LAMPIRAN

Lampiran 1. Data *Sheet Fuel Gas Scrubber*

Data Sheet for Unfired Pressure Vessels

Equipment Name:	**Fuel Gas Scrubber**	**Location:**	Arabian Gulf
Tag No.:	**603-36V-01**	**Plant Location:**	PS-3K
No.of Units:	1	**Manufacturer/Model:**	

	DESIGN DATA		CONSTRUCTION MATERIAL	
1	Orientation	Vertical		
2	Contents	HC, H_2S, CO_2	Part	Material Specification
3	Criticality Rating	2	Shell	SA516Gr.60 (see note 4, 5)
4	Service	Lethal, Sour	Cladding/Lining of shell	- △1
5	Design Code	ASME Sec.VIII DIV.1	Heads	SA516Gr.60 (see note 4, 5)
6	Code Stamp	Yes	Cladding/Lining of heads	- △1
7			Supp. Skirt (Top/Bottom Sec.)	SA516Gr.60/SA283GR.C (note
8	Temperature		Reinforcing pads	-
9	Design - Upper/Lower °C	120/4	Self Reinforcing Nozzles	SA105
10	Operating - Max./Normal / Min. °C	65/ - /59	Nozzle neck (pipes)	SA106Gr.B (note 4, 5)
11	Pressure		Forged Flanges	SA 105 (note 4, 5)
12	Design (Internal) barg	40	Internal Flanges	-
13	Design External barg	Full Vacuum	Welding elbow	SA 234 WPB
14	Operating - Max/Norm/Min barg	-/ 34 /-	Demister	Solution treated SS316L
15	Corrosion Allowance mm	3 △1	Baffles	-
16	Specific Gravity Liquid(HC/W)	Refer Sheet 2	Distributor pipes	-
17	Gross Capacity m^3	6	Base ring/Gusset plate	SA 283 GR C
18	Vessel Dia (ID) mm	1300	Vacuum stiffener rings	-
19	Vessel Length (T/L TO T/L) mm	4000	Vortex breakers	-
20	Shop Hydrotest Pressure (N&C)	Per code	Saddles	-
21	Wind	BS CP3, Chapter V, PART	Internal attachments	SA516 Gr.60 (note 4, 5)
22	Design Wind Speed m/s	45	External attachments	SA 283 GR C
23	Seismic	See note 7	External Bolts	SA 193 GR B7(note 2)
24	Shell Thickness (NOM) mm	30 VTC	Nuts	SA 194 GR 2H (note 2)
25	Min.Head Thickness(Top/Bot) mm	29/29 VTC	Gaskets External	Spiral Wound (note 1)
26	SkirtThickness/Height mm	8/1500	Gaskets Internal	
27	Weld Joint Efficiencies:		Internal Bolts	SS 316
28	Shell	1.0	Nuts	SS 316
29	Head	1.0		
30	Inspection and Testing			
31	Third Party Inspection	Yes	**CONSTRUCTION**	
32	Non Destructive Testing:		Type of Heads	2:1 Ellipsoidal
33	Radiography	100%	Type of support	Skirt Supported
34	Ultrasonic	Yes, per Code/Specn.	Platform/Ladder/Pipe Clip	Required
35	Magnetic Particle	100%	Insulation supports	Required
36	Dye Penetrant	Per Code/Spec	Manway Davit	Required
37	Post Weld Heat Treatment	Yes	Earthing Boss	Required
38	Material Impact Test Required	Per code/spec	Lifting Lugs/Eyes/Trunions	Required
39	Certified Elevated Temp.Test Required	No	Name plate	Required, SS316
40	Insulation (By others) mm	No	**ESTIMATED WEIGHTS**	
41	Fireproofing mm	No △1	Empty Kg	5,700 VTC
42	Painting (External)	ES-Q-12	Shipping Kg	VTA
43	Painting (Internal)	No	Operating Kg	7,800 VTC
44			Field Test Kg	12,900 VTC

NOTES:

1. Gaskets shall be SS316L spiral wound graphite filled with SS316L internal and external rings. Gaskets shall be as per API-60
2. External bolting shall be hot dip galvanised as per BS 729 (BS EN ISO 1461:1999).
3. Indicated thickness of shell, head and skirt are minimum and vendor to confirm the thicknesses.
4. Vessel shall meet all the requirements of NACE MR 0175 and the material shall be HIC tested as per NACE TM 0284.
5. Material for shell and heads shall be of normalised steel, vacuum degassed and secondary calcium treated during manufactur sulphur content and CE shall not be more than 0.16%, 0.003% and 0.41% respectively.
6. Nozzles shall be self reinforced (Integrally Reinforced) type wherever reinforcement required.
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	26-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-146	1

Data Sheet for Unfired Pressure Vessel

Equipment Name :	Fuel Gas Scrubber	**Location:**	Arabian Gulf
Tag No. :	603-36V-01	**Plant Location :**	PS-3K
No. of Units :	1	**Manufacturer/Model :**	

DESIGN DATA

Process Guarantees

Max liquid in Gas outlet shall not exceed 0.1 Usgal/MMSCF

Max Liquid particle size 20 micron.

PROCESS DATA

Fluid Name				
Case		Uwainat Gas	Arab A/B	
Vapour Flow rate	m3/h	364	351	
Vapour Density @ Oper T/P	kg/m3	28.12	26.77	
Vapour Viscosity @ Oper. T/P	cP	0.013	0.014	
Molecular Weight		20.7	20.1	
Liquid HC Flow Rate	m3/h	-	-	
Liquid HC Density @ Oper. T/P	kg/m3	628	619	
Liquid HC Viscosity @ Oper. T/P	cP	0.24	0.24	
Liquid HC Surface Tension	dyne/cm	13.5	13.3	
Slug Holding Liquid Volume	m3	-	-	
Water Flow Rate	m3/h	-	-	
Water Density @ Oper. T/P	kg/m3	-	-	
Water Viscosity @ Oper. T/P	cP	-	-	
Design Margin on Flow Rates	%	10	10	
Corrosive Compounds		H_2S, CO_2		
VESSEL INTERNALS				
Gas Demister/Vane Pack		Gas Demister		
Vortex Breakers				

NOZZLE SCHEDULE

Mark No	Size	Qty.	Flange		Service	Standout (mm)		Reinf Pad (mm)	
	NPS	Nos.	Rating	Type/Face		Ext	Int	Thick	Diam
N1	6"	1	300#	SR/RF	Fluid Inlet				
N2	4"	1	300#	SR/RF	Vapour Outlet				
N3	3"	1	300#	SR/RF	Drain				
N4	4"	1	300#	WN/RF	PSV △1				
N5	2"	1	300#	WN/RF	Vent				
N6	2"	1	300#	WN/RF	Utility Connection △1				
K1A/B	2"	2	300#	WN/RF	Level Indicator				
K2A/B	2"	2	300#	WN/RF	Level Indicator				
K3	2"	1	300#	WN/RF	Pressure Indicator/Transmitter				
K4	2"	1	300#	WN/RF	Pressure Indicator/Transmitter				
K5	2"	1	300#	WN/RF	Temperature Indicator/Transmitte				
M1	20"	1	300#	SR/RF	Manway				
S_A	ID.610	1	-	-	Skirt Access				
Sv	2"	4	-	-	Skirt Vent				
Ss	6"	1	-	-	Skirt Sleeve				

REMARKS

1. Nozzle sizes and elevations shall be confirmed during detailed engineering.
2. SR RF - Self Reinforced (Integrally Reinforced) nozzle with Raised Face Flange.
3. Vendor to provide details of gas demister.

Worley

قطر للبترول Qatar Petroleum

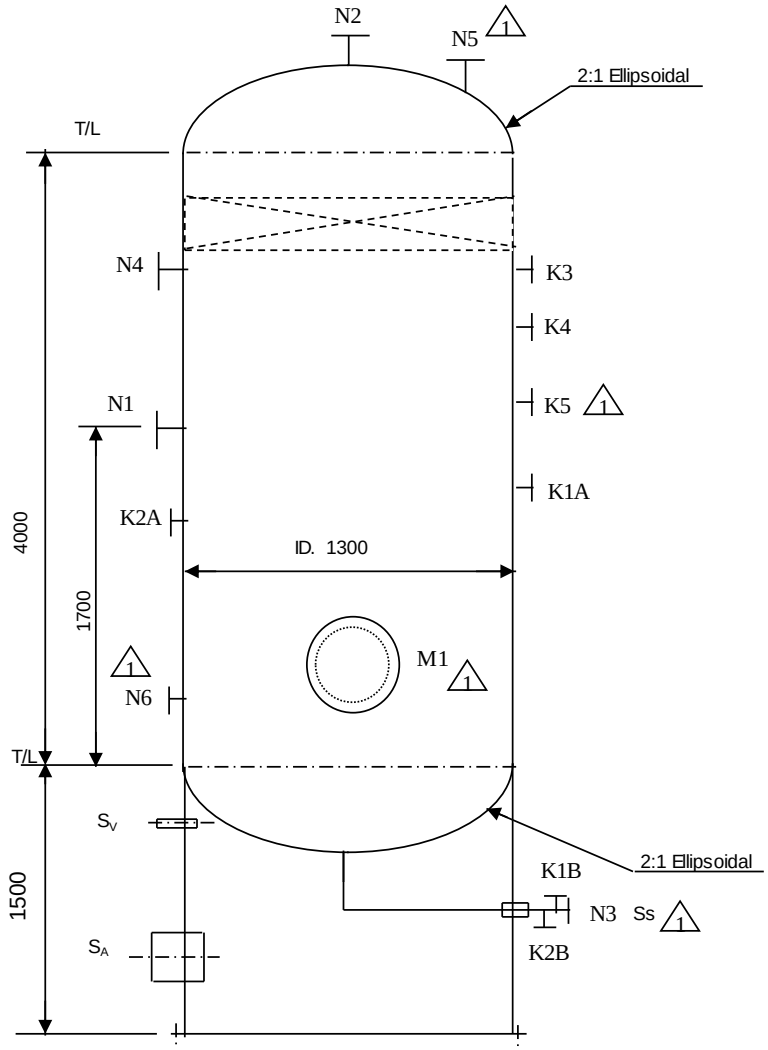
Qatar Petroleum

Bul Hanine Arab "C" Gas Cap Recycling

Project No:	**022/00705**	**Rev:**
Document No:	**00705-MEC-DTS-146**	**1**

Data Sheet for Unfired Pressure Vessel

Equipment Name :	Fuel Gas Scrubber	**Location:**	Arabian Gulf
Tag No. :	603-36V-01	**Plant Location :**	PS-3K
No. of Units :	1	**Manufacturer/Model :**	



LIQUID LEVELS		HC LIQUID
LAHH	mm	1000
LAH	mm	750
NLL	mm	600
LAL	mm	450
LALL	mm	300

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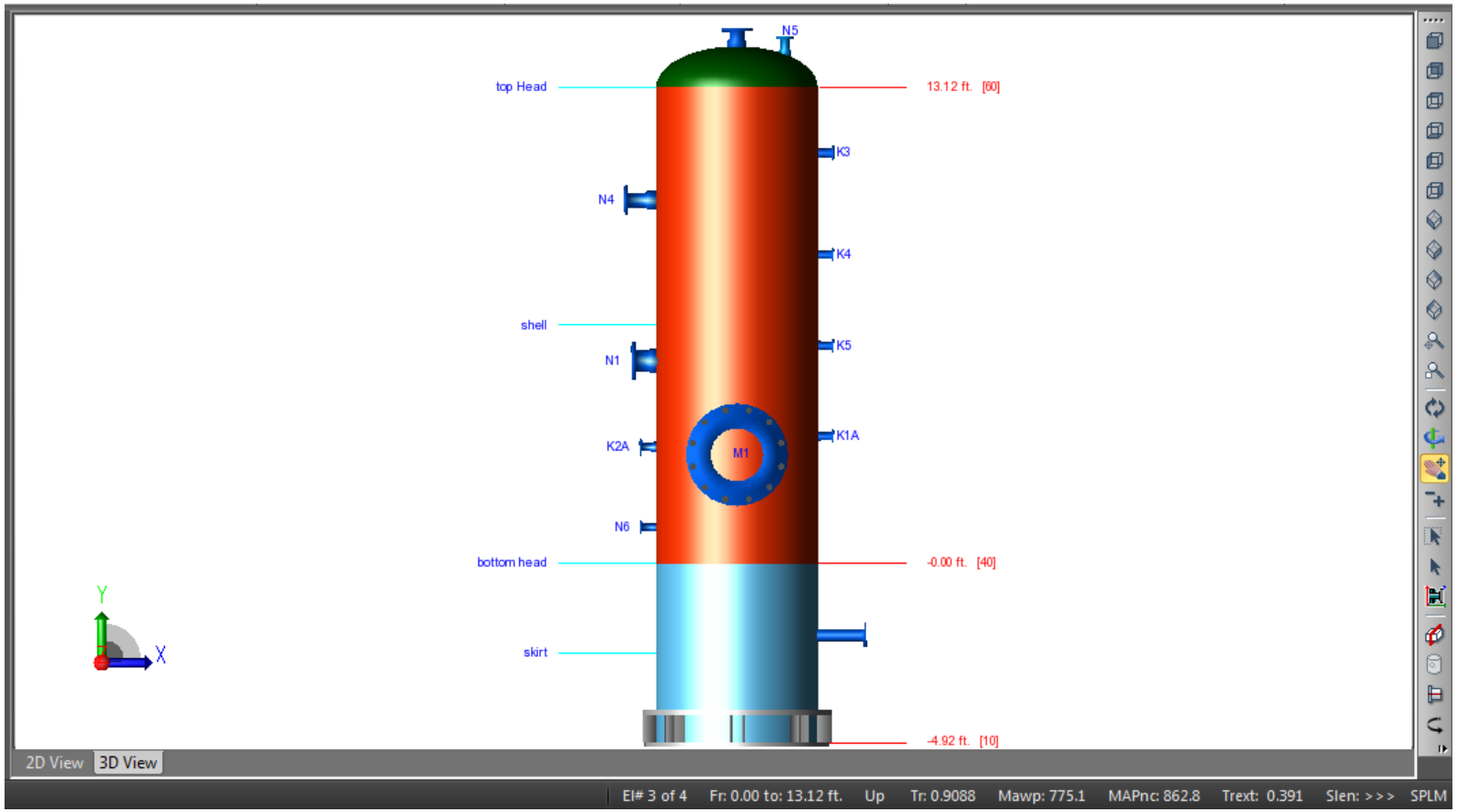
Qatar Petroleum

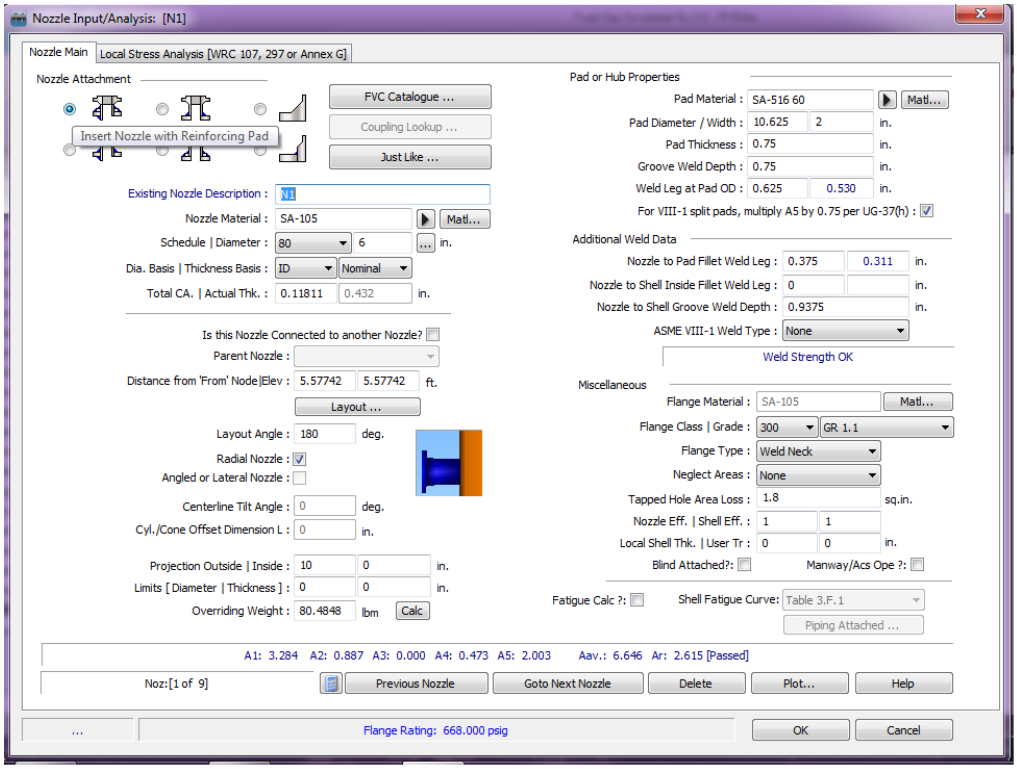
Bul Hanine Arab "C" Gas Cap Recycling

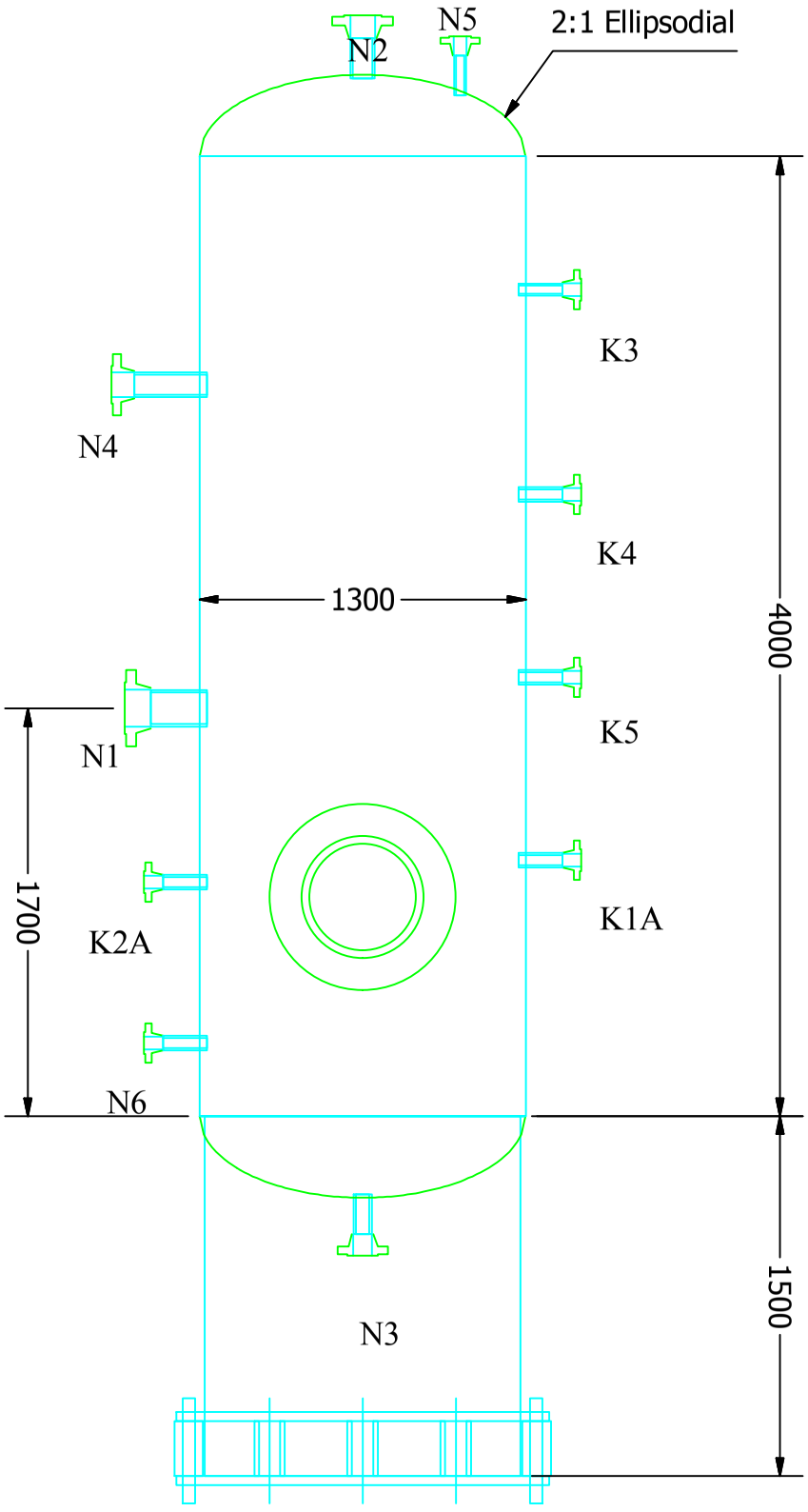
Project No:	**022/00705**	**Rev:**
Document No:	**00705-MEC-DTS-146**	**1**

Lampiran 2. Hasil Perancangan PV Elite 2014



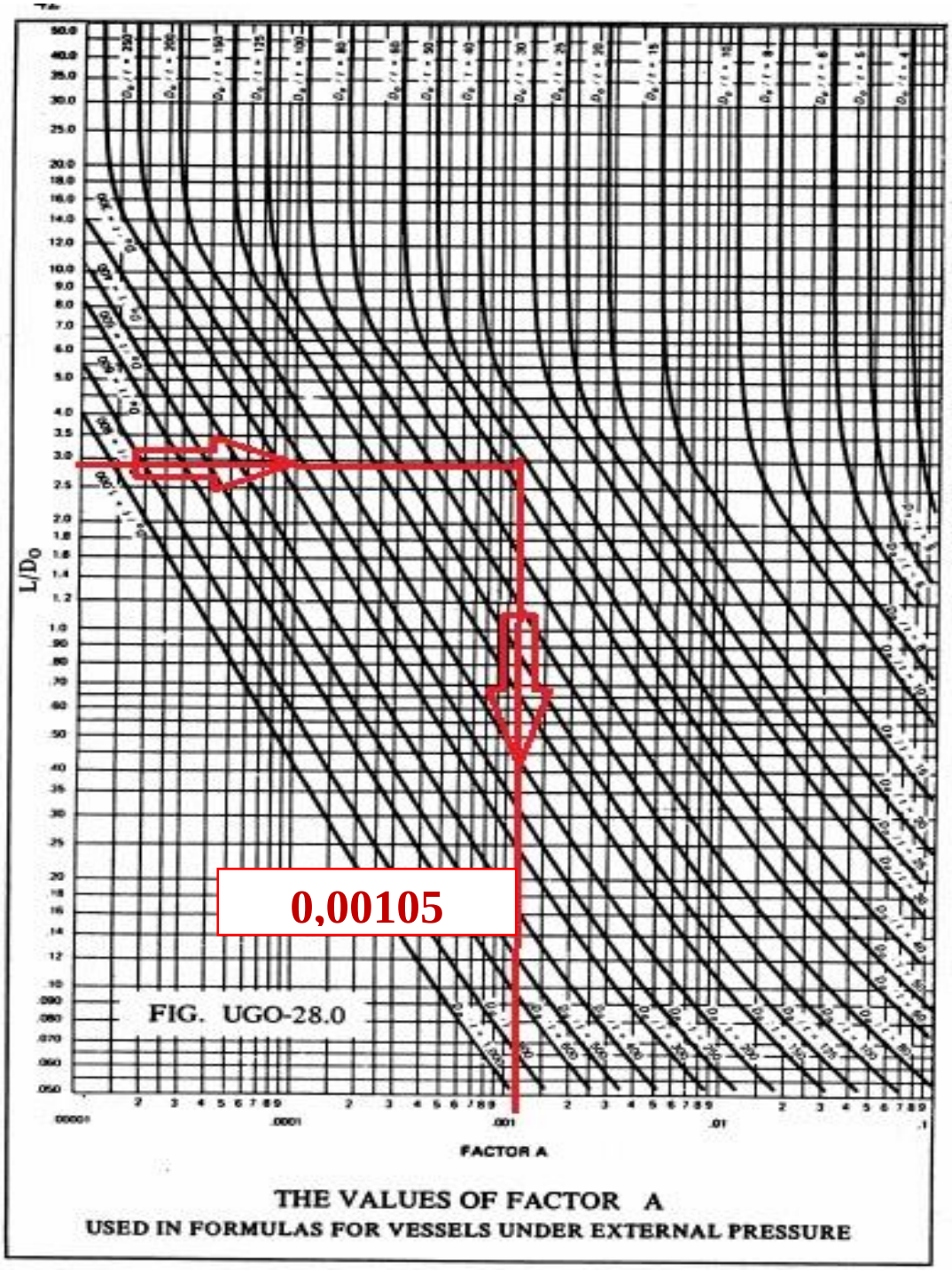
Attachment *nozzle* menggunakan renforcement pad



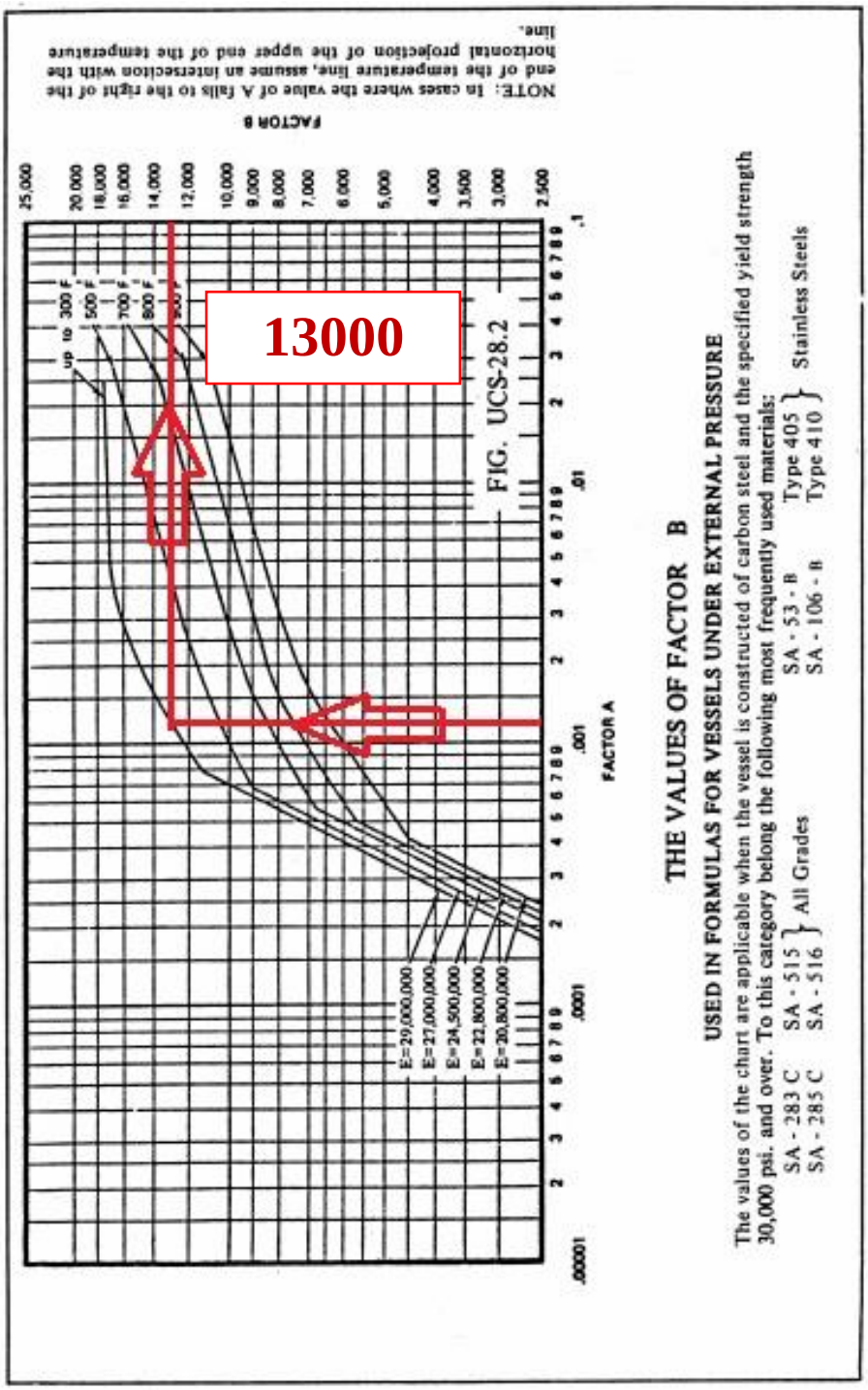


	Skala 1:30	Digambar: Gurun Wisnu Permadi	Peringatan
	Satuan mm	Diperikasa:	
	Tanggal: 30 Desember 2017	Dilihat:	
Universitas Muhammadiyah Yogyakarta	Fuel Gas Scrubber	No. 1	A4

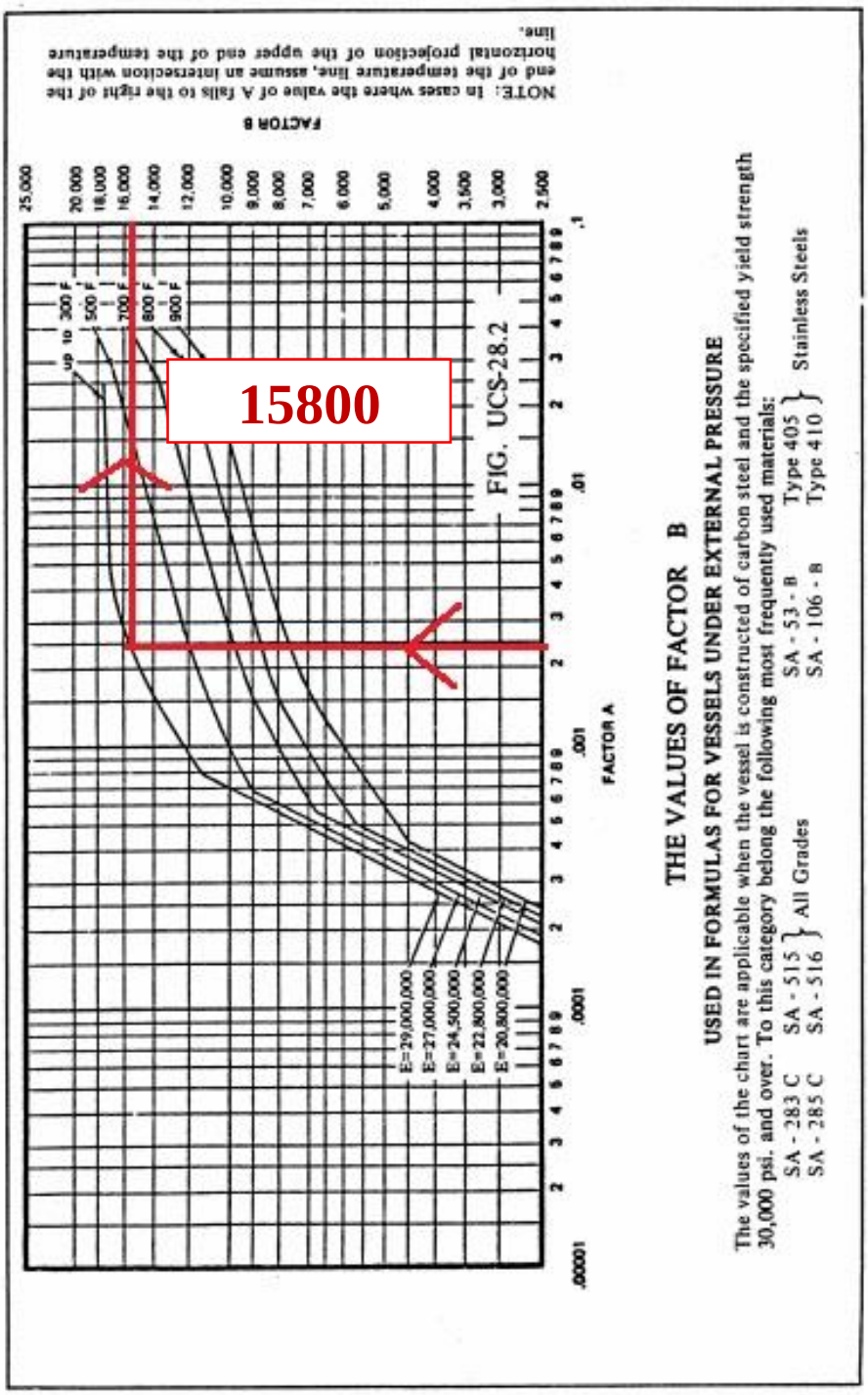
Lampiran 3. Menentukan Faktor A



Lampiran 4. Menentukan Faktor B pada *Shell*



Lampiran 5. Menentukan Faktor B pada *Head*



Lampiran 6. Tebal Dinding *Head* dan *Shell*

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)

Lampiran 7. Perhitungan Ketebalan *Nozzle*

Unit	Size (in)	t	Schedule Nozzle	t nozzle	tn	Di nozzle	Di	Rn	trn
				(required)	corr	(required)	corr		
N1	6	0.204449	STD	0.219	0.10089	6.187	6.42322	3.21161	0.088928
N2	4	0.17676	STD	0.188	0.06989	4.124	4.36022	2.18011	0.060366
N3	3	0.162915	STD	0.188	0.06989	3.214	3.45022	1.72511	0.047768
N4	4	0.17676	STD	0.188	0.06989	3.124	3.36022	1.68011	0.046522
N5	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
N6	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
K1 A/B	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
K2 A/B	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
K3	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
K4 A/B	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
K5 A/B	2	0.14907	40	0.154	0.03589	2.067	2.30322	1.15161	0.031888
M1	20	0.398277	STD	0.438	0.31989	19.124	19.36022	9.68011	0.268039

Lampiran 8. *Element Thickness*.

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
skirt		...	0.31496	0.11811	51.1810	...
bottom hea		580.151	1.14173	0.11811	51.1810	19212.0
shell		580.151	1.18110	0.11811	51.1810	19212.0
top Head		580.151	1.14173	0.11811	51.1810	19212.0

Element Required Thickness and MAWP :

From	To	Design Pressure psig	M.A.W.P. Corroded psig	M.A.P. New & Cold psig	Minimum Thickness in.	Required Thickness in.
skirt		...	No Calc	No Calc	0.31496	No Calc
bottom hea		580.151	747.101	853.344	1.14173	0.89206
shell		580.151	775.141	862.814	1.18110	0.90877
top Head		580.151	747.101	853.344	1.14173	0.89206
Minimum			668.000	740.000		

Lampiran 9. Internal *Pressure*.

Internal Pressure Calculation Results :

ASME Code, Section VIII, Division 1, 2013

Elliptical Head From 30 To 40 SA-516 60 , UCS-66 Crv. D at 248 °F

bottom head

Material UNS Number: K02100

Required Thickness due to Internal Pressure [tr]:

= (P*D*Kcor)/(2*S*E-0.2*P) Appendix 1-4(c)

= (580.151*51.4172*0.994)/(2*19212.00*1.00-0.2*580.151)

= 0.7739 + 0.1181 = 0.8921 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*19212.00*1.00*1.0236)/(0.994*51.4172+0.2*1.0236)

= 766.561 psig

Maximum Allowable Pressure, New and Cold [MAPNC]:

= (2*S*E*t)/(K*D+0.2*t) per Appendix 1-4 (c)

= (2*19212.00*1.00*1.1417)/(1.000*51.1810+0.2*1.1417)

= 853.344 psig

Actual stress at given pressure and thickness, corroded [Sact]:

= (P*(Kcor*D+0.2*t))/(2*E*t)

= (580.151*(0.994*51.4172+0.2*1.0236))/(2*1.00*1.0236)

= 14540.089 psi

Straight Flange Required Thickness:

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

= (580.151*25.7086)/(19212.00*1.00-0.6*580.151)+0.118

= 0.909 in.

Straight Flange Maximum Allowable Working Pressure:

= (S*E*t)/(R+0.6*t) per UG-27 (c)(1)

= (19212.00 * 1.00 * 1.0236)/(25.7086 + 0.6 * 1.0236)

= 747.101 psig

Factor K, corroded condition [Kcor]:

= (2 + (Inside Diameter/(2 * Inside Head Depth))^2)/6

= (2 + (51.417/(2 * 12.913))^2)/6

= 0.993916

Percent Elong. per UCS-79, VIII-1-01-57 (75*tnom/Rf)*(1-Rf/Ro) 9.236 %

Note: Please Check Requirements of UCS-79 as Elongation is > 5%.

MDMT Calculations in the Knuckle Portion:

Govrn. thk, tg = 1.142 , tr = 0.892 , c = 0.1181 in. , E* = 1.00

Stress Ratio = tr * (E*)/(tg - c) = 0.871 , Temp. Reduction = 13 °F

Min Metal Temp. w/o impact per UCS-66, Curve D	-24 °F
Min Metal Temp. at Required thickness (UCS 66.1)	-37 °F

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 1.142 , tr = 0.913 , c = 0.1181 in. , E* = 1.00

Stress Ratio = tr * (E*)/(tg - c) = 0.892 , Temp. Reduction = 11 °F

Min Metal Temp. w/o impact per UCS-66, Curve D -24 °F

Min Metal Temp. at Required thickness (UCS 66.1) -35 °F

Note: Post Weld Heat Treatment is required for this Element/Joint.

Cylindrical Shell From 40 To 50 SA-516 60 , UCS-66 Crv. D at 248 °F

shell

Material UNS Number: K02100

Required Thickness due to Internal Pressure [tr]:

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

= (580.151*25.7086)/(19212.00*1.00-0.6*580.151)

= 0.7907 + 0.1181 = 0.9088 in.

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

= (S*E*t)/(R+0.6*t) per UG-27 (c)(1)

= (19212.00*1.00*1.0630)/(25.7086+0.6*1.0630)

= 775.141 psig

Maximum Allowable Pressure, New and Cold [MAPNC]:

= (S*E*t)/(R+0.6*t) per UG-27 (c)(1)

= (19212.00*1.00*1.1811)/(25.5905+0.6*1.1811)

= 862.814 psig

Actual stress at given pressure and thickness, corroded [Sact]:

= (P*(R+0.6*t))/(E*t)

= (580.151*(25.7086+0.6*1.0630))/(1.00*1.0630)

= 14379.149 psi

Percent Elongation per UCS-79	(50*tnom/Rf)*(1-Rf/Ro)	2.256 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 1.181 , tr = 0.913 , c = 0.1181 in. , E* = 1.00

Stress Ratio = tr * (E*)/(tg - c) = 0.859 , Temp. Reduction = 14 °F

Min Metal Temp. w/o impact per UCS-66, Curve D	-23 °F
Min Metal Temp. at Required thickness (UCS 66.1)	-37 °F

Note: Post Weld Heat Treatment is required for this Element/Joint.

Elliptical Head From 50 To 60 SA-516 60 , UCS-66 Crv. D at 248 °F

top Head

Material UNS Number: K02100

Required Thickness due to Internal Pressure [tr]:

= (P*D*Kcor)/(2*S*E-0.2*P) Appendix 1-4(c)

= (580.151*51.4172*0.994)/(2*19212.00*1.00-0.2*580.151)

= 0.7739 + 0.1181 = 0.8921 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*19212.00*1.00*1.0236)/(0.994*51.4172+0.2*1.0236)

= 766.561 psig

Maximum Allowable Pressure, New and Cold [MAPNC]:

= (2*S*E*t)/(K*D+0.2*t) per Appendix 1-4 (c)

= (2*19212.00*1.00*1.1417)/(1.000*51.1810+0.2*1.1417)

= 853.344 psig

Actual stress at given pressure and thickness, corroded [Sact]:

= (P*(Kcor*D+0.2*t))/(2*E*t)

= (580.151*(0.994*51.4172+0.2*1.0236))/(2*1.00*1.0236)

= 14540.089 psi

Straight Flange Required Thickness:

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

= (580.151*25.7086)/(19212.00*1.00-0.6*580.151)+0.118

= 0.909 in.

Straight Flange Maximum Allowable Working Pressure:

= (S*E*t)/(R+0.6*t) per UG-27 (c)(1)

= (19212.00 * 1.00 * 1.0236)/(25.7086 + 0.6 * 1.0236)

= 747.101 psig

Factor K, corroded condition [Kcor]:

= (2 + (Inside Diameter/(2 * Inside Head Depth))^2)/6

= (2 + (51.417/(2 * 12.913))^2)/6

= 0.993916

Percent Elong. per UCS-79, VIII-1-01-57 (75*tnom/Rf)*(1-Rf/Ro) 9.236 %

Note: Please Check Requirements of UCS-79 as Elongation is > 5%.

MDMT Calculations in the Knuckle Portion:

Govrn. thk, tg = 1.142 , tr = 0.892 , c = 0.1181 in. , E* = 1.00

Stress Ratio = tr * (E*)/(tg - c) = 0.871 , Temp. Reduction = 13 °F

Min Metal Temp. w/o impact per UCS-66, Curve D	-24 °F
Min Metal Temp. at Required thickness (UCS 66.1)	-37 °F

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 1.142 , tr = 0.913 , c = 0.1181 in. , E* = 1.00

Stress Ratio = tr * (E*)/(tg - c) = 0.892 , Temp. Reduction = 11 °F

Min Metal Temp. w/o impact per UCS-66, Curve D	-24 °F
Min Metal Temp. at Required thickness (UCS 66.1)	-35 °F

Note: Post Weld Heat Treatment is required for this Element/Joint.

Lampiran 10. Tes Tekanan Hidrostatik.

Hydrostatic Test Pressure Results:

Pressure per UG99b	= 1.3 * M.A.W.P. * Sa/S	868.400	psig
Pressure per UG99b[34]	= 1.3 * Design Pres * Sa/S	754.196	psig
Pressure per UG99c	= 1.3 * M.A.P. - Head(Hyd)	962.000	psig
Pressure per UG100	= 1.1 * M.A.W.P. * Sa/S	734.800	psig
Pressure per PED	= 1.43 * MAWP	955.240	psig

UG-99(b), Test Pressure Calculation:

= Test Factor * MAWP * Stress Ratio

= 1.3 * 668.000 * 1.000

= 868.400 psig

Horizontal Test performed per: UG-99b

Please note that Nozzle, Shell, Head, Flange, etc MAWPs are all considered when determining the hydrotest pressure for those test types that are based

on the MAWP of the vessel.

Stresses on Elements due to Test Pressure:

From To	Stress	Allowable	Ratio	Pressure
bottom head	19592.6	22230.0	0.881	870.25
shell	19377.5	22230.0	0.872	870.25
top Head	19592.6	22230.0	0.881	870.25

Elements Suitable for Internal Pressure.

Lampiran 11. *Wind Load.*

Input Values:

Wind Design Code		ASCE-7 95	
Basic Wind Speed	[V]	100.70	mile/hr
Surface Roughness Category		C: Open Terrain	
Importance Factor		1.0	
Type of Surface		Moderately Smooth	
Base Elevation		0.0000	ft.
Percent Wind for Hydrotest		33.0	
Using User defined Wind Press. Vs Elev.		N	
Height of Hill or Escarpment	H or Hh	0.0000	ft.
Distance Upwind of Crest	Lh	0.0000	ft.
Distance from Crest to the Vessel	x	0.0000	ft.
Type of Terrain (Hill, Escarpment)		Flat	
Damping Factor (Beta) for Wind (Ope)		0.0100	
Damping Factor (Beta) for Wind (Empty)		0.0000	
Damping Factor (Beta) for Wind (Filled)		0.0000	

Wind Analysis Results

Dynamic Gust-Effect Factor, Operating Case [Gf]:

= (1 + 2 * G * Zbar * sqrt(Q2 + R2))/(1 + 7 * Zbar)

= (1+2*3.500*0.228*sqrt(0.908+0.009))/(1+7*0.228)

= 0.974

Natural Frequency of Vessel (Operating)	14.124 Hz
Natural Frequency of Vessel (Empty)	14.124 Hz
Natural Frequency of Vessel (Test)	12.130 Hz

Note: Per Section 1609 of IBC 2003/06/09 these results are also applicable

for the determination of Wind Loads on structures (1609.1.1).

User Entered Importance Factor is		1.000
Force Coefficient	[Cf]	0.557
Structure Height to Diameter ratio		4.398
Height to top of Structure		19.206 ft.

This is classified as a flexible structure. Dynamic analysis performed.

Sample Calculation for the First Element

The ASCE code performs all calculations in Imperial Units

only. The wind pressure is therefore computed in these units.

Value of [Alpha] and [Zg]:

Exposure Category: C from Table C6-2

Alpha = 9.500 : Zg = 900.000 ft.

Effective Height [z]:

= Centroid Height + Vessel Base Elevation

= 2.461 + 0.000 = 2.461 ft.

Velocity Pressure coefficient evaluated at height z [Kz]:

Because z (2.461 ft.) < 15 ft.

$= 2.01 * (15 / Zg)^{2 / Alpha}$

$= 2.01 * (15/900.000)^{2/9.500}$

= 0.849

Type of Hill: No Hill

As there is No Hill Present: [Kzt]:

K1 = 0, K2 = 0, K3 = 0

Topographical Factor [Kzt]:

$= (1 + K1 * K2 * K3)^2$

$= (1 + 0.000 * 0.000 * 0.000)^2$

$= 1.0000$

Velocity Pressure evaluated at height z, Imperial Units [qz]:

$= 0.00256 * Kz * Kzt * Kd * I * Vr(mph)^2$

$= 0.00256 * 0.849 * 1.000 * 1.000 * 1.000 * 100.700^2$

$= 22.0$ psf

Force on the first element [F]:

$= qz * Gf * Cf * WindArea$

$= 22.037 * 0.974 * 0.557 * 25.497$

$= 304.6$ lb.

Element	Hgt (z) ft.	K1	K2	K3	Kz	Kzt	qz psf
skirt	2.5	0.000	0.000	0.000	0.849	1.000	22.037
bottom head	4.9	0.000	0.000	0.000	0.849	1.000	22.037
shell	11.5	0.000	0.000	0.000	0.849	1.000	22.037
top Head	18.5	0.000	0.000	0.000	0.888	1.000	23.041

Wind Vibration Calculations

This evaluation is based on work by Kanti Mahajan and Ed Zorilla

Nomenclature

Cf - Correction factor for natural frequency

D - Average internal diameter of vessel ft.

Df - Damping Factor < 0.75 Unstable, > 0.95 Stable

Dr - Average internal diameter of top half of vessel ft.

f - Natural frequency of vibration (Hertz)

f1 - Natural frequency of bare vessel based on a unit value of $(D/L^2)(10^4)$

L - Total height of structure ft.

Lc - Total length of conical section(s) of vessel ft.

tb - Uncorroded plate thickness at bottom of vessel in.

V30 - Design Wind Speed provided by user mile/hr

Vc - Critical wind velocity mile/hr

Vw - Maximum wind speed at top of structure mile/hr

W - Total corroded weight of structure lb.

Ws - Cor. vessel weight excl. weight of parts which do not effect stiff. lb.

Z - Maximum amplitude of vibration at top of vessel in.

Dl - Logarithmic decrement (taken as 0.03 for Welded Structures)

Vp - Vib. Chance, <= 0.200E+02 (High); 0.200E+02 < 0.250E+02 (Probable)

P30 - wind pressure 30 feet above the base

Check other Conditions and Basic Assumptions:

#1 - Total Cone Length / Total Length < 0.5

0.000/18.045 = 0.000

#2 - $(D / L^2) * 10^4 < 8.0$ (English Units)

- $(4.42/18.04^2) * 10^4 = 135.826$ [Geometry Violation]

Compute the vibration possibility. If Vp > 0.250E+02 no chance. [Vp]:

$= W / (L * Dr^2)$

$= 12047/(18.04 * 4.285^2)$

= 0.36367E+02

Since Vp is > 0.250E+02 no further vibration analysis is required !

The Natural Frequency for the Vessel (Ope...) is 14.1236 Hz.

Wind Load Calculation

From	To	Wind Height ft.	Wind Diameter ft.	Wind Area sq.in.	Wind Pressure psf	Element Wind Load lb.
20	30	2.46062	5.18109	3671.63	22.0367	304.560
30	40	4.92120	5.34645	0.076989	22.0367	0.0063862
40	50	11.4829	5.35432	10118.4	22.0367	839.313
50	60	18.5374	5.34645	702.348	23.0413	60.9153

Lampiran 12. *Seismic Load*.

Earthquake Analysis Results

The UBC Zone Factor for the Vessel is	0.1500	
The Importance Factor as Specified by the User is .	1.000	
The UBC Frequency and Soil Factor (C) is	2.750	
The UBC Force Factor as Specified by the User is ..	3.000	
The UBC Total Weight (W) for the Vessel is	13418.7	lb.
The UBC Total Shear (V) for the Vessel is	1845.1	lb.
The UBC Top Shear (Ft) for the Vessel is	0.0	lb.

The Natural Frequency for the Vessel (Ope...) is 14.1236 Hz.

Earthquake Load Calculation

From	To	Earthquake Height ft.	Earthquake Weight lb.	Element Ope Load lb.	Element Emp Load lb.
20	30	2.46062	1762.32	57.9108	57.9108
30	40	4.92120	1114.92	73.2733	73.2733
40	50	11.4829	9430.34	1446.13	1446.13
50	60	18.0445	1111.12	267.754	267.754
Top Load		19.11		0	0

Lampiran 13. MAWP *Flange*.

Nozzle Flange MAWP Results :

Nozzle Description	Flange Rating Operating psig	Ambient psig	Temperature °F	Class	Grade|Group
N3	888.2	985.0	248	400	GR 1.1
N1	888.2	985.0	248	400	GR 1.1
N4	888.2	985.0	248	400	GR 1.1
N6	888.2	985.0	248	400	GR 1.1
K1A	888.2	985.0	248	400	GR 1.1
K2A	888.2	985.0	248	400	GR 1.1
K3	888.2	985.0	248	400	GR 1.1
M1	888.2	985.0	248	400	GR 1.1
K4	888.2	985.0	248	400	GR 1.1
K5	888.2	985.0	248	400	GR 1.1
N2	888.2	985.0	248	400	GR 1.1
N5	888.2	985.0	248	400	GR 1.1
Minimum Rating	888.200	985.000	psig	(for Core Elements)	

Note: ANSI Ratings are per ANSI/ASME B16.5 2009 Edition

Lampiran 14. Data *Nozzle*.

Nozzle Schedule:

Description	Nominal Size in.	Flange Sch/Type Cls		Noz. O/Dia in.	Wall Thk in.	Re-Pad ODia in.	Re-Pad Thick in.	Cut Length in.
N6	2.000	160	WNF	2.375	0.344	-	-	7.22
K1A	2.000	160	WNF	2.375	0.344	-	-	7.22
K2A	2.000	160	WNF	2.375	0.344	-	-	7.24
K3	2.000	300	WNF	2.624	0.312	-	-	7.23
K4	2.000	160	WNF	2.375	0.344	-	-	7.22
K5	2.000	160	WNF	2.375	0.344	-	-	7.22
N5	2.000	300	WNF	2.600	0.300	-	-	8.06
N3	3.000	300	WNF	3.812	0.406	-	-	7.21
N4	4.000	300	WNF	4.690	0.345	-	-	12.11
N2	4.000	300	WNF	4.750	0.375	-	-	7.23
N1	6.000	300	WNF	6.800	0.400	-	-	9.50
M1	20.000	40	WNF	20.000	0.593	-	-	13.77

Nozzle Material and Weld Fillet Leg Size Details:

Nozzle	Material	Shl Grve Weld in.	Noz Shl/Pad Weld in.	Pad OD Weld in.	Pad Grve Weld in.	Inside Weld in.
N6	SA-105	1.181	0.375	-	-	-
K1A	SA-105	1.181	1.000	-	-	-
K2A	SA-105	1.181	0.500	-	-	-
K3	SA-105	0.875	0.375	-	-	-
K4	SA-105	0.875	0.375	-	-	-
K5	SA-105	0.875	0.375	-	-	-
N5	SA-105	1.142	0.375	-	-	-
N3	SA-105	1.142	0.375	-	-	-
N4	SA-105	1.181	0.500	-	-	-
N2	SA-105	1.142	0.375	-	-	-
N1	SA-105	1.181	0.375	-	-	-
M1	SA-105	0.875	0.375	-	-	-

Note: The Outside projections below do not include the flange thickness.

Nozzle Miscellaneous Data:

Nozzle	Elevation/Distance From Datum ft.	Layout Angle deg.	Projection Outside in.	Projection Inside in.	Installed In Component
N6	1.000	180.00	6.00	0.00	shell
K1A	4.000	0.00	6.00	0.00	shell
K2A	3.000	180.00	6.00	0.00	shell
K3	11.300	0.00	6.00	0.00	shell
K4	9.000	0.00	6.00	0.00	shell
K5	7.000	0.00	6.00	0.00	shell
N5		0.00	6.00	0.00	top Head
N3		0.00	6.00	0.00	bottom head
N4	11.483	180.00	10.75	0.00	shell
N2		0.00	6.00	0.00	top Head
N1	5.577	180.00	8.00	0.00	shell
M1	3.000	270.00	10.00	0.00	shell

Nozzle Calculation Summary:

Description	MAWP psig	Ext	MAPNC psig	UG45 [tr]	Weld Path	Areas or Stresses
N3	747.10	OK	...	OK 0.316	OK	Passed
N1	775.14	OK	...	OK 0.400	OK	Passed
N4	775.14	OK	...	OK 0.344	OK	Passed
N6	775.14	OK	...	OK 0.253	OK	Passed
K1A	775.14	OK	...	OK 0.253	OK	Passed
K2A	775.14	OK	...	OK 0.253	OK	Passed
K3	775.14	OK	...	OK 0.296	OK	Passed
M1	681.96	OK	...	OK 0.446	OK	Passed
K4	775.14	OK	...	OK 0.253	OK	Passed
K5	775.14	OK	...	OK 0.253	OK	Passed
N2	692.23	OK	...	OK 0.344	OK	Passed
N5	747.10	OK	...	OK 0.296	OK	Passed
N5	747.10	OK	...	OK 0.296	OK	Passed

Min. - Nozzles 681.96 M1
Min. Shell&Flgs 668.00

Computed Vessel M.A.W.P. 668.00 psig

From Node	Nozzle Description	Y Coordinate,	Layout Angle,	Dia. Limit
30	N3	0.000	0.000	6.472
40	N1	66.929	180.000	25.008
40	N4	137.795	180.000	23.008
40	N6	12.000	180.000	19.695
40	K1A	48.000	0.000	19.695
40	K2A	36.000	180.000	20.445
40	K3	135.600	0.000	20.008
40	M1	36.000	270.000	39.422
40	K4	108.000	0.000	19.695
40	K5	84.000	0.000	19.695
50	N2	0.000	0.000	8.472
50	N5	0.000	0.000	5.797

The nozzle spacing is computed by the following:

= Sqrt($ll^2 + lc^2$) where

ll - Arc length along the inside vessel surface in the long. direction.

lc - Arc length along the inside vessel surface in the circ. direction

Lampiran 15. Luas Area Penguat *Nozzle*

- ***Nozzle* N1**

Area Required [A]:
= 0.5(d * tr*F + 2 * tn * tr*F * (1-fr1)) per UG-37(d) or UG-39
= 0.5(6.2362*0.2733*1+2*0.8819*0.2733*1*(1-1.00))
= 2.652 sq.in.

Note: The required area has been increased by the tapped hole area loss.

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)
= 6.236 (1.00 * 1.0630 - 1.0 * 0.273) - 2 * 0.882
(1.00 * 1.0630 - 1.0 * 0.2733) * (1 - 1.000)
= 4.925 sq.in.

Area Available in Nozzle Projecting Outward [A2]:
= (2 * tlnp) * (tn - trn) * fr2
= (2 * 2.205) * (0.2819 - 0.0232) * 1.0000
= 1.141 sq.in.

Area Available in Inward Weld + Outward Weld [A41 + A43]:
= Wo² * fr2 + (Wi-can/0.707)² * fr2
= 0.3750² * 1.0000 + (0.0000)² * 1.0000
= 0.141 sq.in.

Area Available in the Hub Section [A6]:
= (2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= (2 * min(2.205 ,8.000 ,3.000)) * (1.0000 - 0.4000) * 1.000)
= 2.646 sq.in.

- ***Nozzle* N2**

Area Required [A]:
```
 = ( d * tr*F + 2 * tn * tr*F * (1-fr1) ) UG-37(c)
 = (4.2362*0.6978*1.0+2*0.7569*0.6978*1.0*(1-1.00))
 = 2.956 sq.in.
```

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 * 1.0236 - 1.0 * 0.698 ) - 2 * 0.757
   ( 1.00 * 1.0236 - 1.0 * 0.6978 ) * ( 1 - 1.000 )
 = 1.380 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
 = ( 2 * tlnp ) * ( tn - trn ) * fr2
 = ( 2 * 1.892 ) * ( 0.2569 - 0.0625 ) * 1.0000
 = 0.736 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
 = Wo² * fr2 + ( Wi-can/0.707 )² * fr2
 = 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
 = 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
 = ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
 = ( 2 * min(1.892 ,6.000 ,3.000 )) * (0.8750 - 0.3750 ) * 1.000 )
 = 1.892 sq.in.
```

- ***Nozzle* N3**

Area Required [A]:
```
= ( d * tr*F + 2 * tn * tr*F * (1-fr1) ) UG-37(c)
= (3.2362*0.6978*1.0+2*0.8819*0.6978*1.0*(1-1.00))
= 2.258 sq.in.
```

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 )
= 3.236 ( 1.00 * 1.0236 - 1.0 * 0.698 ) - 2 * 0.882
  ( 1.00 * 1.0236 - 1.0 * 0.6978 ) * ( 1 - 1.000 )
= 1.055 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 1.749 ) * ( 0.2879 - 0.0478 ) * 1.0000
= 0.840 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(1.749 ,6.000 ,2.000 )) * (1.0000 - 0.4060 ) * 1.000 )
= 2.077 sq.in.
```

- ***Nozzle* N4**

Area Required [A]:
```
= 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
= 0.5(4.2362*0.2733*1+2*0.8819*0.2733*1*(1-1.00))
= 2.379 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.882
  ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
= 3.345 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 2.205 ) * ( 0.2269 - 0.0210 ) * 1.0000
= 0.908 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.5000² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.250 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(2.205 ,10.750 ,4.000 )) * (1.0000 - 0.3450 ) * 1.000 )
= 2.888 sq.in.
```

- ***Nozzle* N5**

Area Required [A]:
```
= ( d * tr*F + 2 * tn * tr*F * (1-fr1) ) UG-37(c)
= (2.4933*0.7739*1.0+2*0.7569*0.7739*1.0*(1-1.00))
= 1.930 sq.in.
```

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 )
= 3.561 ( 1.00 * 1.0236 - 1.0 * 0.774 ) - 2 * 0.757
  ( 1.00 * 1.0236 - 1.0 * 0.7739 ) * ( 1 - 1.000 )
= 0.889 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2/sin( alpha3 )
= ( 2 * 1.892 ) * ( 0.1819 - 0.0330 ) * 1.0000/sin( 67.8 )
= 0.608 sq.in.
```

Note: See ASME VIII-1 2011(a) Appendix L, L-7.7.7(b) for more information.

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(1.892 ,6.000 ,2.000 )) * (0.8750 - 0.3000 ) * 1.000 )
= 2.176 sq.in.
```

- ***Nozzle* N6**

Area Required [A]:
```
= 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
= 0.5(1.9232*0.2733*1+2*0.3819*0.2733*1*(1-1.00))
= 2.063 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
= 2.890 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.382
  ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
= 2.282 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 0.955 ) * ( 0.2259 - 0.0111 ) * 1.0000
= 0.410 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(0.955 ,6.000 ,2.000 )) * (0.5000 - 0.3440 ) * 1.000 )
= 0.298 sq.in.
```

- ***Nozzle*** **K1A**

Area Required [A]:
```
= 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
= 0.5(1.9232*0.2733*1+2*0.3819*0.2733*1*(1-1.00))
= 2.063 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
= 2.890 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.382
  ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
= 2.282 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 0.955 ) * ( 0.2259 - 0.0111 ) * 1.0000
= 0.410 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= ( Wo² - Area Lost )*fr2 + ( (Wi-can/0.707)² - Area Lost)*fr2
= ( 1.0000² - 0.0020 ) * 1.0000 + ( 0.0000² -0.0000 ) * 1.0000
= 0.998 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(0.955 ,6.000 ,2.000 )) * (0.5000 - 0.3440 ) * 1.000 )
= 0.298 sq.in.
```

- ***Nozzle*** **K2A**

Area Required [A]:
```
 = 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
 = 0.5(1.9232*0.2733*1+2*0.7569*0.2733*1*(1-1.00))
 = 2.063 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
 = 3.640 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.757
   ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
 = 2.874 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
 = ( 2 * tlnp ) * ( tn - trn ) * fr2
 = ( 2 * 1.892 ) * ( 0.2259 - 0.0111 ) * 1.0000
 = 0.813 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
 = Wo² * fr2 + ( Wi-can/0.707 )² * fr2
 = 0.5000² * 1.0000 + ( 0.0000 )² * 1.0000
 = 0.250 sq.in.
```

Area Available in the Hub Section [A6]:
```
 = ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
 = ( 2 * min(1.892 ,6.000 ,2.000 )) * (0.8750 - 0.3440 ) * 1.000 )
 = 2.010 sq.in.
```

- ***Nozzle*** **K3**

Area Required [A]:
```
 = 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
 = 0.5(2.2362*0.2733*1+2*0.3819*0.2733*1*(1-1.00))
 = 2.106 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
 = 2.890 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.382
   ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
 = 2.282 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
 = ( 2 * tlnp ) * ( tn - trn ) * fr2
 = ( 2 * 0.955 ) * ( 0.1939 - 0.0118 ) * 1.0000
 = 0.348 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
 = Wo² * fr2 + ( Wi-can/0.707 )² * fr2
 = 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
 = 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
 = ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
 = ( 2 * min(0.955 ,6.000 ,2.000 )) * (0.5000 - 0.3120 ) * 1.000 )
 = 0.359 sq.in.
```

- ***Nozzle* K4**

Area Required [A]:
```
= 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
= 0.5(1.9232*0.2733*1+2*0.3819*0.2733*1*(1-1.00))
= 2.063 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
= 2.890 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.382
  ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
= 2.282 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 0.955 ) * ( 0.2259 - 0.0111 ) * 1.0000
= 0.410 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(0.955 ,6.000 ,2.000 )) * (0.5000 - 0.3440 ) * 1.000 )
= 0.298 sq.in.
```

- ***Nozzle*** **K5**

Area Required [A]:
```
= 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
= 0.5(1.9232*0.2733*1+2*0.3819*0.2733*1*(1-1.00))
= 2.063 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
= 2.890 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.382
  ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
= 2.282 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 0.955 ) * ( 0.2259 - 0.0111 ) * 1.0000
= 0.410 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(0.955 ,6.000 ,2.000 )) * (0.5000 - 0.3440 ) * 1.000 )
= 0.298 sq.in.
```

- ***Nozzle* M1**

Area Required [A]:
```
= 0.5( d * tr*F + 2 * tn * tr*F * (1-fr1) ) per UG-37(d) or UG-39
= 0.5(1.9232*0.2733*1+2*0.3819*0.2733*1*(1-1.00))
= 2.063 sq.in.
```

Note: The required area has been increased by the tapped hole area loss.

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 )
= 2.890 ( 1.00 * 1.0630 - 1.0 * 0.273 ) - 2 * 0.382
  ( 1.00 * 1.0630 - 1.0 * 0.2733 ) * ( 1 - 1.000 )
= 2.282 sq.in.
```

Area Available in Nozzle Projecting Outward [A2]:
```
= ( 2 * tlnp ) * ( tn - trn ) * fr2
= ( 2 * 0.955 ) * ( 0.2259 - 0.0111 ) * 1.0000
= 0.410 sq.in.
```

Area Available in Inward Weld + Outward Weld [A41 + A43]:
```
= Wo² * fr2 + ( Wi-can/0.707 )² * fr2
= 0.3750² * 1.0000 + ( 0.0000 )² * 1.0000
= 0.141 sq.in.
```

Area Available in the Hub Section [A6]:
```
= ( 2 * min(Tlnp,ho,Hubht)) * (Hubtk - tn) * fr2
= ( 2 * min(0.955 ,6.000 ,2.000 )) * (0.5000 - 0.3440 ) * 1.000 )
= 0.298 sq.in.
```

Lampiran 16. Tegangan Izin Material

- SA 516 Gr.60

TABLE A-1 (CONT'D)
BASIC ALLOWABLE STRESSES IN TENSION FOR METALS[1]
Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Material	Spec. No.	P-No. or S-No. (5)	Grade	Notes	Min. Temp., °F (6)	Specified Min. Strength, ksi		Min. Temp. to 100	200	300
						Tensile	Yield			
Carbon Steel (Cont'd) Plates and Sheets										
...	A 285	1	A	(57)(59)	B	45	24	15.0	14.6	14.2
...	A 285	1	B	(57)(59)	B	50	27	16.7	16.4	16.0
...	A 516	1	55	(57)	C	55	30	18.3	18.3	17.7
...	A 285	1	C	(57)(59)	A	55	30	18.3	18.3	17.7
...	A 516	1	60	(57)	C	60	32	20.0	19.5	18.9
...	A 515	1	60	(57)	B	60	32	20.0	19.5	18.9
...	A 516	1	65	(57)	B	65	35	21.7	21.3	20.7
...	A 515	1	65	(57)	A	65	35	21.7	21.3	20.7
...	A 516	1	70	(57)	B	70	38	23.3	23.1	22.5
...	A 515	1	70	(57)	A	70	38	23.3	23.1	22.5
(≤ 2½ in. thick)	A 537	1	Cl. 1	...	D	70	50	23.3	23.3	22.9
(> 1 in. thick)	A 299	1	...	(57)	A	75	40	25.0	24.4	23.7
(≤ 1 in. thick)	A 299	1	...	(57)	A	75	42	25.0	25.0	24.8

BASIC ALLOWABLE STRESSES IN TENSION FOR METALS[1]
Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Material	Spec. No.	P-No. or S-No. (5)	Grade	Notes	Min. Temp., °F (6)	Specified Min. Strength, ksi		Min. Temp. to 100	200	300
						Tensile	Yield			
Carbon Steel Pipes and Tubes (2)										
A 285 Gr. A	A 134	1	...	(8b)(57)	B	45	24	15.0	14.6	14.2
A 285 Gr. A	A 672	1	A45	(57)(59)(67)	B	45	24	15.0	14.6	14.2
Butt weld	API 5L	S-1	A25	(8a)	−20	45	25	15.0	15.0	14.5
Smls & ERW	API 5L	S-1	A25	(57)(59)	B	45	25	15.0	15.0	14.5
...	A 179	1	...	(57)(59)	−20	47	26	15.7	15.0	14.2
Type F	A 53	1	Gr. A	(8a)(77)	20	48	30	16.0	16.0	16.0
...	A 139	S-1	A	(8b)(77)	A	48	30	16.0	16.0	16.0
...	A 587	1	...	(57)(59)	−20	48	30	16.0	16.0	16.0
...	A 53	1	A	(57)(59)						
...	A 106	1	A	(57)						
...	A 135	1	A	(57)(59)	B	48	30	16.0	16.0	16.0
...	A 369	1	FPA	(57)						
...	API 5L	S-1	A	(57)(59)(77)						
A 285 Gr. B	A 134	1	...	(8b)(57)	B	50	27	16.7	16.4	16.0
A 285 Gr. B	A 672	1	A50	(57)(59)(67)	B	50	27	16.7	16.4	16.0
A 285 Gr. C	A 134	1	...	(8b)(57)	A	55	30	18.3	18.3	17.7
...	A 524	1	Gr. II	(57)	−20	55	30	18.3	18.3	17.7
...	A 333	1	1							
...	A 334	1	1	(57)(59)	−50	55	30	18.3	18.3	17.7
A 285 Gr. C	A 671	1	CA55	(59)(67)	A					
A 285 Gr. C	A 672	1	A55	(57)(59)(67)	A					
A 516 Gr. 55	A 672	1	C55	(57)(67)	C	55	30	18.3	18.3	17.7
A 516 Gr. 60	A 671	1	CC60	(57)(67)	C	60	32	20.0	19.5	18.9
A 515 Gr. 60	A 671	1	CB60							
A 515 Gr. 60	A 672	1	B60	(57)(67)	B	60	32	20.0	19.5	18.9
A 516 Gr. 60	A 672	1	C60	(57)(67)	C					

- SA105

TABLE 2-1.1 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) A 537 Cl. 1 (3)

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.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	285	740	990	1480	2220	3705	6170
200	260	675	900	1350	2025	3375	5625
300	230	655	875	1315	1970	3280	5470
400	200	635	845	1270	1900	3170	5280
500	170	600	800	1200	1795	2995	4990
600	140	550	730	1095	1640	2735	4560
650	125	535	715	1075	1610	2685	4475
700	110	535	710	1065	1600	2665	4440
750	95	505	670	1010	1510	2520	4200
800	80	410	550	825	1235	2060	3430
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

Lampiran 17. ***Seismic Zone***