LAMPIRAN

Data Sheet for Unfired Pressure Vessels

Equipment Name:	Closed Drain Drum	**Location:**	Arabian Gulf
Tag No.:	603-39V-01	**Plant Location:**	PS-3K
No.of Units:	1	**Manufacturer/Model:**	

	DESIGN DATA			CONSTRUCTION MATERIAL	
1	Orientation		Horizontal	Part	Material Specification
2	Contents		HC, H_2S, CO_2 and H_2o	Shell	SA516Gr.60 (note 5)
3	Criticality Rating		3	Cladding/Lining of shell	See note 5
4	Service		Lethal	Heads	SA516Gr.60 (note 5)
5	Design Code		ASME Sec.VIII DIV.1	Cladding/Lining of heads	See note 5
6	Code Stamp		Yes	Boot	-
7				Reinforcing pads	SA516Gr.60
8	Temperature			Self Reinforcing Nozzles	-
9	Design - Upper/Lower	°C	168/-29 △1	Nozzle neck (pipes) above 3"NB	SA106Gr.B (note 5)
10	Operating - Max. / Normal / Mir	°C	-/45/-	Nozzle neck 3"NB and below	SB444Gr.1 UNS N06625
11	Pressure			Forged Flanges above 3"NB	SA105 (note 5)
12	Design (Internal)	barg	3.5	Forged Flanges 3"NB and below	SB564Gr.1 UNS N06625
13	Design External	barg	-	Demister	-
14	Operating - Max/Norm/Min	barg	-/0.5/-	Baffles	-
15	Corrosion Allowance	mm	3 on Carbon Steel	Distributor pipes	-
16	Specific Gravity Liquid(HC/W)		Refer sheet 2 of 3	Base ring/plate	-
17	Gross Capacity	m^3	15	Vortex Breakers	SA516Gr.60 (note 5)
18	Vessel Dia (ID)	mm	1800	Anode protection	-
19	Vessel Length (T/L TO T/L)	mm	5400	Saddles(Weir pl./support ribs)	SA516Gr.60/A283Gr.C
20	Shop Hydrotest Pressure (N&C)		Per code	Internal attachments	-
21	Wind		BS CP3, Chapter V, PART	External attachments	SA 283 Gr C
22	Design Wind Speed	m/s	45	External Bolts	SA 193 Gr B7 (note 2)
23	Seismic		See note 7	Nuts	SA 194 Gr 2H (note 2)
24	Shell Thickness (NOM)	mm	5+3 VTC (note 5)	Gaskets External	Spiral Wound (note 1)
25	Min.Head Thickness(Top/Bot)	mm	5+3 VTC (note 5)	Gaskets Internal	
26	SkirtThickness/Height	mm	-	Internal Bolts	
27	Weld Joint Efficiencies:			Nuts	
28	Shell		1.0		
29	Head		1.0		
30	Inspection and Testing			**CONSTRUCTION**	
31	Third Party Inspection		Yes	Type of Heads	2:1 Ellipsoidal
32	Non Destructive Testing:			Type of support	Saddle
33	Radiography		100%	Platform/Ladder/Pipe Clip	Required
34	Ultrasonic		Per Code/Spec	Insulation supports	Not Required
35	Magnetic Particle		100 %	Manway Davit	Required
36	Dye Penetrant		yes	Earthing Boss	Required
37	Post Weld Heat Treatment		yes	Lifting Lugs/Eyes/Trunions	Required
38	Material Impact Test Required		Per Code / Spec	Name plate	Required, SS316
39	Certified Elevated Temp.Test Required		No	**ESTIMATED WEIGHTS**	
40	Insulation	mm	No	Empty Kg	3,800 VTC
41	Fireproofing	mm	No	Shipping Kg	VTA
42	Painting (External)		ES-Q-12 (note 6)	Operating Kg	13,700 VTC
43	Painting (Internal)		No	Field Test Kg	19,200 VTC

NOTES:

1. Gaskets shall be Inconel 625 spiral wound graphite filled with Inconel 625 internal and external rings. Gaskets shall be as per API-601.
2. External bolting shall be hot dip galvanised as per BS 729 (BS EN ISO 1461:1999).
3. Indicated thickness of shell, head are minimum and vendor to confirm the thicknesses.
4. Inside diameter of 20"NB manway shall be 457 mm.
5. All internal surfaces of the vessel, nozzle sizes above 3" NB including gasket faces shall be weld deposited with minimum 3 mm thick Inconel 625 before PWHT. Iron content in Inconel 625 weld deposition shall not be more than 7 % . Alternatively Monel 400 weld deposition can be considered during detailed design.
6. System 5 for equipment in splash zone to be used.
7. Refer Environmental data:1535-0-56-0001.

VTC: Vendor to confirm, VTA: Vendor to advise.

REV	DATE	ISSUE DESCRIPTION	ORIG	CHKD	APPRD.	PROJECT	CLIENT APPR.
1	29-Jul-01	APPROVED FOR DETAILED DESIGN	NVR	GMP	GMP	IDB	
0	24-06-2001	ISSUED FOR COMMENTS	NVR	GMP	CPS	IDB	

Worley

Qatar Petroleum

Qatar Petroleum
Bul Hanine Arab "C" Gas Cap Recycling

Project No: 022/00705	**Rev:**
Document No: 00705-MEC-DTS-198	1

00705-MEC-DTS-198R1.XLS

Data Sheet for Unfired Pressure Vessel

Equipment Name : Closed Drain Drum	**Location:** Arabian Gulf
Tag No. : 603-39V-01	**Plant Location :** PS-3K
No. of Units : 1	**Manufacturer/Model :**

1	**DESIGN DATA**					
2	**PROCESS DATA**					
3	Fluid Name		Condensate			
4	Case					
5	Vapour Flow rate	Act m3/h	-			
6	Vapour Density @ Oper T/P	kg/m3	-			
7	Vapour Viscosity @ Oper. T/P	cP	-			
8	Vapour Molecular Weight		-			
9	Liquid HC Flow Rate	Act m3/h	3.9			
10	Liquid HC Density @ Oper. T/P	kg/m3	725			
11	Liquid HC Viscosity @ Oper. T/P	cP	0.62			
12	Liquid HC Surface Tension	dyne/cm	21.2			
13	Slug Holding Liquid Volume	m3	0			
14	Water Flow Rate	Act m3/h	-			
15	Water Density @ Oper. T/P	kg/m3	-			
16	Water Viscosity @ Oper. T/P	cP	-			
17	Design Margin on Flow Rates	%	-			
18	Corrosive Compounds		H_2S, CO_2 and H_2O			
19	VESSEL INTERNALS					
20	Gas Demister/Vane Pack					
21	Vortex Breakers		N8			

NOZZLE SCHEDULE

Mark No	Size	Qty.	Flange		Service	Standout (mm)		Reinf Pad (mm)	
	NPS	Nos.	Rating	Type/Face		Ext	Int	Thick	Diam
N1	4"	1	150#	WN/RF	Fluid Inlet (150# header)				
N2	4"	1	300#	WN/RF	Fluid Inlet (300# header)				
N3	4"	1	600#	WN/RF	Fluid Inlet (600# header)				
N4	4"	1	900#	WN/RF	Fluid Inlet (900# header)	△1			
N5	4"	1	1500#	WN/RF	Fluid Inlet (1500# header)				
N6	4"	1	2500#	WN/RF	Fluid Inlet (250# header)				
N7	10"	1	150#	WN/RF	Vapour Outlet to LP KO Drum				
N8	2"	1	150#	WN/RF	Liquid Outlet to Pumps				
N9	3"	1	150#	WN/RF	Drain				
N10	2"	1	150#	WN/RF	Fluid inlet from Open drains				
N11	2"	1	150#	WN/RF	Fluid inlet from Open drains				
N12	8"	1	150#	WN/RF	LP Flare header inlet △1				
K1 A/B	4"	2	150#	WN/RF	Level Bridle Condensate				
K2 A/B	4"	2	150#	WN/RF	Level Bridle Condensate				
K3	2"	1	150#	WN/RF	Pressure Indicator				
K4	2"	1	150#	WN/RF	Temperature Indicator				
M1	20"	1	150#	WN/RF	Manway				
M2	20"	1	150#	WN/RF	Manway △1				

COMMENTS

1. Nozzle sizes and elevations shall be confirmed during detailed engineering.

Worley

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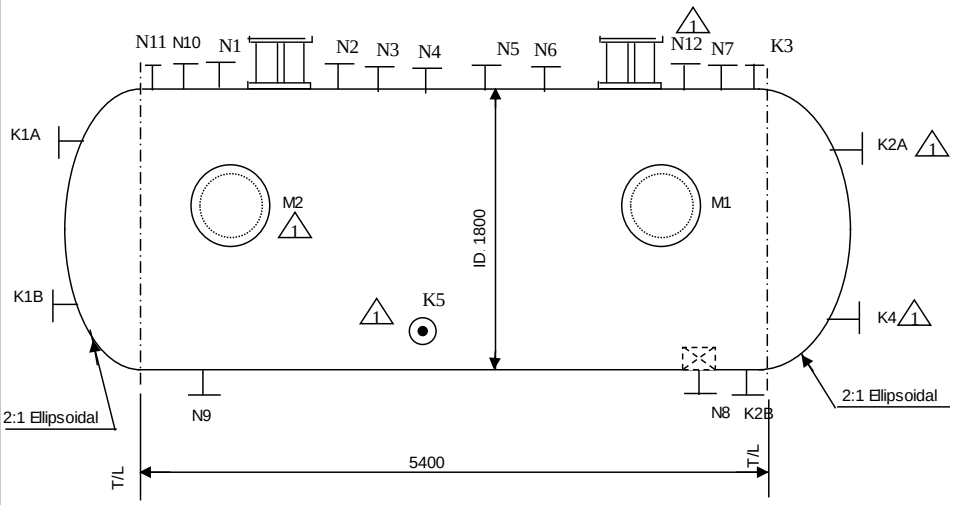
Bul Hanine Arab "C" Gas Cap Recycling

Project No:	**022/00705**	**Rev:**
Document No:	**00705-MEC-DTS-198**	**1**

00705-MEC-DTS-198R1.XLS

Data Sheet for Unfired Pressure Vessel

Equipment Name : Closed Drain Drum	**Location:** Arabian Gulf
Tag No. : 603-39V-01	**Plant Location :** PS-3K
No. of Units : 1	**Manufacturer/Model :**



Datum taken from bottom of vessel

LIQUID LEVELS		LIQUID
LAHH	mm	1500
LAH	mm	1200
LAL	mm	500
LALL	mm	300

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Qatar Petroleum

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Bul Hanine Arab "C" Gas Cap Recycling

Project No:	**022/00705**	**Rev:**
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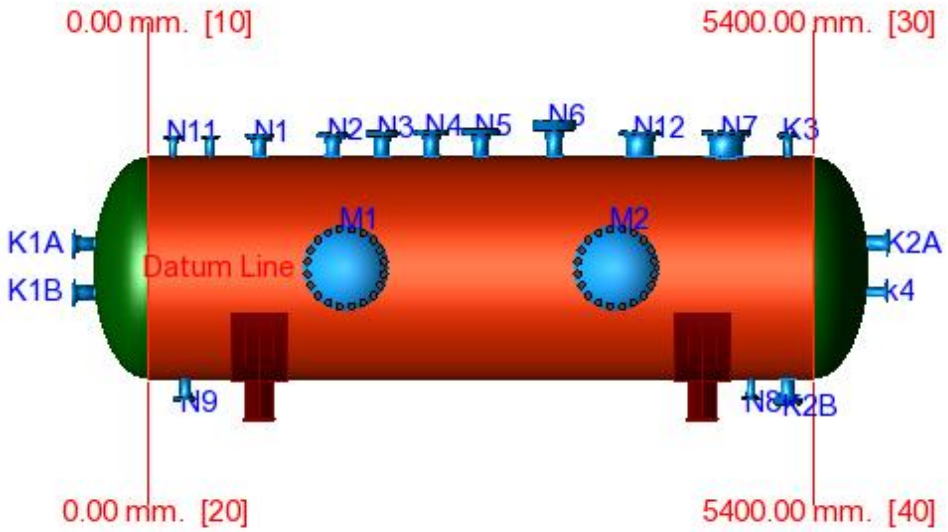
00705-MEC-DTS-198R1.XLS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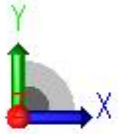
N11
N1
N2
N3
N4
N5
N6
N12
N7
K3
M1
M2
K1A
K1B
Datum Line
K2A
k4
N9
N8
K2B
0.00 mm. [20]
5400.00 mm. [40]


Y
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Tebal Dinding Shell & Head

Ukuran Tebal Dinding Shell & Head Standar :

- 1/4 = 0,25	- 7/8 = 0,875	- 1-1/2 = 1,5
- 5/16 = 0,3125	- 15/16 = 0,9375	- 1-9/16 = 1,5625
- 3/8 = 0,375	- 1 = 1,0	- 1-5/8 = 1,625
- 7/16 = 0,4375	- 1-1/16 = 1,0625	- 1-11/16 = 0,6875
- 1/2 = 0,5	- 1-1/8 = 1,125	- 1-3/4 = 1,75
- 9/16 = 0,5625	- 1-3/16 = 1,1875	- 1-13/16 = 1,8125
- 5/8 = 0,625	- 1-1/4 = 1,25	- 1-7/8 = 1,875
- 11/16 = 0,6875	- 1-5/16 = 1,3125	- 1-15/16 = 1,9375
- 3/4 = 0,75	- 1-3/8 = 1,375	- 2 = 2,0
- 13/16 = 0,8125	- 1-7/16 = 1,4375	- 2-1/4 = 2,25

Satuan : inch **(hlm : 374)**

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd psig	Nominal Thickness in.	Total Corr Allowance in.	Element Diameter in.	Allowable Stress(SE) psi
10	20	50.7644	0.11811	0.11811	70.8661	17100.0
20	30	50.7644	0.11811	0.11811	70.8661	17100.0
30	40	50.7644	0.11811	0.11811	70.8661	17100.0

Element Required Thickness and MAWP :

		Design	M.A.W.P.	M.A.P.	Minimum	Required

From	To	Pressure	Corroded	New & Cold	Thickness	Thickness
		psig	psig	psig	in.	in.
10	20	50.7644	63.2976	120.565	0.25000	0.22322
20	30	50.7644	63.2976	120.141	0.25000	0.22384
30	40	50.7644	63.2976	120.565	0.25000	0.22322
Minimum			**63.298**	**120.140**		

MAWP: 50.836 psig, limited by: Nozzle Reinforcement.

Internal Pressure Calculation Results :

ASME Code, Section VIII, Division 1, 2015

Elliptical Head From 10 To 20 SA-516 60 , UCS-66 Crv. C at 334 °F

Material UNS Number: K02100

Required Thickness due to Internal Pressure [tr]:

= (P*D*Kcor)/(2*S*E-0.2*P) Appendix 1-4(c)
= (50.764*71.1024*0.996)/(2*17100.00*1.00-0.2*50.764)
= 0.1051 + 0.1181 = 0.2232 in.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:

= (2*S*E*t)/(Kcor*D+0.2*t) per Appendix 1-4 (c)
= (2*17100.00*1.00*0.1319)/(0.996*71.1024+0.2*0.1319)
= 63.696 psig

Cylindrical Shell From 20 To 30 SA-516 60 , UCS-66 Crv. C at 334 °F

Material UNS Number: K02100

Required Thickness due to Internal Pressure [tr]:

= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (50.764*35.5512)/(17100.00*1.00-0.6*50.764)
= 0.1057 + 0.1181 = 0.2238 in.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:

= (S*E*t)/(R+0.6*t) per UG-27 (c)(1)
= (17100.00*1.00*0.1319)/(35.5512+0.6*0.1319)
= 63.298 psig

Elliptical Head From 30 To 40 SA-516 60 , UCS-66 Crv. C at 334 °F

Material UNS Number: K02100

Required Thickness due to Internal Pressure [tr]:

= (P*D*Kcor)/(2*S*E-0.2*P) Appendix 1-4(c)
= (50.764*71.1024*0.996)/(2*17100.00*1.00-0.2*50.764)
= 0.1051 + 0.1181 = 0.2232 in.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:

= (2*S*E*t)/(Kcor*D+0.2*t) per Appendix 1-4 (c)
= (2*17100.00*1.00*0.1319)/(0.996*71.1024+0.2*0.1319)
= 63.696 psig

Hydrostatic Test Pressure Results:

Pressure per UG99b	= 1.3 * M.A.W.P. * Sa/S	66.087	psig
Pressure per UG99b[36]	= 1.3 * Design Pres * Sa/S	65.994	psig
Pressure per UG99c	= 1.3 * M.A.P. - Head(Hyd)	153.624	psig
Pressure per UG100	= 1.1 * M.A.W.P. * Sa/S	55.920	psig
Pressure per PED	= 1.43 * MAWP	72.696	psig
Pressure per App 27-4	= 1.3 * M.A.W.P. * Sa/S	66.087	psig

UG-99(b), Test Pressure Calculation:

= Test Factor * MAWP * Stress Ratio
= 1.3 * 50.836 * 1.000
= 66.087 psig

Nozzle Flange MAWP Results :

Nozzle Description	Flange Rating Operating psig	Ambient psig	Temperature °F	Class	Grade/Group
K1A	219.7	285.0	334	150	GR 1.1
K1B	219.7	285.0	334	150	GR 1.1
N1	219.7	285.0	334	150	GR 1.1
N2	648.1	740.0	334	300	GR 1.1
N3	1294.5	1480.0	334	600	GR 1.1
N4	1942.7	2220.0	334	900	GR 1.1
N5	3235.6	3705.0	334	1500	GR 1.1
N6	5391.6	6170.0	334	2500	GR 1.1
N7	219.7	285.0	334	150	GR 1.1
N8	219.7	285.0	334	150	GR 1.1
N9	219.7	285.0	33	4 150	GR 1.1
N10	219.7	285.0	334	150	GR 1.1
N11	219.7	285.0	334	150	GR 1.1
N12	219.7	285.0	334	150	GR 1.1
K3	219.7	285.0	334	150	GR 1.1
K2B	219.7	285.0	334	150	GR 1.1
M1	219.7	285.0	334	150	GR 1.1
M2	219.7	285.0	334	150	GR 1.1
K2A	219.7	285.0	334	150	GR 1.1
k4	219.7	285.0	334	150	GR 1.1
Minimum Rating	219.688	285.000	psig	(for Core Elements)	

NOZZLE K1A

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.404	NA	NA
Area in Shell	A1	0.159	NA	NA
Area in Nozzle Wall	A2	0.075	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.114	NA	NA

TOTAL AREA AVAILABLE	Atot	0.437	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2643*0.0947*1.0+2*0.1189*0.0947*1.0*(1-1.00))
= 0.404 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.264 (1.00 * 0.1319 - 1.0 * 0.095) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.0947) * (1 - 1.000)
= 0.159 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2/sin(alpha3)
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000/sin(85.3)
= 0.075 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.1477 - 4.5036) * 0.2362 * 1.0000
= 0.114 in²

NOZZLE K1B

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.404	NA	NA
Area in Shell	A1	0.159	NA	NA
Area in Nozzle Wall	A2	0.075	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.114	NA	NA
TOTAL AREA AVAILABLE	Atot	0.437	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2643*0.0947*1.0+2*0.1189*0.0947*1.0*(1-1.00))
= 0.404 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.264 (1.00 * 0.1319 - 1.0 * 0.095) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.0947) * (1 - 1.000)
= 0.159 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2/sin(alpha3)
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000/sin(85.3)
= 0.075 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.1477 - 4.5036) * 0.2362 * 1.0000
= 0.114 in²

NOZZLE N1

AREA AVAILABLE, A1 to A5		Design	External	Mapnc

Area Required	Ar	0.448	NA	NA
Area in Shell	A1	0.111	NA	NA
Area in Nozzle Wall	A2	0.074	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.184	NA	NA
TOTAL AREA AVAILABLE	Atot	0.459	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
= 0.448 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.111 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000
= 0.074 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE N2

Results of Nozzle Reinforcement Area Calculations: (in²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.448	NA	NA
Area in Shell	A1	0.111	NA	NA
Area in Nozzle Wall	A2	0.074	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.184	NA	NA
TOTAL AREA AVAILABLE	Atot	0.459	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
= 0.448 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.111 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000
= 0.074 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE N3

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.448	NA	NA
Area in Shell	A1	0.111	NA	NA
Area in Nozzle Wall	A2	0.074	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.184	NA	NA
TOTAL AREA AVAILABLE	Atot	0.459	NA	NA

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
= 0.448 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:
= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.111 in²

Area Available in Nozzle Wall Projecting Outward [A2]:
= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000
= 0.074 in²

Area Available in Welds [A41 + A42 + A43]:
= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE N4

Results of Nozzle Reinforcement Area Calculations: (in²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.448	NA	NA
Area in Shell	A1	0.111	NA	NA
Area in Nozzle Wall	A2	0.074	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.184	NA	NA
TOTAL AREA AVAILABLE	Atot	0.459	NA	NA

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
= 0.448 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:
= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.111 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000
= 0.074 in²

Area Available in Welds [A41 + A42 + A43]:
= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE N5

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.448	NA	NA
Area in Shell	A1	0.111	NA	NA
Area in Nozzle Wall	A2	0.074	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.184	NA	NA

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
= 0.448 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:
= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.111 in²

Area Available in Nozzle Wall Projecting Outward [A2]:
= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000
= 0.074 in²

Area Available in Welds [A41 + A42 + A43]:
= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE N6

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.448	NA	NA
Area in Shell	A1	0.111	NA	NA
Area in Nozzle Wall	A2	0.074	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.184	NA	NA
TOTAL AREA AVAILABLE	Atot	0.459	NA	NA

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
= 0.448 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 4.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.111 in²

Area Available in Nozzle Wall Projecting Outward [A2]:
= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000
= 0.074 in²

Area Available in Welds [A41 + A42 + A43]:
= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE N7

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	1.082	NA	NA
Area in Shell	A1	0.268	NA	NA
Area in Nozzle Wall	A2	0.153	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.575	NA	NA
TOTAL AREA AVAILABLE	Atot	1.085	NA	NA

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (10.2362*0.1057*1.0+2*0.2469*0.1057*1.0*(1-1.00))
= 1.082 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:
= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 10.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.247
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.268 in²

Area Available in Nozzle Wall Projecting Outward [A2]:
= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.2469 - 0.0152) * 1.0000
= 0.153 in²

Area Available in Welds [A41 + A42 + A43]:
= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (13.9764 - 10.7299) * 0.2362 * 1.0000
= 0.575 in²

NOZZLE N8

Reinforcement CALCULATION, Description: N8

ASME Code, Section VIII, Div. 1, 2015, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	2.000	in.
Actual Thickness Used in Calculation	0.344	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(Sv*E-0.6*P) per UG-27 (c)(1)
= (50.76*35.5512)/(17100*1.00-0.6*50.76)
= 0.1057 in.

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(Sn*E-0.6*P) per UG-27 (c)(1)
= (50.76*1.12)/(34059*1.00-0.6*50.76)
= 0.0017 in.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	Dl	4.4724	in.
Parallel to Vessel Wall, opening length	d	2.2362	in.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	0.3297	in.

Note:
Taking a UG-36(c)(3)(a) exemption for nozzle: N8.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the UG-37 small nozzle area calculation or force the Appendix 1-10 computation in Nozzle Design Options.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures	ta =	0.1198 in.
Wall Thickness per UG16(b),	tr16b =	0.1806 in.
Wall Thickness, shell/head, internal pressure	trb1 =	0.2238 in.
Wall Thickness	tb1 = max(trb1, tr16b) =	0.2238 in.
Wall Thickness	tb2 = max(trb2, tr16b) =	0.1806 in.
Wall Thickness per table UG-45	tb3 =	0.2961 in.

Determine Nozzle Thickness candidate [tb]:
= min[tb3, max(tb1,tb2)]
= min[0.296 , max(0.2238 , 0.1806)]
= 0.2238 in.

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
= max(ta, tb)
= max(0.1198 , 0.2238)
= 0.2238 in.

Available Nozzle Neck Thickness = 0.3441 in. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle to Flange Weld skipped as Nozzle is not a Carbon Steel material.
Nozzle-Shell Weld for Nozzle skipped as Nozzle is not a Carbon Steel material.

Weld Size Calculations, Description: N8

Intermediate Calc. for nozzle/shell Welds	Tmin	0.1319	in.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.0923 = 0.7 * tmin.	0.2783 = 0.7 * Wo in.

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a) (small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case	63.298	psig

Note: The MAWP of this junction was limited by the parent Shell/Head.
The Drop for this Nozzle is : 0.0255 in.
The Cut Length for this Nozzle is, Drop + Ho + H + T : 4.2125 in.

NOZZLE N9

Reinforcement CALCULATION, Description: N9

ASME Code, Section VIII, Div. 1, 2015, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	3.000	in.
Actual Thickness Used in Calculation	0.300	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(Sv*E-0.6*P) per UG-27 (c)(1)

= (50.76*35.5512)/(17100*1.00-0.6*50.76)
= 0.1057 in.

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(Sn*E-0.6*P) per UG-27 (c)(1)
= (50.76*1.62)/(34059*1.00-0.6*50.76)
= 0.0024 in.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	Dl	6.4724	in.
Parallel to Vessel Wall, opening length	d	3.2362	in.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	0.3297	in.

Note:
Taking a UG-36(c)(3)(a) exemption for nozzle: N9.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the UG-37 small nozzle area calculation or force the Appendix 1-10 computation in Nozzle Design Options.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures	ta	= 0.1205 in.
Wall Thickness per UG16(b),	tr16b	= 0.1806 in.
Wall Thickness, shell/head, internal pressure	trb1	= 0.2238 in.
Wall Thickness	tb1 = max(trb1, tr16b)	= 0.2238 in.
Wall Thickness	tb2 = max(trb2, tr16b)	= 0.1806 in.
Wall Thickness per table UG-45	tb3	= 0.3157 in.

Determine Nozzle Thickness candidate [tb]:
= min[tb3, max(tb1,tb2)]
= min[0.316 , max(0.2238 , 0.1806)]
= 0.2238 in.

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
= max(ta, tb)
= max(0.1205 , 0.2238)
= 0.2238 in.

Available Nozzle Neck Thickness = 0.3000 in. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle to Flange Weld skipped as Nozzle is not a Carbon Steel material.
Nozzle-Shell Weld for Nozzle skipped as Nozzle is not a Carbon Steel material.

Weld Size Calculations, Description: N9

Intermediate Calc. for nozzle/shell Welds	Tmin	0.1319	in.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.0923 = 0.7 * tmin.	0.2783 = 0.7 * Wo in.

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a)
(small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case	63.298	psig

Note: The MAWP of this junction was limited by the parent Shell/Head.
The Drop for this Nozzle is : 0.0457 in.
The Cut Length for this Nozzle is, Drop + Ho + H + T : 4.2328 in.

NOZZLE N10

Reinforcement CALCULATION, Description: N10

ASME Code, Section VIII, Div. 1, 2015, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	2.000	in.
Actual Thickness Used in Calculation	0.344	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(Sv*E-0.6*P) per UG-27 (c)(1)
= (50.76*35.5512)/(17100*1.00-0.6*50.76)
= 0.1057 in.
Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(Sn*E-0.6*P) per UG-27 (c)(1)
= (50.76*1.12)/(34059*1.00-0.6*50.76)
= 0.0017 in.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	Dl	4.4724	in.
Parallel to Vessel Wall, opening length	d	2.2362	in.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	0.3297	in.

Note:
Taking a UG-36(c)(3)(a) exemption for nozzle: N10.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the UG-37 small nozzle area calculation or force the Appendix 1-10 computation in Nozzle Design Options.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures	ta	= 0.1198 in.
Wall Thickness per UG16(b),	tr16b	= 0.1806 in.
Wall Thickness, shell/head, internal pressure	trb1	= 0.2238 in.
Wall Thickness	tb1 = max(trb1, tr16b)	= 0.2238 in.
Wall Thickness	tb2 = max(trb2, tr16b)	= 0.1806 in.
Wall Thickness per table UG-45	tb3	= 0.2961 in.

Determine Nozzle Thickness candidate [tb]:
= min[tb3, max(tb1,tb2)]
= min[0.296 , max(0.2238 , 0.1806)]
= 0.2238 in.
Minimum Wall Thickness of Nozzle Necks [tUG-45]:
= max(ta, tb)
= max(0.1198 , 0.2238)
= 0.2238 in.
Available Nozzle Neck Thickness = 0.3441 in. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:
Nozzle to Flange Weld skipped as Nozzle is not a Carbon Steel material.
Nozzle-Shell Weld for Nozzle skipped as Nozzle is not a Carbon Steel material.
Weld Size Calculations, Description: N10

Intermediate Calc. for nozzle/shell Welds	Tmin	0.1319	in.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.0923 = 0.7 * tmin.	0.2783 = 0.7 * Wo in.

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a)
(small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case	63.298	psig

Note: The MAWP of this junction was limited by the parent Shell/Head.
The Drop for this Nozzle is : 0.0255 in.
The Cut Length for this Nozzle is, Drop + Ho + H + T : 4.2125 in.

NOZZLE N11

Reinforcement CALCULATION, Description: N11
ASME Code, Section VIII, Div. 1, 2015, UG-37 to UG-45

Actual Inside Diameter Used in Calculation		2.000	in.

```
 Actual Thickness Used in Calculation                    0.344  in.
```
Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]

```
  = (P*R)/(Sv*E-0.6*P) per UG-27 (c)(1)
  = (50.76*35.5512)/(17100*1.00-0.6*50.76)
  = 0.1057 in.
```

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]

```
  = (P*R)/(Sn*E-0.6*P) per UG-27 (c)(1)
  = (50.76*1.12)/(34059*1.00-0.6*50.76)
  = 0.0017 in.
```

UG-40, Limits of Reinforcement : [Internal Pressure]

```
 Parallel to Vessel Wall (Diameter Limit)            Dl     4.4724  in.
 Parallel to Vessel Wall, opening length              d     2.2362  in.
 Normal to Vessel Wall (Thickness Limit), no pad   Tlnp     0.3297  in.
```

Note:
Taking a UG-36(c)(3)(a) exemption for nozzle: N11.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the UG-37 small nozzle area calculation or force the Appendix 1-10 computation in Nozzle Design Options.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

```
 Wall Thickness for Internal/External pressures      ta = 0.1198 in.
 Wall Thickness per UG16(b),                      tr16b = 0.1806 in.
 Wall Thickness, shell/head, internal pressure     trb1 = 0.2238 in.
 Wall Thickness                 tb1 = max(trb1, tr16b) = 0.2238 in.
 Wall Thickness                 tb2 = max(trb2, tr16b) = 0.1806 in.
 Wall Thickness per table UG-45                   tb3 = 0.2961 in.
```

Determine Nozzle Thickness candidate [tb]:

```
  = min[ tb3, max( tb1,tb2) ]
  = min[ 0.296 , max( 0.2238 , 0.1806 ) ]
  = 0.2238 in.
```

inimum Wall Thickness of Nozzle Necks [tUG-45]:

```
  = max( ta, tb )
  = max( 0.1198 , 0.2238 )
  = 0.2238 in.
```

Available Nozzle Neck Thickness = 0.3441 in. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle to Flange Weld skipped as Nozzle is not a Carbon Steel material.
Nozzle-Shell Weld for Nozzle skipped as Nozzle is not a Carbon Steel material.

Weld Size Calculations, Description: N11

```
 Intermediate Calc. for nozzle/shell Welds   Tmin      0.1319  in.
```

Results Per UW-16.1:

```
                      Required Thickness    Actual Thickness
 Nozzle Weld          0.0923 = 0.7 * tmin.  0.2783 = 0.7 * Wo in.
```

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a)
(small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:

```
 Converged Max. Allow. Pressure in Operating case       63.298  psig
```

Note: The MAWP of this junction was limited by the parent Shell/Head.
The Drop for this Nozzle is : 0.0255 in.
The Cut Length for this Nozzle is, Drop + Ho + H + T : 4.2125 in.

NOZZLE N12

```
AREA AVAILABLE, A1 to A5     |    Design|  External|     Mapnc|
```

Area Required	Ar	0.871	NA	NA
Area in Shell	A1	0.215	NA	NA
Area in Nozzle Wall	A2	0.126	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.456	NA	NA
TOTAL AREA AVAILABLE	Atot	0.888	NA	NA

.

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (8.2362*0.1057*1.0+2*0.2039*0.1057*1.0*(1-1.00))
= 0.871 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 8.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.204
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.215 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.2039 - 0.0122) * 1.0000
= 0.126 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (11.2205 - 8.6441) * 0.2362 * 1.0000
= 0.456 in²

NOZZLE K3

Reinforcement CALCULATION, Description: K3

ASME Code, Section VIII, Div. 1, 2015, UG-37 to UG-45

Actual Inside Diameter Used in Calculation		2.000	in.
Actual Thickness Used in Calculation		0.344	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]

= (P*R)/(Sv*E-0.6*P) per UG-27 (c)(1)
= (50.76*35.5512)/(17100*1.00-0.6*50.76)
= 0.1057 in.

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]

= (P*R)/(Sn*E-0.6*P) per UG-27 (c)(1)
= (50.76*1.12)/(34059*1.00-0.6*50.76)
= 0.0017 in.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	Dl	4.4724	in.
Parallel to Vessel Wall, opening length	d	2.2362	in.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	0.3297	in.

Note:

Taking a UG-36(c)(3)(a) exemption for nozzle: K3.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the UG-37 small nozzle area calculation or force the Appendix 1-10 computation in Nozzle Design Options.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

```
 Wall Thickness for Internal/External pressures      ta = 0.1198 in.
 Wall Thickness per UG16(b),                      tr16b = 0.1806 in.
 Wall Thickness, shell/head, internal pressure     trb1 = 0.2238 in.
 Wall Thickness                tb1 = max(trb1, tr16b) = 0.2238 in.
 Wall Thickness                tb2 = max(trb2, tr16b) = 0.1806 in.
 Wall Thickness per table UG-45                   tb3 = 0.2961 in.
```

Determine Nozzle Thickness candidate [tb]:

```
  = min[ tb3, max( tb1,tb2) ]
  = min[ 0.296 , max( 0.2238 , 0.1806 ) ]
  = 0.2238 in.
```

Minimum Wall Thickness of Nozzle Necks [tUG-45]:

```
  = max( ta, tb )
  = max( 0.1198 , 0.2238 )
  = 0.2238 in.
```

Available Nozzle Neck Thickness = 0.3441 in. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle to Flange Weld skipped as Nozzle is not a Carbon Steel material.

Nozzle-Shell Weld for Nozzle skipped as Nozzle is not a Carbon Steel material.

Weld Size Calculations, Description: K3

```
 Intermediate Calc. for nozzle/shell Welds   Tmin      0.1319  in.
```

Results Per UW-16.1:

```
                      Required Thickness    Actual Thickness
 Nozzle Weld          0.0923 = 0.7 * tmin.  0.2783 = 0.7 * Wo in.
```

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a)
(small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:

```
 Converged Max. Allow. Pressure in Operating case       63.298  psig
```

Note: The MAWP of this junction was limited by the parent Shell/Head.

The Drop for this Nozzle is : 0.0255 in.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 4.2125 in.

NOZZLE K2B

```
AREA AVAILABLE, A1 to A5      |    Design|  External|     Mapnc|
 ---------------------------------------------------------------
 Area Required             Ar |     0.448|        NA|        NA|
 Area in Shell             A1 |     0.111|        NA|        NA|
 Area in Nozzle Wall       A2 |     0.074|        NA|        NA|
 Area in Inward Nozzle     A3 |     0.000|        NA|        NA|
 Area in Welds    A41+A42+A43 |     0.090|        NA|        NA|
 Area in Element           A5 |     0.184|        NA|        NA|
 TOTAL AREA AVAILABLE    Atot |     0.459|        NA|        NA|
```

.Area Required [A]:

```
  = ( d * tr*F + 2 * tn * tr*F * (1-fr1) ) UG-37(c)
  = (4.2362*0.1057*1.0+2*0.1189*0.1057*1.0*(1-1.00))
  = 0.448 in²
```

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

```
  = d( E1*t - F*tr ) - 2 * tn( E1*t - F*tr ) * ( 1 - fr1 )
  = 4.236 ( 1.00 * 0.1319 - 1.0 * 0.106 ) - 2 * 0.119
    ( 1.00 * 0.1319 - 1.0 * 0.1057 ) * ( 1 - 1.000 )
  = 0.111 in²
```

Area Available in Nozzle Wall Projecting Outward [A2]:

```
  = ( 2 * Tlwp ) * ( tn - trn ) * fr2
  = ( 2 * 0.330 ) * ( 0.1189 - 0.0063 ) * 1.0000
  = 0.074 in²
```

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (5.5118 - 4.4740) * 0.2362 * 1.0000
= 0.184 in²

NOZZLE M1

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	2.140	NA	NA
Area in Shell	A1	0.529	NA	NA
Area in Nozzle Wall	A2	0.294	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	1.272	NA	NA
TOTAL AREA AVAILABLE	Atot	2.186	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (20.2362*0.1057*1.0+2*0.4760*0.1057*1.0*(1-1.00))
= 2.140 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 20.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.476
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)
= 0.529 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2
= (2 * 0.330) * (0.4760 - 0.0301) * 1.0000
= 0.294 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4
= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00
= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4
= (26.5748 - 21.1882) * 0.2362 * 1.0000
= 1.272 in²

NOZZLE M2

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	2.140	NA	NA
Area in Shell	A1	0.529	NA	NA
Area in Nozzle Wall	A2	0.294	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	1.272	NA	NA
TOTAL AREA AVAILABLE	Atot	2.186	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (20.2362*0.1057*1.0+2*0.4760*0.1057*1.0*(1-1.00))
= 2.140 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 20.236 (1.00 * 0.1319 - 1.0 * 0.106) - 2 * 0.476
(1.00 * 0.1319 - 1.0 * 0.1057) * (1 - 1.000)

= 0.529 n²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2

= (2 * 0.330) * (0.4760 - 0.0301) * 1.0000

= 0.294 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4

= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00

= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4

= (26.5748 - 21.1882) * 0.2362 * 1.0000

= 1.272 in²

NOZZLE K2A

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.404	NA	NA
Area in Shell	A1	0.159	NA	NA
Area in Nozzle Wall	A2	0.075	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.090	NA	NA
Area in Element	A5	0.114	NA	NA
TOTAL AREA AVAILABLE	Atot	0.437	NA	NA

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)

= (4.2643*0.0947*1.0+2*0.1189*0.0947*1.0*(1-1.00))

= 0.404 in²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)

= 4.264 (1.00 * 0.1319 - 1.0 * 0.095) - 2 * 0.119
(1.00 * 0.1319 - 1.0 * 0.0947) * (1 - 1.000)

= 0.159 in²

Area Available in Nozzle Wall Projecting Outward [A2]:

= (2 * Tlwp) * (tn - trn) * fr2/sin(alpha3)

= (2 * 0.330) * (0.1189 - 0.0063) * 1.0000/sin(85.3)

= 0.075 in²

Area Available in Welds [A41 + A42 + A43]:

= (Wo² - Ar Lost)*Fr3+((Wi-can/0.707)² - Ar Lost)*fr2 + Wp²*fr4

= (0.0649) * 1.00 + (0.0000) * 1.00 + 0.0248² * 1.00

= 0.090 in²

Area Available in Element [A5]:

= (min(Dp,DL)-(Nozzle OD))*(min(tp,Tlwp,te))*fr4

= (5.1477 - 4.5036) * 0.2362 * 1.0000

= 0.114 in²

NOZZLE k4

Reinforcement CALCULATION, Description: k4

ASME Code, Section VIII, Div. 1, 2015, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	2.000	in.
Actual Thickness Used in Calculation	0.344	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Elliptical Head, Tr [Int. Press]

= (P*K1*D))/(2*Sv*E-0.2*P) per UG-37(a)(3)

= (50.76*0.897*71.1024)/(2 *17100.00*1.00-0.2*50.76)

= 0.0947 in.

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]

= (P*R)/(Sn*E-0.6*P) per UG-27 (c)(1)

= (50.76*1.12)/(34059*1.00-0.6*50.76)

= 0.0017 in.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	Dl	4.4724	in.
Parallel to Vessel Wall, opening length	d	2.2362	in.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	0.3297	in.

Note:
Taking a UG-36(c)(3)(a) exemption for nozzle: k4.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the UG-37 small nozzle area calculation or force the Appendix 1-10 computation in Nozzle Design Options.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures	ta =	0.1198 in.
Wall Thickness per UG16(b),	tr16b =	0.1806 in.
Wall Thickness, shell/head, internal pressure	trb1 =	0.2232 in.
Wall Thickness	tb1 = max(trb1, tr16b) =	0.2232 in.
Wall Thickness	tb2 = max(trb2, tr16b) =	0.1806 in.
Wall Thickness per table UG-45	tb3 =	0.2961 in.

Determine Nozzle Thickness candidate [tb]:
= min[tb3, max(tb1,tb2)]
= min[0.296 , max(0.2232 , 0.1806)]
= 0.2232 in.

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
= max(ta, tb)
= max(0.1198 , 0.2232)
= 0.2232 in.

Available Nozzle Neck Thickness = 0.3441 in. --> OK

Weld Size Calculations, Description: k4

Intermediate Calc. for nozzle/shell Welds	Tmin	0.1319	in.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.0923 = 0.7 * tmin.	0.2783 = 0.7 * Wo in.

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a)
(small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case	63.298	psig

Note: The MAWP of this junction was limited by the parent Shell/Head.
The Drop for this Nozzle is : 0.1812 in.
The Cut Length for this Nozzle is, Drop + Ho + H + T : 4.3701 in.

Lampiran 9. Tegangan Izin Material

- SA 516 Gr.60

(14)

Table A-1 Basic Allowable Stresses in Tension for Metals (Cont'd)

Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Material	Spec. No.	Type/ Grade	UNS No.	Class/ Condition/ Temper	Size, in.	P-No. (5)	Notes	Min. Temp., °F (6)	Specified Min. Strength, ksi Tensile	Yield	Min. Temp. to 100	200	300
Carbon Steel Pipes and Tubes (2)													
A285 Gr. A	A134	...	...	...	...	1	(8b)(57)	B	45	24	15.0	14.7	14.2
A285 Gr. A	A672	A45	K01700	...	...	1	(57)(59)(67)	B	45	24	15.0	14.7	14.2
Butt weld	API 5L	A25	...	...	...	1	(8a)(77)	−20	45	25	15.0	15.0	14.7
Smls & ERW	API 5L	A25	...	...	...	1	(57)(59)(77)	B	45	25	15.0	15.0	14.7
...	A179	...	K01200	...	...	1	(57)(59)	−20	47	26	15.7	15.7	15.3
Type F	A53	A	K02504	...	...	1	(8a)	20	48	30	16.0	16.0	16.0
...	A139	A	...	...	...	1	(8b)	A	48	30	16.0	16.0	16.0
...	A587	...	K11500	...	...	1	(57)(59)	−20	48	30	16.0	16.0	16.0
...	A53	A	K02504	...	...	1	(57)(59)	B	48	30	16.0	16.0	16.0
...	A106	A	K02501	...	...	1	(57)	B	48	30	16.0	16.0	16.0
...	A135	A	...	...	...	1	(57)(59)	B	48	30	16.0	16.0	16.0
...	A369	FPA	K02501	...	...	1	(57)	B	48	30	16.0	16.0	16.0
...	API 5L	A	...	...	...	1	(57)(59)(77)	B	48	30	16.0	16.0	16.0
A285 Gr. B	A134	...	...	...	...	1	(8b)(57)	B	50	27	16.7	16.5	15.9
A285 Gr. B	A672	A50	K02200	...	...	1	(57)(59)(67)	B	50	27	16.7	16.5	15.9
A285 Gr. C	A134	...	...	...	...	1	(8b)(57)	A	55	30	18.3	18.3	17.7
...	A524	II	K02104	...	...	1	(57)	−20	55	30	18.3	18.3	17.7
...	A333	1	K03008	...	...	1	(57)(59)	−50	55	30	18.3	18.3	17.7
...	A334	1	K03008	...	...	1	(57)(59)	−50	55	30	18.3	18.3	17.7
A285 Gr. C	A671	CA55	K02801	...	...	1	(59)(67)	A	55	30	18.3	18.3	17.7
A285 Gr. C	A672	A55	K02801	...	...	1	(57)(59)(67)	A	55	30	18.3	18.3	17.7
A516 Gr. 55	A672	C55	K01800	...	...	1	(57)(67)	C	55	30	18.3	18.3	17.7
A516 Gr. 60	A671	CC60	K02100	...	...	1	(57)(67)	C	60	32	20.0	19.5	18.9
A515 Gr. 60	A671	CB60	K02401	...	...	1	(57)(67)	B	60	32	20.0	19.5	18.9
A515 Gr. 60	A672	B60	K02401	...	...	1	(57)(67)	B	60	32	20.0	19.5	18.9
A516 Gr. 60	A672	C60	K02100	...	...	1	(57)(67)	C	60	32	20.0	19.5	18.9
...	A139	B	K03003	...	...	1	(8b)	A	60	35	20.0	20.0	20.0
...	A135	B	K03018	...	...	1	(57)(59)	B	60	35	20.0	20.0	20.0
...	A524	I	K02104	...	...	1	(57)	−20	60	35	20.0	20.0	20.0
...	A53	B	K03005	...	...	1	(57)(59)	B	60	35	20.0	20.0	20.0
...	A106	B	K03006	...	...	1	(57)	B	60	35	20.0	20.0	20.0
...	A333	6	K03006	...	...	1	(57)	−50	60	35	20.0	20.0	20.0
...	A334	6	K03006	...	...	1	(57)	−50	60	35	20.0	20.0	20.0
...	A369	FPB	K03006	...	...	1	(57)	−20	60	35	20.0	20.0	20.0
...	A381	Y35	...	...	...	1	...	A	60	35	20.0	20.0	20.0
...	API 5L	B	...	...	...	1	(57)(59)(77)	B	60	35	20.0	20.0	20.0

Table A-1 Basic Allowable Stresses in Tension for Metals (Cont'd)

Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Basic Allowable Stress, *S*, ksi, at Metal Temperature, °F [Note (1)]														
400	500	600	650	700	750	800	850	900	950	1,000	1,050	1,100	Type/ Grade	Spec. No.
														Carbon Steel Pipes and Tubes (2)
13.7	13.0	12.3	11.9	11.5	10.7	9.2	7.9	5.9	...	...	...	...	...	A134
13.7	13.0	12.3	11.9	11.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	A45	A672
14.2	...	...	...	...	...	...	...	...	...	...	...	...	A25	API 5L
14.2	...	...	...	...	...	...	...	...	...	...	...	...	A25	API 5L
14.8	14.1	13.3	12.8	12.4	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	...	A179
16.0	...	...	...	...	...	...	...	...	...	...	...	...	A	A53
...	...	...	...	...	...	...	...	...	...	...	...	...	A	A139
16.0	16.0	15.3	14.6	12.5	10.7	9.2	7.9	...	...	...	...	...	...	A587
16.0	16.0	15.3	14.6	12.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	A	A53
16.0	16.0	15.3	14.6	12.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	A	A106
16.0	16.0	15.3	14.6	12.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	A	A135
16.0	16.0	15.3	14.6	12.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	FPA	A369
16.0	16.0	15.3	14.6	12.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	A	API 5L
15.4	14.7	13.8	13.3	12.5	10.7	9.2	7.9	5.9	...	...	...	...	...	A134
15.4	14.7	13.8	13.3	12.5	10.7	9.2	7.9	5.9	4.0	2.5	1.6	1.0	A50	A672
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	...	...	...	...	...	A134
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	4.0	2.5	...	...	II	A524
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	4.0	2.5	1.6	1.0	1	A333
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	4.0	2.5	1.6	1.0	1	A334
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	4.0	2.5	1.6	1.0	CA55	A671
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	4.0	2.5	1.6	1.0	A55	A672
17.1	16.3	15.3	14.8	14.3	13.0	10.8	8.7	5.9	4.0	2.5	1.6	1.0	C55	A672
18.2	17.4	16.4	15.8	15.3	13.9	11.4	8.7	5.9	4.0	2.5	...	...	CC60	A671
18.2	17.4	16.4	15.8	15.3	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	CB60	A671
18.2	17.4	16.4	15.8	15.3	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	B60	A672
18.2	17.4	16.4	15.8	15.3	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	C60	A672
...	...	...	...	...	...	...	...	...	...	...	...	...	B	A139
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	...	...	B	A135
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	...	...	I	A524
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	B	A53
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	B	A106
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	6	A333
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	6	A334
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	FPB	A369
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	Y35	A381
19.9	19.0	17.9	17.3	16.7	13.9	11.4	8.7	5.9	4.0	2.5	1.6	1.0	B	API 5L

Lampiran 10. MAWP *Flange*

Table F2-1.1 Pressure–Temperature Ratings for Group 1.1 Materials

Nominal Designation	Forgings	Castings	Plates
C–Si	A 105 (1)	A 216 Gr. WCB (1)	A 515 Gr. 70 (1)
C–Mn–Si	A 350 Gr. LF2 (1)		A 516 Gr. 70 (1), (2)
C–Mn–Si–V	A 350 Gr. LF6 Cl. 1 (4)		A 537 Cl. 1 (3)
$3\frac{1}{2}$Ni	A 350 Gr. LF 3		

	Working Pressures by Classes, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	285	740	985	1480	2220	3705	6170
200	260	680	905	1360	2035	3395	5655
300	230	655	870	1310	1965	3270	5450
400	200	635	845	1265	1900	3170	5280
500	170	605	805	1205	1810	3015	5025
600	140	570	755	1135	1705	2840	4730
650	125	550	730	1100	1650	2745	4575
700	110	530	710	1060	1590	2655	4425
750	95	505	675	1015	1520	2535	4230
800	80	410	550	825	1235	2055	3430
850	65	320	425	640	955	1595	2655
900	50	230	305	460	690	1150	1915
950	35	135	185	275	410	685	1145
1000	20	85	115	170	255	430	715

NOTES:

(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.

(2) Not to be used over 850°F.

(3) Not to be used over 700°F.

(4) Not to be used over 500°F.

Table F2-3.8 Pressure–Temperature Ratings for Group 3.8 Materials

Nominal Designation	Forgings	Castings	Plates
54Ni–16Mo–15Cr	B 462 Gr. N10276 (1), (2)		B 575 Gr. N10276 (1), (2)
60Ni–22Cr–9Mo–3.5Cb	B 564 Gr. N06625 (3), (4)		B 443 Gr. N06625 (3), (4)
62Ni–28Mo–5Fe	B 335 Gr. N10001 (1), (5), (6)		B 333 Gr. N10001 (1), (6)
70Ni–16Mo–7Cr–5Fe	B 573 Gr. N10003 (5), (3)		B 434 Gr. N10003 (3)
61Ni–16Mo–16Cr	B 574 Gr. N06455 (1), (5), (6)		B 575 Gr. N06455 (1), (6)
42Ni–21.5Cr–3Mo–2.3Cu	B 564 Gr. N08825 (3), (7)		B 424 Gr. N08825 (3), (7)
55Ni–21Cr–13.5Mo	B 462 Gr. N06022 (1), (2), (8)		B 575 Gr. N06022 (1), (2), (8)
55Ni–23Cr–16Mo–1.6Cu	B 462 Gr. N06200 (1), (6)		B 575 Gr. N06200 (1), (6)

	Working Pressures by Classes, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	700	930	1395	2095	3490	5820
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	205	275	410	615	1030	1715
1250	...	165	220	330	495	825	1370
1300	...	120	160	240	360	600	1000