)	Corrosion C (mm)	Location	Load	Req'd Thk Due to Tension (mm)	Req'd Thk Due to Compression (mm)
		S_t	S_c						
Operating, Hot & Corroded	2,00	1406,14	1030,55	80,00	3,0000	top	Weight	0,2244	0,2244
						Bottom	Weight	0,0091	0,0091
Operating, Hot & New	2,00	1406,14	1161,27	80,00	0,0000	top	Weight	0,2187	0,2187
						Bottom	Weight	0,0041	0,0041
Hot Shut Down, Corroded	0,00	1406,14	1030,55	80,00	3,0000	top	Weight	0,0006	0,0006
						Bottom	Weight	0,0006	0,0006
Hot Shut Down, New	0,00	1406,14	1161,27	80,00	0,0000	top	Weight	0,0009	0,0009
						Bottom	Weight	0,0016	0,0016
Empty, Corroded	0,00	1406,14	1030,55	21,11	3,0000	top	Weight	0,0006	0,0006
						Bottom	Weight	0,0006	0,0006
Empty, New	0,00	1406,14	1161,27	21,11	0,0000	top	Weight	0,0009	0,0009
						Bottom	Weight	0,0016	0,0016
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0,00	1406,14	1030,55	80,00	3,0000	top	Weight	0,0006	0,0006
						Bottom	Weight	0,0006	0,0006

Appendix 1-5(g), U-2(g) analysis of large end juncture, stress in the cylinder Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	outer	**inner**	**outer**	**inner**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight Corroded	-2.189,310	2.888,641	-2.189,310	2.888,641	3.606,744	3.606,744	-698,456	-698,456	1.803,372

Appendix 1-5(g), U-2(g) analysis of large end juncture, stress in the cone Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	outer	**inner**	**outer**	**inner**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight Corroded	-2.048,862	3.029,090	-2.048,862	3.029,090	4.218,414	4.218,414	-417,652	-417,652	2.109,207

Appendix 1-5(g), U-2(g) analysis of small end juncture, stress in the cylinder Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	inner	**outer**	**inner**	**outer**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight Corroded	-46,873	115,925	-46,873	115,925	3.606,744	3.606,744	104,142	104,142	1.803,372

Appendix 1-5(g), U-2(g) analysis of small end juncture, stress in the cone Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	inner	**outer**	**inner**	**outer**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight Corroded	-10,553	84,516	-10,553	84,516	4.218,414	4.218,414	109,036	109,036	2.109,207

Appendix 1-5(g), U-2(g) analysis of large end juncture, stress in the cylinder Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	outer	**inner**	**outer**	**inner**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight New	-776,760	1.142,339	-776,760	1.142,339	3.606,744	3.606,744	-162,783	-162,783	1.803,372

Appendix 1-5(g), U-2(g) analysis of large end juncture, stress in the cone Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	outer	**inner**	**outer**	**inner**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight New	-703,340	1.215,760	-703,340	1.215,760	4.218,414	4.218,414	-16,018	-16,018	2.109,207

Appendix 1-5(g), U-2(g) analysis of small end juncture, stress in the cylinder Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	inner	**outer**	**inner**	**outer**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight New	-6,794	34,775	-6,794	34,775	3.606,744	3.606,744	37,784	37,784	1.803,372

Appendix 1-5(g), U-2(g) analysis of small end juncture, stress in the cone Internal pressure = 14,62 kg/cm^2									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	inner	**outer**	**inner**	**outer**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Weight New	1,236	33,105	1,236	33,105	0,000	4.218,414	44,090	44,090	2.109,207

Appendix 1-5(g), U-2(g) analysis of large end juncture, stress in the cylinder Internal pressure = 27,85 kg/cm^2 (MAP)									
Loading	**S_L (windward, MPa)**		**S_L (leeward, MPa)**		**Allowable S_L (MPa)**		**S_{tm} (MPa)**		
	outer	**inner**	**outer**	**inner**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Pressure	-1.479,363	2.175,618	0,000	0,000	3.606,744	3.606,744	-309,667	0,000	1.803,372

Appendix 1-5(g), U-2(g) analysis of large end juncture, stress in the cone Internal pressure = 27,85 kg/cm^2 (MAP)									
Loading	**S_L (windward, MPa)**		**S_L (leeward, MPa)**		**Allowable S_L (MPa)**		**S_{tm} (MPa)**		
	outer	**inner**	**outer**	**inner**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Pressure	-1.339,531	2.315,449	0,000	0,000	4.218,414	4.218,414	-30,004	0,000	2.109,207

Appendix 1-5(g), U-2(g) analysis of small end juncture, stress in the cylinder Internal pressure = 27,85 kg/cm^2 (MAP)									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	inner	**outer**	**inner**	**outer**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Pressure	-12,838	65,708	0,000	0,000	3.606,744	3.606,744	71,836	0,000	1.803,372

Appendix 1-5(g), U-2(g) analysis of small end juncture, stress in the cone Internal pressure = 27,85 kg/cm^2 (MAP)									
Loading	**s_L (windward, MPa)**		**s_L (leeward, MPa)**		**Allowable s_L (MPa)**		**s_{tm} (MPa)**		
	inner	**outer**	**inner**	**outer**	**compressive**	**tensile**	**windward**	**leeward**	**allowable**
Pressure	2,335	62,551	0,000	0,000	0,000	4.218,414	83,852	0,000	2.109,207

Cylinder #2

ASME Section VIII Division 1, 2001 Edition, A03 Addenda

Component:	Cylinder
Material specification:	SA-106 B Smls pipe (ASME II-D p. 10, ln. 15)
Pipe NPS and Schedule:	0,750" Sch 160 DN 20

Material is impact test exempt per UCS-66(d)(NPS 4 or smaller pipe)

Internal design pressure: P = 2 kg/cm^2 @ 80°C

Static liquid head:

P_{th}=0,0245 kg/cm^2(SG=1,0000, H_s=245,57 mm, Horizontal test head)

Corrosion allowance: Inner C = 3,00 mm Outer C = 0,00 mm

Design MDMT = 0,00°C
Rated MDMT = -103,89°C

No impact test performed
Material is not normalized
Material is not produced to Fine Grain Practice
PWHT is not performed

Radiography:	Longitudinal joint -	Seamless No RT
	Top circumferential joint -	None UW-11(c) Type 1
	Bottom circumferential joint -	None UW-11(c) Type 1

Estimated weight: New = 0,4333 kg corr = 0,2279 kg
Capacity: New = 0,0285 liters corr = 0,0547 liters

OD = 26,67 mm
Length L_c = 150,00 mm
t = 5,56 mm

Design thickness, (at 80,00°C) Appendix 1-1

t = $P*R_o/(S*E + 0,40*P)$ + Corrosion
= 2,0000*13,33/(1202,2498*0,85 + 0,40*2,0000) + 3,00
= 3,0277 mm

Maximum allowable working pressure, (at 80,00°C) Appendix 1-1

P = $S*E*t/(R_o - 0,40*t) - P_s$
= 1202,2498*0,85*1,8653 / (13,33 - 0,40*1,8653) - 0,0000
= 152,8268 kg/cm^2

Maximum allowable pressure, (at 21,11°C) Appendix 1-1

P = $S*E*t/(R_o - 0,40*t)$
= 1202,2498*0,85*4,8650 / (13,33 - 0,40*4,8650)
= 434,3824 kg/cm^2

Design thickness = 3,03 mm

The governing condition is due to internal pressure.

The cylinder thickness of 5,56 mm is adequate.

Thickness Required Due to Pressure + External Loads

Condition	Pressure P (kg/cm²)	Allowable Stress Before UG-23 Stress Increase (kg/cm²)		Temperature (°C)	Corrosion C (mm)	Load	Req'd Thk Due to Tension (mm)	Req'd Thk Due to Compression (mm)
		S_t	S_c					
Operating, Hot & Corroded	2,00	1202,25	1202,25	80,00	3,0000	Weight	0,0132	0,0132
Operating, Hot & New	2,00	1202,25	1202,25	80,00	0,0000	Weight	0,0100	0,0100
Hot Shut Down, Corroded	0,00	1202,25	1202,25	80,00	3,0000	Weight	0,0004	0,0004
Hot Shut Down, New	0,00	1202,25	1202,25	80,00	0,0000	Weight	0,0008	0,0008
Empty, Corroded	0,00	1202,25	1202,25	-17,78	3,0000	Weight	0,0004	0,0004
Empty, New	0,00	1202,25	1202,25	-17,78	0,0000	Weight	0,0008	0,0008
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0,00	1202,25	1202,25	80,00	3,0000	Weight	0,0004	0,0004