S.C. CONFIND - S.R.L.

CAMPINA

BREVIAR DE CALCUL

SEPARATOR ORIZONTAL TRIFAZIC 80mc

P3902-BC

REVIZIE					
1	30.10.2012		A.Maftei	A.Stoica	G.Colea
Rev.	Data	Descriere	Intocmit	Verificat	Aprobat

Table of Contents

Warnings and Errors : 4
Input Echo : 5
XY Coordinate Calculations : 22
Internal Pressure Calculations : 23
Element and Detail Weights : 31
Nozzle Flange MAWP : 34
Wind Load Calculation : 36
Earthquake Load Calculation : 39
Center of Gravity Calculation : 41
Horizontal Vessel Analysis (Ope.) : 42
Horizontal Vessel Analysis (Test) : 62
Nozzle Calcs. : GV1a 78
Nozzle Calcs. : R1 82
Nozzle Calcs. : R3 86
Nozzle Calcs. : GV2a 90
Nozzle Calcs. : GV2b 94
Nozzle Calcs. : M1 98
Nozzle Calcs. : R8 102
Nozzle Calcs. : R2 106
Nozzle Calcs. : R6 110
Nozzle Calcs. : R7c 114
Nozzle Calcs. : R7b 118
Nozzle Calcs. : R7a 122
Nozzle Calcs. : R5 126
Nozzle Calcs. : R4 130
Nozzle Calcs. : R17b 134
Nozzle Calcs. : R17d 138
Nozzle Calcs. : R11 143
Nozzle Calcs. : R9 147
Nozzle Calcs. : R18a 152
Nozzle Calcs. : R10 157
Nozzle Calcs. : R12 162
Nozzle Calcs. : R17a 167
Nozzle Calcs. : R20 171

Nozzle Calcs. : GV1b 175
Nozzle Calcs. : R19 179
Nozzle Calcs. : R15 183
Nozzle Calcs. : R18b 187
Nozzle Calcs. : R16 191
Nozzle Calcs. : R14 195
Nozzle Calcs. : R13 199
Nozzle Schedule : 203
Nozzle Summary : 207
Vessel Design Summary : 222

DESIGN CALCULATION

In Accordance with European Code EN-13445

Analysis Performed by : CONFIND S.R.L.

Job File : D:\PROIECTE CONFIND\P3902-SOT 80 MC\LUCRU\PVELIT

Date of Analysis : Nov 7,2012

PV Elite 2011, March 2011, Service Pack 1

Class From To : Basic Element Checks.

==========

Class From To: Check of Additional Element Data

==========

There were no geometry errors or warnings.

PV Elite Vessel Analysis Program: Input Data

Design Internal Pressure (for Hydrotest)	0.6000	MPa
Design Internal Temperature	60	C
Type of Hydrotest	1	
Hydrotest Position	Horizontal	
Projection of Nozzle from Vessel Top	0.0000	mm
Projection of Nozzle from Vessel Bottom	0.0000	mm
Minimum Design Metal Temperature	-20	C
Type of Construction	Welded	
Special Service	None	
Degree of Radiography	N/A	
Miscellaneous Weight Percent	0.	
Use Higher Longitudinal Stresses (Flag)	Y	
Select t for Internal Pressure (Flag)	N	
Select t for External Pressure (Flag)	N	
Select t for Axial Stress (Flag)	N	
Select Location for Stiff. Rings (Flag)	N	
Consider Vortex Shedding	N	
Perform a Corroded Hydrotest	N	
Is this a Heat Exchanger	No	
User Defined Hydro. Press. (Used if > 0)	0.0000	MPa
User defined MAWP	0.0000	MPa
User defined MAPnc	0.0000	MPa

Load Case 1	NP+EW+WI+FW+BW
Load Case 2	NP+EW+EE+FS+BS
Load Case 3	NP+OW+WI+FW+BW
Load Case 4	NP+OW+EQ+FS+BS
Load Case 5	NP+HW+HI
Load Case 6	NP+HW+HE
Load Case 7	IP+OW+WI+FW+BW
Load Case 8	IP+OW+EQ+FS+BS

Load Case 9	EP+OW+WI+FW+BW	
Load Case 10	EP+OW+EQ+FS+BS	
Load Case 11	HP+HW+HI	
Load Case 12	HP+HW+HE	
Load Case 13	IP+WE+EW	
Load Case 14	IP+WF+CW	
Load Case 15	IP+VO+OW	
Load Case 16	IP+VE+OW	
Load Case 17	IP+VF+CW	
Load Case 18	FS+BS+IP+OW	
Load Case 19	FS+BS+EP+OW	
Wind Design Code	ASCE-7 93	
Design Wind Speed	112.65	km/hr
Exposure Constant	C	
Importance Factor	1.	
Roughness Factor	1	
Base Elevation	0.0000	mm
Percent Wind for Hydrotest	33.	
Using User defined Wind Press. Vs Elev.	N	
Damping Factor (Beta) for Wind (Ope)	0.0100	
Damping Factor (Beta) for Wind (Empty)	0.0000	
Damping Factor (Beta) for Wind (Filled)	0.0000	
Seismic Design Code	UBC 1997	
UBC Seismic Zone (1=1,2=2a,3=2b,4=3,5=4)	0	
UBC Importance Factor	1.250	
UBC Seismic Coefficient Ca	0.360	
UBC Seismic Coefficient Cv	0.840	
UBC Seismic Coefficient Nv	1.000	
UBC Horizontal Force Factor	2.000	
Apply Allowables per paragraph 1612.3.2	No	

Design Nozzle for Des. Press. + St. Head	Y
Consider MAP New and Cold in Noz. Design	N
Consider External Loads for Nozzle Des.	Y
Use ASME VIII-1 Appendix 1-9	N

Complete Listing of Vessel Elements and Details:

Element From Node	10	
Element To Node	20	
Element Type	Elliptical	
Description	FUND ELIPSOIDAL 1	
Distance "FROM" to "TO"	50.000	mm
Inside Diameter	3000.0	mm
Element Thickness	14.000	mm
Internal Corrosion Allowance	3.0000	mm
Nominal Thickness	14.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	0.6000	MPa
Design Temperature Internal Pressure	60	C
Design External Pressure	0.0000	MPa
Design Temperature External Pressure	-20	C
Effective Diameter Multiplier	1.2	
Material Name	P355NH	
Allowable Stress, Ambient	204.17	MPa
Allowable Stress, Operating	204.17	MPa
Material Density	0.007810	kg/cm^3
Elliptical Head Factor	2.	

Element From Node	10	
Detail Type	Nozzle	
Detail ID	GV1a	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Nozzle Diameter	508.	mm

Nozzle Schedule	DIN10.0	
Nozzle Class	10	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	10	
Detail Type	Nozzle	
Detail ID	R1	
Dist. from "FROM" Node / Offset dist	1100.0	mm
Nozzle Diameter	219.10001	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	10	
Detail Type	Nozzle	
Detail ID	R3	
Dist. from "FROM" Node / Offset dist	1200.0	mm
Nozzle Diameter	114.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Element To Node	30	
Element Type	Cylinder	
Description	VIROLA	
Distance "FROM" to "TO"	10350.	mm
Inside Diameter	3000.0	mm
Element Thickness	14.000	mm
Internal Corrosion Allowance	3.0000	mm
Nominal Thickness	14.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	0.6000	MPa
Design Temperature Internal Pressure	60	C
Design External Pressure	0.0000	MPa
Design Temperature External Pressure	-20	C
Effective Diameter Multiplier	1.2	
Material Name	P355NH	

Element From Node	20	
Detail Type	Saddle	
Detail ID	left Sdl	
Dist. from "FROM" Node / Offset dist	850.00	mm
Width of Saddle	400.00	mm
Height of Saddle at Bottom	2000.0	mm
Saddle Contact Angle	120.	
Height of Composite Ring Stiffener	0.0000	mm
Width of Wear Plate	500.00	mm
Thickness of Wear Plate	14.000	mm
Contact Angle, Wear Plate (degrees)	127.	

Element From Node	20	
Detail Type	Saddle	
Detail ID	right sdl	
Dist. from "FROM" Node / Offset dist	9600.0	mm

Width of Saddle	400.00	mm
Height of Saddle at Bottom	2000.0	mm
Saddle Contact Angle	120.	
Height of Composite Ring Stiffener	0.0000	mm
Width of Wear Plate	500.00	mm
Thickness of Wear Plate	14.000	mm
Contact Angle, Wear Plate (degrees)	127.	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	GV2a	
Dist. from "FROM" Node / Offset dist	500.00	mm
Nozzle Diameter	508.	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	10	
Layout Angle	0.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	GV2b	
Dist. from "FROM" Node / Offset dist	7950.0	mm
Nozzle Diameter	508.	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	10	
Layout Angle	0.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	M1	
Dist. from "FROM" Node / Offset dist	3860.0	mm
Nozzle Diameter	51.	mm
Nozzle Schedule	DIN12.5	
Nozzle Class	None	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	None	
Nozzle Matl	P285QH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R8	
Dist. from "FROM" Node / Offset dist	6940.0	mm
Nozzle Diameter	168.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	0.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R2	
Dist. from "FROM" Node / Offset dist	9220.0	mm
Nozzle Diameter	168.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	

Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R6	
Dist. from "FROM" Node / Offset dist	9950.0	mm
Nozzle Diameter	219.10001	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	0.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R7c	
Dist. from "FROM" Node / Offset dist	250.00	mm
Nozzle Diameter	168.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	40	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	

Detail Type	Nozzle	
Detail ID	R7b	
Dist. from "FROM" Node / Offset dist	2700.0	mm
Nozzle Diameter	168.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	40	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R7a	
Dist. from "FROM" Node / Offset dist	7650.0	mm
Nozzle Diameter	168.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	40	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R5	
Dist. from "FROM" Node / Offset dist	8910.0	mm
Nozzle Diameter	219.10001	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	180.	

Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R4	
Dist. from "FROM" Node / Offset dist	10100.	mm
Nozzle Diameter	168.3	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R17b	
Dist. from "FROM" Node / Offset dist	8650.0	mm
Nozzle Diameter	51.	mm
Nozzle Schedule	DIN12.5	
Nozzle Class	40	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P285QH	
Element From Node	20	
Detail Type	Nozzle	

Detail ID	R17d	
Dist. from "FROM" Node / Offset dist	10240.	mm
Nozzle Diameter	51.	mm
Nozzle Schedule	DIN12.5	
Nozzle Class	40	
Layout Angle	-161.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P285QH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R11	
Dist. from "FROM" Node / Offset dist	9100.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	90.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R9	
Dist. from "FROM" Node / Offset dist	8800.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	95.685898	
Blind Flange (Y/N)	Y	

Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R18a	
Dist. from "FROM" Node / Offset dist	8950.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	113.347	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R10	
Dist. from "FROM" Node / Offset dist	9100.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	142.429	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R12	

Dist. from "FROM" Node / Offset dist	8800.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	131.338	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R17a	
Dist. from "FROM" Node / Offset dist	8650.0	mm
Nozzle Diameter	51.	mm
Nozzle Schedule	DIN12.5	
Nozzle Class	40	
Layout Angle	283.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P285QH	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R20	
Dist. from "FROM" Node / Offset dist	8920.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	0.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N

Grade of Attached Flange	GR 1.1	
Nozzle Matl	P285QH	

Element From Node	30	
Element To Node	40	
Element Type	Elliptical	
Description	FUND ELIPSOIDAL 2	
Distance "FROM" to "TO"	50.000	mm
Inside Diameter	3000.0	mm
Element Thickness	14.000	mm
Internal Corrosion Allowance	3.0000	mm
Nominal Thickness	14.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	0.6000	MPa
Design Temperature Internal Pressure	60	C
Design External Pressure	0.0000	MPa
Design Temperature External Pressure	-20	C
Effective Diameter Multiplier	1.2	
Material Name	P355NH	
Elliptical Head Factor	2.	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	GV1b	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Nozzle Diameter	508.	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	10	
Layout Angle	0.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	R19	
Dist. from "FROM" Node / Offset dist	850.00	mm
Nozzle Diameter	219.10001	mm
Nozzle Schedule	DIN10.0	
Nozzle Class	16	
Layout Angle	180.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	R15	
Dist. from "FROM" Node / Offset dist	700.00	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	90.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	R18b	
Dist. from "FROM" Node / Offset dist	860.00	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	

Nozzle Class	16	
Layout Angle	126.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	R16	
Dist. from "FROM" Node / Offset dist	1100.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	141.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	R14	
Dist. from "FROM" Node / Offset dist	1086.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	158.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P355NH	

Element From Node	30	
Detail Type	Nozzle	
Detail ID	R13	
Dist. from "FROM" Node / Offset dist	1011.0	mm
Nozzle Diameter	88.900002	mm
Nozzle Schedule	DIN8.0	
Nozzle Class	16	
Layout Angle	81.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	P285QH	

XY Coordinate Calculations

From	To	X (Horiz.) mm	Y (Vert.) mm	DX (Horiz.) mm	DY (Vert.) mm
FUND ELIPS		50.0000	...	50.0000	...
VIROLA		10400.0	...	10350.0	...
FUND ELIPS		10450.0	...	50.0000	...

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd MPa	Nominal Thickness mm	Total Corr Allowance mm	Element Diameter mm	Allowable Stress(SE) MPa
FUND ELIPS		0.6000	14.000	3.0000	3000.0	204.17
VIROLA		0.6000	14.000	3.0000	3000.0	204.17
FUND ELIPS		0.6000	14.000	3.0000	3000.0	204.17

Element Required Thickness and MAWP :

From	To	Design Pressure MPa	M.A.W.P. Corroded MPa	M.A.P. New & Cold MPa	Minimum Thickness mm	Required Thickness mm
FUND ELIPS		0.60000	1.09314	1.41195	14.0000	9.47391
VIROLA		0.60000	1.48884	1.89677	14.0000	7.42332
FUND ELIPS		0.60000	1.29354	1.68320	14.0000	8.87677
Minimum			1.093	1.412		

MAWP: 1.093 MPa, limited by: FUND ELIPSOIDAL 1.

Internal Pressure Calculation Results :

European Std: EN 13445-3: 2009(E) Issue 1 (2009-07)

Elliptical Head From 10 To 20 P355NH at 60 C

FUND ELIPSOIDAL 1

Design Stress at Ambient Temperature = 204.174 MPa

Required thickness = 9.474 mm

Required thickness in the crown = 6.970 mm

This is an Elliptical Head

The Material is Carbon Steel which affects value of fb:

Buckling Strs at ope. fb = Yield/1.5 = 329.552 /1.5 = 219.701 MPa

Buckling Strs at amb. fb = Yield/1.5 = 355.012 /1.5 = 236.675 MPa

Ellipsoidal head find geometry for equiv. tori-head EN13445 Equation 7.5.4:

Pressure including hydro head P : 0.6000 MPa

Inside Head Diameter (new) Di : 3000.0000 mm

Head Thickness (new) e : 14.0000 mm

Head Aspect Ratio (new) Di/2h : 2.0000

Head Corrosion Allowance Internal ci : 3.0000 mm

Head Corrosion Allowance External co : 0.0000 mm

Joint Efficiency Z : 1.0000

hi = 0.5 * Di/AR + c = 0.5 * 3000.00/2.000+3.00 = 753.0000 mm

K = Di / (2 * hi) = 3006.000 / (2 * 753.000) = 1.9960

r = Di((0.5 / K) - 0.08) = 3006.000((0.5/1.996)-0.08) = 512.5200 mm

R = Di(0.44*K+ 0.02) = 3006.000 (0.44*1.996+0.02) = 2700.1306 mm

The nozzle is outside the 80% limit:

Nozzle corroded inside Diameter di : 225.1000 mm

Y = Min(e/R, 0.04) = Min(6.47391/2700.1306, 0.04) = 0.0023976

Z = Log10(1 / Y) = Log10(1 / 0.002) = 2.6202

X = r / Di = 512.5200 / 3006.0000 = 0.17050

N = 1.006 - 1 / (6.2+(90 * Y)^4))

= 1.006-1 / (6.2+(90*0.0024)^4) = 0.84477

Beta01 = N(-0.1833*Z^3 + 1.0383*Z^2 - 1.2943*Z + 0.837)

= 0.845 (-.1833*2.620^3 + 2.2124*2.620^2 - 3.2937*2.620 + 1.887

= 1.0785

Beta02 = max (0.95 * (0.56 - 1.94 * Y - 82.5 * Y^2), 0.5)

= max (0.95 * (0.56 - 1.94 * 0.002 - 82.5 * 0.002^2), 0.5)

= 0.5271

Beta = 10 ((0.2 - X) * Bets01 + (X - 0.1) * Beta02

= 10 ((0.2 - 0.1705) * 1.0785 + (0.1705 - 0.1) * 0.5271

= 0.6898

Thickness Due to Design Internal Pressure: e = Max(es, ey, eb) - para 7.5.3.2

Compute from Section 7.7.3 [Beta_k]:

V = Log10(1000 * P / S)

= Log10(1000 * 0.600 / 204.174) = 0.4682

Note: Compute Beta_K using the Korbbogen equations.

$A = 0.54 + 0.41 * V - 0.044 * V^3$

$= 0.54 + 0.41 * 0.468 - 0.044 * 0.468^3 = 0.7274$

$B = 7.77 - 4.53 * V + 0.744 * V^2$

$= 7.77 - 4.53 * 0.468 + 0.744 * 0.468^2 = 5.8123$

Beta_k = max (A + B * di/De, 1.0 + 0.5 * B * di/De)

= max (0.727 + 5.812 * 225.100 /3028.000 , 1.0 +

0.3 * 5.812 * 225.100 /3028.000) = 1.2160

Thickness Due to Design Internal Pressure: e = Max(es, ey, eb) - para 7.5.3.2

Required Crown Thickness due to Internal Pressure, see Figure 7.5-3 [es]:

= P * R/(2 * f * z - 0.5 * P)

= 0.600 * 2700.1 /(2 * 204.174 * 1.00 - 0.5 * 0.600)

= 3.9703 mm

ey = Beta*Beta_k*P(0.75*R+0.2*Di)/f

=1.216*0.690*0.600(0.75*2700.13+0.2*3006.00/

204.1738 = 6.4739 mm

$eb = (0.75R+0.2Di)((P/111*fb)*(Di/r)^{0.825})^{1/1.5}$

$= (0.75*2700.13+0.2*3006.00) *$

$(0.60/111 *219.70)(3006.00/512.52)^{0.825})^{1/1.5}$

$= 5.8780$ mm

Computed Head Thickness per EN13445 - 7.5.4:

= Max(es,eb,ey)+c+cext = Max(3.9703,5.8780,6.4739) + 3.0000 + 0.0000

= 6.4739 + 3.0000 +0.0000 = 9.4739 mm

The head is suitable for the design pressure.

Computed Stress at Design Pressure [Stres]:

= 112.048 MPa

Computed Maximum Allowable Working Pressure - Design [MAWP]:

MAWP - Phydro = 1.0931 - 0.0000 = 1.0931 MPa

Computed Maximum Pressure New and Cold [MAPNC]:

= 1.412 MPa

Uncorrected (for liquid) Hydrotest Pressure:

= 1.534 MPa

Elongation of the extreme fiber:

For a spun head per EN 13445-4 Para 9.2.1 [F]:

assuming the blank is 20% larger than the head diameter

= 100 * ln(3633.600 /(3000.000 - 2 * 14.000)) = 19.161 %

For a segmented head per EN 13445-4 Para 9.2.5 [F]:

= 100 * e / R = 100 * 0.551 / 59.331 = 0.929 %

If F exceeds 5% PWHT may be required. Please refer

to EN 13445 Part 4 Table 9.4.1

Required Thickness of Straight Flange = 7.423 mm

Min. Des. Temp. per EN13445 Part 2: Thickness 14.000 mm at -20 C:

User entered Minum Design Temperature: -20.000 C

Note: The Component is NOT Post Weld Heat Treated.

Yield Value of the Component 355.0125 MPa

Selected Graph: B4.1-4 per EN13445-2 B4

Note: Computed Impact Test Temp. Tkt: -3 C.

Impact Testing is Required!

Cylindrical Shell From 20 To 30 P355NH at 60 C

VIROLA

Design Stress at Ambient Temperature = 204.174 MPa

Thickness due to internal pressure [e]:

```
= P * Di / ( 2 * f * z - P ) EN13445 Equation: 7.4.2:

= 0.60 * 3006.00 / ( 2 * 204.174 * 1.000 - 0.600 ) + c + cext

= 4.4233 + 3.0000 + 0.0000 = 7.4233 mm
```

The shell is suitable for the design pressure.

Maximum Working Pressure Hot and Corroded [MAWP]:

```
= ( 2 * f * ecor * z ) / (Di + ecor) - Phead

= ( 2 * 204.17 * 11.0000 * 1.000 ) / (3006.00 + 11.0000 )-0.00

= 1.489 MPa
```

Maximum Pressure New and Cold [MAPNC]:

```
= ( 2 * fa * e * z ) / ( D + e )

= ( 2 * 204.17 * 14.00 * 1.000 ) / ( 3000.00 + 14.00 )

= 1.897 MPa
```

Stress at Design Pressure [Stres]:

```
=  P * ( Di + ecor ) /(2 * ecor * z)

= 0.600 * (3006.000 + 11.0000 ) / (2 * 11.0000 * 1.000 )

= 82.282 MPa
```

Uncorrected (for liquid) Hydrotest Pressure per 6.2.2 stress limitation:

```
= ( 2 * Ftest * e * z ) / (Di + e)

= ( 2 * 338.11 * 14.00 * 1.000 ) / ( 3000.00 + 14.00 )

= 3.141 MPa
```

Elongation of the extreme fiber per EN 13445-4 Para 9.2.2 [F]

```
= 50*Max(e, enom) / Rm = 50*Max(14.000 ,14.000 )/1508.500 = 0.464 %
```

Min. Des. Temp. per EN13445 Part 2: Thickness 14.000 mm at -20 C:

User entered Minum Design Temperature: -20.000 C

Note: The Component is NOT Post Weld Heat Treated.

Yield Value of the Component 355.0125 MPa

Selected Graph: B4.1-4 per EN13445-2 B4

Note: Computed Impact Test Temp. Tkt: -3 C.

Impact Testing is Required!

Elliptical Head From 30 To 40 P355NH at 60 C

FUND ELIPSOIDAL 2

Design Stress at Ambient Temperature = 204.174 MPa

```
     Required thickness              =      8.877 mm

     Required thickness in the crown =      6.970 mm
```

This is an Elliptical Head

The Material is Carbon Steel which affects value of fb:

```
 Buckling Strs at ope. fb = Yield/1.5 = 329.652 /1.5 = 219.768 MPa

 Buckling Strs at amb. fb = Yield/1.5 = 355.012 /1.5 = 236.675 MPa
```

Ellipsoidal head find geometry for equiv. tori-head EN13445 Equation 7.5.4:

```
  Pressure including hydro head              P : 0.6000 MPa

  Inside Head Diameter     (new)            Di : 3000.0000 mm

  Head Thickness           (new)             e : 14.0000 mm

  Head Aspect Ratio        (new)         Di/2h : 2.0000

  Head Corrosion Allowance Internal         ci : 3.0000 mm

  Head Corrosion Allowance External         co : 0.0000 mm

  Joint Efficiency                           Z : 1.0000

  hi = 0.5 * Di/AR + c = 0.5 * 3000.00/2.000+3.00 = 753.0000  mm

  K  = Di / (2 * hi) = 3006.000 / (2 * 753.000) = 1.9960

  r  = Di((0.5 / K) - 0.08) = 3006.000((0.5/1.996)-0.08) = 512.5200  mm

  R  = Di(0.44*K+ 0.02) = 3006.000 (0.44*1.996+0.02) = 2700.1306  mm

  Y  = Min(e/R, 0.04) = Min(5.87677/2700.1306, 0.04) = 0.0021765

  Z  = Log10(1 / Y) = Log10(1 /  0.002) = 2.6622

  X  = r / Di = 512.5200 / 3006.0000 = 0.17050

  N  = 1.006 - 1 / ( 6.2+( 90 * Y )^4) )

     = 1.006-1 / (6.2+( 90*0.0022)^4) = 0.84475

   Beta01 = N( -0.1833*Z^3 + 1.0383*Z^2 - 1.2943*Z + 0.837 )

          = 0.845 (-.1833*2.662^3 + 2.2124*2.662^2 - 3.2937*2.662 + 1.887

          = 1.0911

   Beta02 = max ( 0.95 * ( 0.56 - 1.94 * Y - 82.5 * Y^2), 0.5 )

          = max ( 0.95 * ( 0.56 - 1.94 * 0.002 - 82.5 * 0.002^2), 0.5 )

          = 0.5276

   Beta   = 10 ( ( 0.2 - X ) * Bets01 + ( X - 0.1 ) * Beta02
```

= 10 ((0.2 - 0.1705) * 1.0911 + (0.1705 - 0.1) * 0.5276

= 0.6938

Thickness Due to Design Internal Pressure: e = Max(es, ey, eb) - para 7.5.3.2

Required Crown Thickness due to Internal Pressure, see Figure 7.5-3 [es]:

= P * R/(2 * f * z - 0.5 * P)

= 0.600 * 2700.1 /(2 * 204.174 * 1.00 - 0.5 * 0.600)

= 3.9703 mm

ey = Beta*P(0.75*R+0.2*Di)/f =0.69*0.6(0.75*2700.1+0.2*3006.0)/

204.1738 = 5.3550 mm

eb = $(0.75R+0.2Di)((P/111*fb)*(Di/r)^{0.825})^{1/1.5}$

= (0.75*2700.13+0.2*3006.00) *

$(0.60/111 *219.77)(3006.00/512.52)^{0.825})^{1/1.5}$

= 5.8768 mm

Computed Head Thickness per EN13445 - 7.5.4:

= Max(es,eb,ey)+c+cext = Max(3.9703,5.8768,5.3550) + 3.0000 + 0.0000

= 5.8768 + 3.0000 +0.0000 = 8.8768 mm

The head is suitable for the design pressure.

Actual stress at design pressure cannot be computed

because the thickness for buckling pressure controls.

Computed Maximum Allowable Working Pressure - Design [MAWP]:

MAWP - Phydro = 1.2935 - 0.0000 = 1.2935 MPa

Computed Maximum Pressure New and Cold [MAPNC]:

= 1.683 MPa

Uncorrected (for liquid) Hydrotest Pressure:

= 1.534 MPa

Elongation of the extreme fiber:

For a spun head per EN 13445-4 Para 9.2.1 [F]:

assuming the blank is 20% larger than the head diameter

= 100 * ln(3633.600 /(3000.000 - 2 * 14.000)) = 19.161 %

For a segmented head per EN 13445-4 Para 9.2.5 [F]:

= 100 * e / R = 100 * 0.551 / 59.331 = 0.929 %

If F exceeds 5% PWHT may be required. Please refer to EN 13445 Part 4 Table 9.4.1

Required Thickness of Straight Flange = 7.423 mm

Min. Des. Temp. per EN13445 Part 2: Thickness 14.000 mm at -20 C:

User entered Minum Design Temperature: -20.000 C

Note: The Component is NOT Post Weld Heat Treated.

Yield Value of the Component 355.0125 MPa

Selected Graph: B4.1-4 per EN13445-2 B4

Note: Computed Impact Test Temp. Tkt: -3 C.

Impact Testing is Required!

Hydrostatic Test Pressure Results:

Note: The Hydrotest Pressure Derivation is an Iterative Process

Limited by: Ellipse Head FUND ELIPSOIDAL

Hydrotest pressure is based upon stress (ftest) in the weakest element:

Note: 1.5 / 1.05 = 1.429, The PED requirement is 1.43

```
ftest = Yield Stress / 1.05
      = 355.012 / 1.05 = 338.107 MPa

Test Pressure = Calc Test Press - Liquid Head
              = 1.534 - 0.029 = 1.504 MPa
```

Elements Suitable for Internal Pressure.

Element and Detail Weights

From	To	Element Metal Wgt. kg	Element ID Volume cm3	Corroded Metal Wgt. kg	Corroded ID Volume cm3	Extra due Misc % kg
10	20	1240.58	3.888E+06	974.741	3.911E+06	...
20	30	10756.8	73.17E+06	8460.26	73.47E+06	...
30	40	1245.35	3.888E+06	978.486	3.911E+06	...
Total		13242	80949800.00	10413	81288112.00	0

Weight of Details

From	Type	Weight of Detail kg	X Offset, Dtl. Cent. mm	Y Offset, Dtl. Cent. mm	Description
10	Nozl	88.1762	-750.000	...	GV1a
10	Nozl	22.4052	-509.902	...	R1
10	Nozl	18.7288	-450.000	...	R3
20	Sadl	851.391	850.000	1736.00	left Sdl
20	Sadl	851.391	9600.00	1736.00	right sdl
20	Nozl	88.1762	500.000	1754.00	GV2a
20	Nozl	88.1762	7950.00	1754.00	GV2b
20	Nozl	1.07926	3860.00	1525.50	M1
20	Nozl	17.3716	6940.00	1584.15	R8
20	Nozl	17.3716	9220.00	1584.15	R2
20	Nozl	24.8760	9950.00	1609.55	R6
20	Nozl	18.5834	250.000	1584.15	R7c
20	Nozl	18.5834	2700.00	1584.15	R7b
20	Nozl	18.5834	7650.00	1584.15	R7a
20	Nozl	20.7100	8910.00	1609.55	R5
20	Nozl	17.3716	10100.0	1584.15	R4
20	Nozl	3.10788	8650.00	1525.50	R17b
20	Nozl	0.44871	10240.0	1525.50	R17d

20|Nozl|	8.76849	9100.00	1544.45	R11
20|Nozl|	5.35114	8800.00	1544.45	R9
20|Nozl|	6.91690	8950.00	1544.45	R18a
20|Nozl|	6.45956	9100.00	1544.45	R10
20|Nozl|	6.10067	8800.00	1544.45	R12
20|Nozl|	2.45844	8650.00	1525.50	R17a
20|Nozl|	8.76849	8920.00	1544.45	R20
30|Nozl|	88.6208	800.000	...	GV1b
30|Nozl|	28.8188	667.960	...	R19
30|Nozl|	5.74814	713.325	700.000	R15
30|Nozl|	7.02170	664.492	695.755	R18b
30|Nozl|	7.02170	559.902	692.252	R16
30|Nozl|	7.02170	567.350	406.823	R14
30|Nozl|	4.26533	604.048	998.553	R13

Total Weight of Each Detail Type

Total Weight of Saddles	1702.8	
Total Weight of Nozzles	657.1	
Sum of the Detail Weights	2359.9	kg

Weight Summary

Fabricated Wt.	- Bare Weight W/O Removable Internals	15602.6	kg
Shop Test Wt.	- Fabricated Weight + Water (Full)	96503.0	kg
Shipping Wt.	- Fab. Wt + Rem. Intls.+ Shipping App.	15602.6	kg
Erected Wt.	- Fab. Wt + Rem. Intls.+ Insul. (etc)	15602.6	kg
Ope. Wt. no Liq	- Fab. Wt + Intls. + Details + Wghts.	15602.6	kg
Operating Wt.	- Empty Wt + Operating Liq. Uncorroded	15602.6	kg
Oper. Wt. + CA	- Corr Wt. + Operating Liquid	12773.4	kg
Field Test Wt.	- Empty Weight + Water (Full)	96503.0	kg

Note: The Corroded Weight and thickness are used in the Horizontal

Vessel Analysis (Ope Case) and Earthquake Load Calculations.

Outside Surface Areas of Elements

From	To	Surface Area mm²
10	20	10.41E+06
20	30	98.46E+06
30	40	10.41E+06
Total		119285824.000 mm²

Nozzle Flange MAWP Results :

Nozzle Description	Flange Rating Operating MPa	Ambient MPa	Temperature C	Class	Grade|Group
GV1a	6895.0	6895.0	60	10	GR 1.1
R1	6895.0	6895.0	60	16	GR 1.1
R3	6895.0	6895.0	60	16	GR 1.1
GV2a	6895.0	6895.0	60	10	GR 1.1
GV2b	6895.0	6895.0	60	10	GR 1.1
R8	6895.0	6895.0	60	16	GR 1.1
R2	6895.0	6895.0	60	16	GR 1.1
R6	6895.0	6895.0	60	16	GR 1.1
R7c	6895.0	6895.0	60	40	GR 1.1
R7b	6895.0	6895.0	60	40	GR 1.1
R7a	6895.0	6895.0	60	40	GR 1.1
R5	6895.0	6895.0	60	16	GR 1.1
R4	6895.0	6895.0	60	16	GR 1.1
R17b	6895.0	6895.0	60	40	GR 1.1
R17d	6895.0	6895.0	60	40	GR 1.1
R11	6895.0	6895.0	60	16	GR 1.1
R9	6895.0	6895.0	60	16	GR 1.1
R18a	6895.0	6895.0	60	16	GR 1.1
R10	6895.0	6895.0	60	16	GR 1.1
R12	6895.0	6895.0	60	16	GR 1.1
R17a	6895.0	6895.0	60	40	GR 1.1
R20	6895.0	6895.0	60	16	GR 1.1
GV1b	6895.0	6895.0	60	10	GR 1.1
R19	6895.0	6895.0	60	16	GR 1.1
R15	6895.0	6895.0	60	16	GR 1.1
R18b	6895.0	6895.0	60	16	GR 1.1
R16	6895.0	6895.0	60	16	GR 1.1
R14	6895.0	6895.0	60	16	GR 1.1

R13	6895.0	6895.0	60	16	GR 1.1

Minimum Rating 6895.000 6895.000 MPa

Note: ANSI Ratings are per ANSI/ASME B16.5 2003 Edition

Wind Analysis Results

User Entered Importance Factor is	1.000	
Gust Factor (Gh, Gbar) Static	1.239	
Shape Factor (Cf) for the Vessel is	0.546	
User Entered Basic Wind Speed	112.7	km/hr
Exposure Category	C	
Table Lookup Value Alpha from Table C6	7.0000	
Table Lookup Value Zg from Table C6	900.0000	
Table Lookup Value Do from Table C6	0.0050	

Wind Load Results per ASCE-7 93:

Sample Calculation for the First Element:

Rougness Factor = 1.000

Values [cf1] and [cf2]

Because RoughFact = 1 and DQZ > 2.5 and H/D < 7.0

Interpolating to find the final cf:

Because H / D < 7.0

CF = CF1 + (CF2-CF1)*(H/D - 1) / (7 - 1)

= 0.500 + (0.600 -0.500)*(3.758 - 1) / (7 - 1)

= 0.546

Value of Alpha, Zg is taken from Table C6-2 [Alpha, Zg]

For Exposure Category C:

Alpha = 7.000 , Zg = 274320.000 mm

Height of Interest for First Element [z]

= Centroid Hgt + Base Height

= 2000.000 + 0.000 = 2000.000 mm

but: z = Max(4572.000 , 2000.000) = 4572.000 mm

Note: Because z < 15 feet, use 15 feet to compute kz.

Velocity Pressure Coefficient [kZ]:

$= 2.58(z/zg)^{2/Alpha}$: z is Elevation of First Element

$= 2.58(4572.000 /900)^{2/7.0}$

= 0.801

Determine if Static or Dynamic Gust Factor Applies

Height to Diameter ratio :

= Maximum Height(length)^2 / Sum of Area of the Elements

= 11214.001 (^2) / 33459536

= 3.758

Vibration Frequency = 33.000 Hz

Because H/D < 5 And Frequency > 1.0: Static Analysis Implemented

The following two calculations allow for any user units

Compute [tz]

$= 2.35 * Sqrt(DO / VesselHtg/30(feet)^{1/Alpha}$

$= 2.35 * Sqrt(0.005 / 11214.001)^{1/9144.000}$

= 0.161

Compute [Gh]

= 0.65 + 3.65 * tz

= 0.65 + 3.65 * 0.161 = 1.239

Wind Pressure - (performed in Imperial Units) [qz]

Importance Factor: I = 1.000

Wind Speed = 112.651 km/hr Converts to 70.000 mph

$qz = 0.00256 * kZ * (I * Vr)^2$

$= 0.00256 * 0.801 *(1.000 * 70.000)^2 = 10.046$ psf

Converts to: 49.052 kg/m²

Force on the First Element [Fz]

= qz * Gh * CF * Wind Area

= 49.052 * 1.239 * 0.546 * 1998613

= 650.357 N

Element	z	GH	Area	qz	Force
	mm		mm²	kg/m²	N
FUND ELIPSOIDAL	2000.0	1.239	1998613.9	49.1	650.4
VIROLA	2000.0	1.239	37607764.0	49.1	12237.7
FUND ELIPSOIDAL	2000.0	1.239	1998613.9	49.1	650.4

Wind Load Calculation

From	To	Wind Height mm	Wind Diameter mm	Wind Area mm²	Height Factor kg/m²	Element Wind Load N
10	20	2000.00	3633.60	1.999E+06	49.0518	650.357
20	30	2000.00	3633.60	37.61E+06	49.0518	12237.7
30	40	2000.00	3633.60	1.999E+06	49.0518	650.357

Note: Loads multiplied by the Scalar multiplier value of 0.7143

Earthquake Analysis Results per UBC 1997

The UBC Zone Factor for the Vessel is 0.0000

The Importance Factor as Specified by the User is . 1.250

The UBC Force Factor as Specified by the User is .. 2.000

The UBC Total Weight (W) for the Vessel is ..... 125255.5 N

The UBC Total Shear (V) for the Vessel is ..... 28183.1 N

The UBC Seismic Coefficient Value Ca is 0.360

The UBC Seismic Coefficient Value Cv is 0.840

Note: The base shear printed above has been modified

by the user defined Earthquake scalar.

Calculation Steps for Computing the design Base Shear (V) per UBC 1997

Computation of V per equation (34-1):

V = 0.7 * Ca * I * W

V = 0.7 * 0.360 * 1.250 * 125255

V = 39455.5 N

Computation of V per equation (30-5):

V = 2.5 * Ca * I * W / R

V = 2.5 * 0.360 * 1.25 * 125255 / 2.000

V = 70456.2 N

The computed base shear is the minimum of V from 34-1 and 30-5.

Computation of V per equation (34-2), minimum V. V cannot be less than

this value !

V = 0.56 * Ca * I * W

V = 0.56 * 0.360 * 1.250 * 125255

V = 31564.4 N

Total Adjusted Base Shear V:

= V * Scalar Multiplier = 39455.5 * 0.7143 = 28183.1 N

Next Sum the earthquake weights times their heights (wi*hi):

Current Sum = Prev. Sum + Wght 25051. * Hght 1500.000 = 37591892.

Current Sum = Prev. Sum + Wght 25051. * Hght 1500.000 = 75183784.

Current Sum = Prev. Sum + Wght 25051. * Hght 1500.000 = 112775680.

Current Sum = Prev. Sum + Wght 25051. * Hght 1500.000 = 150367568.

Current Sum = Prev. Sum + Wght 25051. * Hght 1500.000 = 187959472.

Compute the load at each level based on equation 30-15 and multiply

by the load case scalar. The sum will be the total adjusted shear.

Fx = (V * wx * hx / (sum of (wi * hi))) * EqFact

Fx = [(39455.) * 25051. * 1500.000 / 187959472.]*0.7143 = 5637.

Fx = [(39455.) * 25051. * 1500.000 / 187959472.]*0.7143 = 5637.

Fx = [(39455.) * 25051. * 1500.000 / 187959472.]*0.7143 = 5637.

Fx = [(39455.) * 25051. * 1500.000 / 187959472.]*0.7143 = 5637.

Fx = [(39455.) * 25051. * 1500.000 / 187959472.]*0.7143 = 5637.

Earthquake Load Calculation

From	To	Earthquake Height mm	Earthquake Weight N	Element Ope Load N
10	20	1500.00	25051.1	5636.61
20	Sadl	1500.00	25051.1	5636.61
Sadl	30	1500.00	25051.1	5636.61
20	30	1500.00	25051.1	5636.61
30	40	1500.00	25051.1	5636.61

Shop/Field Installation Options :

Note : The CG is computed from the first Element From Node

Center of Gravity of Saddles	5275.000 mm
Center of Gravity of Nozzles	5864.705 mm
Center of Gravity of Bare Shell New and Cold	5227.023 mm
Center of Gravity of Bare Shell Corroded	5227.021 mm
Vessel CG in the Operating Condition	5266.221 mm
Vessel CG in the Fabricated (Shop/Empty) Condition	5259.114 mm

ASME Horizontal Vessel Analysis: Stresses for the Left Saddle

(per ASME Sec. VIII Div. 2 based on the Zick method.)

Horizontal Vessel Stress Calculations : Operating Case

Input and Calculated Values:

Vessel Mean Radius	Rm	1508.50	mm
Stiffened Vessel Length per 4.15.6	L	10450.00	mm
Distance from Saddle to Vessel tangent	a	685.00	mm
Saddle Width	b	400.00	mm
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	500.00	mm
Wear Plate Bearing Angle	theta1	127.00	
Wear Plate Thickness	tr	14.0	mm
Wear Plate Allowable Stress	Sr	204.17	MPa
Inside Depth of Head	h2	753.00	mm
Shell Allowable Stress used in Calculation		204.17	MPa
Head Allowable Stress used in Calculation		204.17	MPa
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Operating Case		86763.61	N

Horizontal Vessel Analysis Results:	**Actual**	**Allowable**	
Long. Stress at Top of Midspan	39.18	204.17	MPa
Long. Stress at Bottom of Midspan	43.10	204.17	MPa
Long. Stress at Top of Saddles	41.17	204.17	MPa
Long. Stress at Bottom of Saddles	41.11	204.17	MPa
Tangential Shear in Shell	4.60	163.34	MPa
Tangential Shear in Head	4.60	163.34	MPa
Circ. Stress at Horn of Saddle	4.62	255.22	MPa
Addl. Stress in Head as Stiffener	83.92	255.22	MPa
Circ. Compressive Stress in Shell	1.00	204.17	MPa

Intermediate Results: Saddle Reaction Q due to Wind or Seismic

Saddle Reaction Force due to Wind Ft [Fwt]:

= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E

= 3.00 * (13538.4 /2 + 0) * 2000.0000 / 2612.7986

= 15544.8 N

Saddle Reaction Force due to Wind Fl or Friction [Fwl]:

= Max(Fl, Friction Load, Sum of X Forces) * B / Ls

= Max(4156.52 , 0.00 , 0) * 2000.0000 / 8750.0010

= 950.1 N

Saddle Reaction Force due to Earthquake Fl or Friction [Fsl]:

= Max(Fl, Friction Force, Sum of X Forces) * B / Ls

= Max(28183.05 , 0.00 , 0) * 2000.0000 / 8750.0010

= 6441.8 N

Saddle Reaction Force due to Earthquake Ft [Fst]:

= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E

= 3.00 * (28183 /2 + 0) * 2000.0000 / 2612.7986

= 32359.6 N

Load Combination Results for Q + Wind or Seismic [Q]:

= Saddle Load + Max(Fwl, Fwt, Fsl, Fst)

= 54403 + Max(950 , 15544 , 6441 , 32359)

= 86763.6 N

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	95112.34	N
Transverse Shear Load Saddle	14091.53	N
Longitudinal Shear Load Saddle	28183.05	N

Formulas and Substitutions for Horizontal Vessel Analysis:

Note: Wear Plate is Welded to the Shell, k = 0.1

The Computed K values from Table 4.15.1:

K1 = 0.1066	K2 = 1.1707	K3 = 0.8799	K4 = 0.4011
K5 = 0.7603	K6 = 0.0529	K7 = 0.0132	K8 = 0.3405
K9 = 0.2711	K10 = 0.0581	K1* = 0.1923	K6p = 0.0472
K7P = 0.0118			

The suffix 'p' denotes the values for a wear plate if it exists.

Note: Dimension a is less than Rm/2.

Moment per Equation 4.15.3 [M1]:

```
= -Q*a [1 - (1- a/L + (R²-h2²)/(2a*L))/(1+(4h2)/3L)]

= -86763*685.00[1-(1-685.00/10450.00+(1508.500²-753.000²)/
  (2*685.00*10450.00))/(1+(4*753.00)/(3*10450.00))]

= -2293745.0 N-mm
```

Moment per Equation 4.15.4 [M2]:

```
= Q*L/4(1+2(R²-h2²)/(L²))/(1+(4h2)/( 3L))-4a/L

= 86763*10450/4(1+2(1508²-753²)/(10450²))/(1+(4*753)/
  (3*10450))-4*684/10450

= 153901664.0 N-mm
```

Longitudinal Stress at Top of Shell (4.15.6) [Sigma1]:

```
= P * Rm/(2t) - M2/(pi*Rm²t)

= 0.60 * 1508.500 /(2*11.00 ) - .15390E+09/(pi*1508.5²*11.00 )

= 39.18 MPa
```

Longitudinal Stress at Bottom of Shell (4.15.7) [Sigma2]:

```
= P * Rm/(2t) + M2/(pi * Rm² * t)

= 0.60 * 1508.500 /(2 * 11.00 ) + .15390E+09/(pi * 1508.5² * 11.00 )

= 43.10 MPa
```

Longitudinal Stress at Top of Shell at Support (4.15.8) [Sigma3]:

```
= P * Rm/(2t) - M1/(pi * Rm² * t)

= 0.60 * 1508.500 /(2 * 11.00 ) - -2293745.0/(pi * 1508.5² * 11.00 )

= 41.17 MPa
```

Longitudinal Stress at bottom of Shell at Support (4.15.9) [Sigma4]:

```
= P * Rm/(2t) + M1/(pi*Rm²t)

= 0.60 * 1508.500 /(2*11.00 ) + -2293745.0/(pi*1508.5²*11.00 )

= 41.11 MPa
```

Maximum Shear Force in the Saddle (4.15.5) [T]:

```
= Q(L-2a)/(L+(4*h2/3))

= 86763 ( 10450.00 - 2 * 685.00 )/(10450.00 + ( 4 * 753.00 /3))

= 68780.7 N
```

Shear Stress in the shell no rings, stiffened (4.15.15) [tau3]:

```
= K3 * Q / ( Rm * t )
```

= 0.8799 * 86763 / (1508.5000 * 11.0000)

= 4.60 MPa

Shear Stress in the head, shell stiffened (4.15.16) [tau3*]:

= K3 * Q / (Rm * th)

= 0.8799 * 86763 / (1508.5000 * 11.0000)

= 4.60 MPa

Membrane stress in the head as a stiffener (4.15.18) [sigma5]:

= K4 * Q/(Rm*th) + ((P*Ri)/(2*th)) * (Ri/h2)

= 0.4011 * 86763 /(1508.50 * 11.000) +

((0.60 * 1503.00)/(2 * 11.000))*(1503.00 / 753.00)

= 83.92 MPa

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(1508.500 * 11.000)

= 100.476 mm

Circumferential Stress in shell, no rings (4.15.23) [sigma6]:

= -K5 * Q * k / (t * (b + X1 + X2))

= -0.7603 * 86763 * 0.1 / (11.000 * (400.00 + 100.48 + 100.48))

= -1.00 MPa

Effective reinforcing plate width (4.15.1) [B1]:

= min(b + 1.56 * sqrt(Rm * t), 2a)

= min(400.00 + 1.56 * sqrt(1508.500 * 11.000), 2 * 685.000)

= 600.95 mm

Wear Plate/Shell Stress ratio (4.15.29) [eta]:

= min(Sr/S, 1)

= min(204.174 / 204.174 , 1)

= 1.0000

Circumferential Stress at wear plate (4.15.26) [sigma6,r]:

= -K5 * Q * k / (B1(t + eta * tr))

= -0.7603 * 86763 * 0.1 / (600.953 (11.000 + 1.000 * 14.000))

= -0.44 MPa

Circ. Comp. Stress at Horn of Saddle, L<8Rm (4.15.28) [sigma7,r*]:

= -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)²)

= -86763 /(4(11.000 + 1.000 * 14.000)600.953) -

12*0.013*86763*1508.500/(10450.00(11.000+1.000*14.000)²)

= -4.62 MPa

Results for Vessel Ribs, Web and Base:

Baseplate Length	Bplen	2400.0000	mm
Baseplate Thickness	Bpthk	20.0000	mm
Baseplate Width	Bpwid	400.0000	mm
Number of Ribs (inc. outside ribs)	Nribs	4	
Rib Thickness	Ribtk	20.0000	mm
Web Thickness	Webtk	20.0000	mm
Web Location	Webloc	Center	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	6.	7706.	42385.	310826.
Wearplate	18.	7000.	126000.	2382331.
Web	227.	8060.	1825590.	522580448.
BasePlate	438.	8000.	3504000.	1535017472.
Totals	688.	30766.	5497976.	2060291072.

Value C1 = Sumof(Ay)/Sumof(A) = 179. mm

Value I = Sumof(Io) - C1*Sumof(Ay) = 1077801472. mm**4

Value As = Sumof(A) - Ashell = 23060. mm²

K1 = (1+Cos(beta)-.5*Sin(beta)²)/(pi-beta+Sin(beta)*Cos(beta)) = 0.2035

Fh = K1 * Q = 0.2035 * 86763.609 = 17658.2793 N

Tension Stress, St = (Fh/As) = 0.7658 MPa

Allowed Stress, Sa = 0.6 * Yield Str = 143.9676 MPa

d = B - R*Sin(theta) / theta = 708.0291 mm

Bending Moment, M = Fh * d = 12507644.0000 N-mm

Bending Stress, Sb = (M * C1 / I) = 2.0731 MPa

Allowed Stress, Sa = 2/3 * Yield Str = 159.9640 MPa

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (4 * BasePlateLength *

AllStress))½

= (3 * (86763 + 8348) * 400.00 / (4 * 2400.000 * 159.964))½

= 8.621 mm

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

= (Bplen - Clearance) / (Nribs - 1)

= (2400.0000 - 25.4) / (4 - 1) = 791.5333 mm

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 791.5333 * 400.0000 / 2 = 0.2E+06 mm²

Axial Load [P]:

= Ap * Bp

= 158306.7 * 0.09 = 14307.6 N

Area of the Rib and Web [Ar]:

= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk

= (400.000 - 25.4 - 20.000) * 20.000 + 791.5333 /2 * 20.000

= 15007.332 mm²

Compressive Stress [Sc]:

= P/Ar

= 14307.6 / 15007.3320 = 0.9535 MPa

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	200.0	7346.0	1469200.0	0.0	96825736.0
Web	200.0	7915.3	1583066.5	0.0	527688.2
Values	200.0	15261.3	3052266.5	0.0	97353424.0

Bending Moment [Rm]:

= Fl /(2 * Bplen) * e * rl / 2

= 28183.1 /(2 * 2400.00) * 791.533 * 1194.00 / 2

= 2775661 N-mm

KL/R < Cc (14.8245 < 128.2550) per AISC E2-1

Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)

Sca = (1-(14.82)²/(2 * 128.25²)) * 239 /

(5/3+3*(14.82)/(8* 128.25)-(14.82³)/(8*128.25³)

Sca = 139.40 MPa

AISC Unity Check on Outside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 0.95 / 139.40 + (2775661 /486767.094) / 159.96

Check = 0.04

Check of Inside Ribs

Inertia of Saddle, Inner Ribs - Axial Direction

	Y	A	AY	Ay²	Io
Rib	187.3	7092.0	1328331.4	0.0	87609584.0
Web	187.3	15830.7	2965083.8	0.0	527688.2
Values	187.3	22922.7	4293415.0	0.0	88137272.0

KL/R < Cc (7.6626 < 128.2550) per AISC E2-1

Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)

Sca = (1-(7.66)²/(2 * 128.25²)) * 239 /

(5/3+3*(7.66)/(8* 128.25)-(7.66³)/(8*128.25³)

Sca = 141.81 MPa

AISC Unity Check on Inside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 1.25 / 141.81 + (2209106 /470567.375) / 159.96

Check = 0.04

Input Data for Base Plate Bolting Calculations:

Total Number of Bolts per BasePlate	Nbolts	4	
Total Number of Bolts in Tension/Baseplate	Nbt	4	
Bolt Material Specification		C45E N	
Bolt Allowable Stress	Stba	113.34	MPa
Bolt Corrosion Allowance	Bca	0.0000	mm
Distance from Bolts to Edge	Edgedis	99.9998	mm
Nominal Bolt Diameter	Bnd	30.0000	mm
Thread Series	Series	TEMA Metric	
BasePlate Allowable Stress	S	204.17	MPa
Area Available in a Single Bolt	BltArea	502.9650	mm²
Saddle Load QO (Weight)	QO	62752.7	N
Saddle Load QL (Wind/Seismic contribution)	QL	6441.8	N

Maximum Transverse Force	Ft	14091.5	N
Maximum Longitudinal Force	Fl	28183.1	N
Saddle Bolted to Steel Foundation		No	

Bolt Area Calculation per Dennis R. Moss

Bolt Area Requirement Due to Longitudinal Load [Bltarearl]:

= 0.0 (QO > QL --> No Uplift in Longitudinal direction)

Bolt Area due to Shear Load [Bltarears]:

= Fl / (Stba * Nbolts)

= 28183.05 / (113.34 * 4.00)

= 62.1718 mm^2

Bolt Area due to Transverse Load

Moment on Baseplate Due to Transverse Load [Rmom]:

= B * Ft + Sum of X Moments

= 2000.00 * 14091.53 + 0.00

= 28194480.00 N-mm

Eccentricity (e):

= Rmom / QO

= 28194480 / 62752.73

= 449.11 mm > Bplen/6 --> Uplift in Transverse direction

f = Bplen / 2 - Edgedis

= 2400.00 / 2 - 100.00

= 1100.00 mm

Modular Ratio Of Steel/Concrete (n1):

= ES / EC

= 203402.50 / 21526.32

= 9.45

K1 = 3 (e - 0.5 * Bplen)

= 3 (449.11 - 0.5*2400.00)

= -2252.66 mm

K2 = 6 * n1 * At / Bpwid * (f + e)

= 6 * 9.45 * 2011.86 / 400.00 * (1100.00 + 449.11)

= 441731.77 mm^2

K3 = -K2 * (0.5 * Bplen + f)

= -441731.78 * (0.5 * 2400.00 + 1100.00)

= -1015983110.23 mm ³

Iteratively Solving for the Effective Bearing Length:

$Y^3 + K1 * Y^2 + K2 * Y + K3 = 0$

$Y^3 + -2252.66 * Y^2 + 441731.78 * Y + -0.1E+10 = 0$

Y = 2256.44 mm

Num = (Bplen / 2 - Y / 3 - e)

= (2400.00 / 2 - 2256.44 / 3 - 449.11)

= -1.26

Denom = (Bplen / 2 - Y / 3 + f)

= (2400.00 / 2 - 2256.44 / 3 + 1100.00)

= 1547.85

Total Bolt Tension Force [Tforce]:

= - QO * Num / Denom

= - 62752.73 * -1.26 / 1547.85

= 51.07 N

Bolt Area Required due to Transverse Load [Bltareart]

= Tforce / (Stba * Nbt)

= 51.07 / (113.34 * 4.00)

= 0.1127 mm²

Required of a Single Bolt [Bltarear]

= max[Bltarearl, Bltarears, Bltareart]

= max[0.0000 , 62.1718 , 0.1127]

= 62.1718 mm²

Baseplate Thickness Calculation per D. Moss:

Bearing Pressure (fc)

= 2 * (QO + Tforce) / (Y * Bplen)

= 2 * (62752.73 + 51.07) / (2256.44 * 2400.00)

= 0.02 MPa

Distance from Baseplate Edge to the Web [ADIST]:

= (Bplen - Weblngth) / 2

= (2400.00 - 2349.20) / 2

= 25.4000 mm

Overturning Moment due To Bolt Tension [Mt]:

= Tforce * Adist

= 51.07 * 25.40

= 1297.73 N-mm

Equivalent Bearing Pressure (f1):

= fc * (Y - Adist) / Y

= 0.02 * (2256.44 - 25.40) / 2256.44

= 0.02 MPa

Overturning Moment due to Bearing Pressure [Mc]:

= (Adist² * Bpwid / 6) * (f1 + 2 * fc)

= (25.40² * 400.00 / 6) * (0.02 + 2 * 0.02)

= 2982.78 N-mm

Baseplate Required Thickness [Treq]:

= (6 * max(Mt,Mc) / (Bpwid * Sba))½

= (6 *max(1297.73 ,2982.78 / (400.00 * 306.26))½

= 0.3822 mm

ASME Horizontal Vessel Analysis: Stresses for the Right Saddle

(per ASME Sec. VIII Div. 2 based on the Zick method.)

Input and Calculated Values:

Vessel Mean Radius	Rm	1508.50	mm
Stiffened Vessel Length per 4.15.6	L	10450.00	mm
Distance from Saddle to Vessel tangent	a	685.00	mm
Saddle Width	b	400.00	mm
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	500.00	mm
Wear Plate Bearing Angle	theta1	127.00	
Wear Plate Thickness	tr	14.0	mm
Wear Plate Allowable Stress	Sr	204.17	MPa
Inside Depth of Head	h2	753.00	mm
Shell Allowable Stress used in Calculation		204.17	MPa
Head Allowable Stress used in Calculation		204.17	MPa
Circumferential Efficiency in Plane of Saddle		1.00	

Circumferential Efficiency at Mid-Span	1.00		
Saddle Force Q, Operating Case	86513.67	N	

Horizontal Vessel Analysis Results:	**Actual**	**Allowable**	
Long. Stress at Top of Midspan	39.19	204.17	MPa
Long. Stress at Bottom of Midspan	43.09	204.17	MPa
Long. Stress at Top of Saddles	41.17	204.17	MPa
Long. Stress at Bottom of Saddles	41.11	204.17	MPa
Tangential Shear in Shell	4.59	163.34	MPa
Tangential Shear in Head	4.59	163.34	MPa
Circ. Stress at Horn of Saddle	4.61	255.22	MPa
Addl. Stress in Head as Stiffener	83.91	255.22	MPa
Circ. Compressive Stress in Shell	1.00	204.17	MPa

Intermediate Results: Saddle Reaction Q due to Wind or Seismic

Saddle Reaction Force due to Wind Ft [Fwt]:

= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E

= 3.00 * (13538.4 /2 + 0) * 2000.0000 / 2612.7986

= 15544.8 N

Saddle Reaction Force due to Wind Fl or Friction [Fwl]:

= Max(Fl, Friction Load, Sum of X Forces) * B / Ls

= Max(4156.52 , 0.00 , 0) * 2000.0000 / 8750.0010

= 950.1 N

Saddle Reaction Force due to Earthquake Fl or Friction [Fsl]:

= Max(Fl, Friction Force, Sum of X Forces) * B / Ls

= Max(28183.05 , 0.00 , 0) * 2000.0000 / 8750.0010

= 6441.8 N

Saddle Reaction Force due to Earthquake Ft [Fst]:

= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E

= 3.00 * (28183 /2 + 0) * 2000.0000 / 2612.7986

= 32359.6 N

Load Combination Results for Q + Wind or Seismic [Q]:

= Saddle Load + Max(Fwl, Fwt, Fsl, Fst)

= 54154 + Max(950 , 15544 , 6441 , 32359)

= 86513.7 N

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	94862.41	N
Transverse Shear Load Saddle	14091.53	N
Longitudinal Shear Load Saddle	28183.05	N

Formulas and Substitutions for Horizontal Vessel Analysis:

Note: Wear Plate is Welded to the Shell, k = 0.1

The Computed K values from Table 4.15.1:

K1 = 0.1066	K2 = 1.1707	K3 = 0.8799	K4 = 0.4011
K5 = 0.7603	K6 = 0.0529	K7 = 0.0132	K8 = 0.3405
K9 = 0.2711	K10 = 0.0581	K1* = 0.1923	K6p = 0.0472
K7P = 0.0118			

The suffix 'p' denotes the values for a wear plate if it exists.

Note: Dimension a is less than Rm/2.

Moment per Equation 4.15.3 [M1]:

= -Q*a [1 - (1- a/L + (R²-h2²)/(2a*L))/(1+(4h2)/3L)]

= -86513*685.00[1-(1-685.00/10450.00+(1508.500²-753.000²)/
(2*685.00*10450.00))/(1+(4*753.00)/(3*10450.00))]

= -2287137.5 N-mm

Moment per Equation 4.15.4 [M2]:

= Q*L/4(1+2(R²-h2²)/(L²))/(1+(4h2)/(3L))-4a/L

= 86513*10450/4(1+2(1508²-753²)/(10450²))/(1+(4*753)/
(3*10450))-4*684/10450

= 153458320.0 N-mm

Longitudinal Stress at Top of Shell (4.15.6) [Sigma1]:

= P * Rm/(2t) - M2/(pi*Rm²t)

= 0.60 * 1508.500 /(2*11.00) - .15346E+09/(pi*1508.5²*11.00)

= 39.19 MPa

Longitudinal Stress at Bottom of Shell (4.15.7) [Sigma2]:

= P * Rm/(2t) + M2/(pi * Rm² * t)

= 0.60 * 1508.500 /(2 * 11.00) + .15346E+09/(pi * 1508.5² * 11.00)

= 43.09 MPa

Longitudinal Stress at Top of Shell at Support (4.15.8) [Sigma3]:

= P * Rm/(2t) - M1/(pi * Rm² * t)

= 0.60 * 1508.500 /(2 * 11.00) - -2287137.5/(pi * 1508.5² * 11.00)

= 41.17 MPa

Longitudinal Stress at bottom of Shell at Support (4.15.9) [Sigma4]:

= P * Rm/(2t) + M1/(pi*Rm²t)

= 0.60 * 1508.500 /(2*11.00) + -2287137.5/(pi*1508.5²*11.00)

= 41.11 MPa

Maximum Shear Force in the Saddle (4.15.5) [T]:

= Q(L-2a)/(L+(4*h2/3))

= 86513 (10450.00 - 2 * 685.00)/(10450.00 + (4 * 753.00 /3))

= 68582.5 N

Shear Stress in the shell no rings, stiffened (4.15.15) [tau3]:

= K3 * Q / (Rm * t)

= 0.8799 * 86513 / (1508.5000 * 11.0000)

= 4.59 MPa

Shear Stress in the head, shell stiffened (4.15.16) [tau3*]:

= K3 * Q / (Rm * th)

= 0.8799 * 86513 / (1508.5000 * 11.0000)

= 4.59 MPa

Membrane stress in the head as a stiffener (4.15.18) [sigma5]:

= K4 * Q/(Rm*th) + ((P*Ri)/(2*th)) * (Ri/h2)

= 0.4011 * 86513 /(1508.50 * 11.000) +

((0.60 * 1503.00)/(2 * 11.000))*(1503.00 / 753.00)

= 83.91 MPa

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(1508.500 * 11.000)

= 100.476 mm

Circumferential Stress in shell, no rings (4.15.23) [sigma6]:

= -K5 * Q * k / (t * (b + X1 + X2))

= -0.7603 * 86513 * 0.1 / (11.000 * (400.00 + 100.48 + 100.48))

= -1.00 MPa

Effective reinforcing plate width (4.15.1) [B1]:

= min(b + 1.56 * sqrt(Rm * t), 2a)

= min(400.00 + 1.56 * sqrt(1508.500 * 11.000), 2 * 685.000)

= 600.95 mm

Wear Plate/Shell Stress ratio (4.15.29) [eta]:

= min(Sr/S, 1)

= min(204.174 / 204.174 , 1)

= 1.0000

Circumferential Stress at wear plate (4.15.26) [sigma6,r]:

= -K5 * Q * k / (B1(t + eta * tr))

= -0.7603 * 86513 * 0.1 / (600.953 (11.000 + 1.000 * 14.000))

= -0.44 MPa

Circ. Comp. Stress at Horn of Saddle, L<8Rm (4.15.28) [sigma7,r*]:

= -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)²)

= -86513 /(4(11.000 + 1.000 * 14.000)600.953) -

12*0.013*86513*1508.500/(10450.00(11.000+1.000*14.000)²)

= -4.61 MPa

Results for Vessel Ribs, Web and Base

Baseplate Length	Bplen	2400.0000	mm
Baseplate Thickness	Bpthk	20.0000	mm
Baseplate Width	Bpwid	400.0000	mm
Number of Ribs (inc. outside ribs)	Nribs	4	
Rib Thickness	Ribtk	20.0000	mm
Web Thickness	Webtk	20.0000	mm
Web Location	Webloc	Center	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	6.	7706.	42385.	310826.
Wearplate	18.	7000.	126000.	2382331.
Web	227.	8060.	1825590.	522580448.
BasePlate	438.	8000.	3504000.	1535017472.
Totals	688.	30766.	5497976.	2060291072.

Value C1 = Sumof(Ay)/Sumof(A) = 179. mm

Value I = Sumof(Io) - C1*Sumof(Ay) = 1077801472. mm**4

Value As = Sumof(A) - Ashell = 23060. mm²

K1 = (1+Cos(beta)-.5*Sin(beta)²)/(pi-beta+Sin(beta)*Cos(beta)) = 0.2035

Fh = K1 * Q = 0.2035 * 86513.672 = 17607.4102 N

Tension Stress, St = (Fh/As) = 0.7636 MPa

Allowed Stress, Sa = 0.6 * Yield Str = 143.9676 MPa

d = B - R*Sin(theta) / theta = 708.0291 mm

Bending Moment, M = Fh * d = 12471613.0000 N-mm

Bending Stress, Sb = (M * C1 / I) = 2.0671 MPa

Allowed Stress, Sa = 2/3 * Yield Str = 159.9640 MPa

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (4 * BasePlateLength *
AllStress))½

= (3 * (86513 + 8348) * 400.00 / (4 * 2400.000 * 159.964))½

= 8.610 mm

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

= (Bplen - Clearance) / (Nribs - 1)

= (2400.0000 - 25.4) / (4 - 1) = 791.5333 mm

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 791.5333 * 400.0000 / 2 = 0.2E+06 mm²

Axial Load [P]:

= Ap * Bp

= 158306.7 * 0.09 = 14266.3 N

Area of the Rib and Web [Ar]:

= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk

= (400.000 - 25.4 - 20.000) * 20.000 + 791.5333 /2 * 20.000

= 15007.332 mm²

Compressive Stress [Sc]:

= P/Ar

= 14266.3 / 15007.3320 = 0.9507 MPa

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	200.0	7346.0	1469200.0	0.0	96825736.0
Web	200.0	7915.3	1583066.5	0.0	527688.2
Values	200.0	15261.3	3052266.5	0.0	97353424.0

Bending Moment [Rm]:

= Fl /(2 * Bplen) * e * rl / 2

= 28183.1 /(2 * 2400.00) * 791.533 * 1194.00 / 2

= 2775661 N-mm

KL/R < Cc (14.8245 < 128.2550) per AISC E2-1

Sca = $(1-(Klr)^2/(2*Cc^2))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)$

Sca = $(1-(14.82)^2/(2 * 128.25^2)) * 239 /$

$(5/3+3*(14.82)/(8* 128.25)-(14.82^3)/(8*128.25^3)$

Sca = 139.40 MPa

AISC Unity Check on Outside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 0.95 / 139.40 + (2775661 /486767.094) / 159.96

Check = 0.04

Check of Inside Ribs

Inertia of Saddle, Inner Ribs - Axial Direction

	Y	A	AY	Ay²	Io
Rib	187.3	7092.0	1328331.4	0.0	87609584.0
Web	187.3	15830.7	2965083.8	0.0	527688.2
Values	187.3	22922.7	4293415.0	0.0	88137272.0

KL/R < Cc (7.6626 < 128.2550) per AISC E2-1

Sca = $(1-(Klr)^2/(2*Cc^2))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)$

Sca = $(1-(7.66)^2/(2 * 128.25^2)) * 239 /$

$(5/3+3*(7.66)/(8* 128.25)-(7.66^3)/(8*128.25^3)$

Sca = 141.81 MPa

AISC Unity Check on Inside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 1.24 / 141.81 + (2209106 /470567.375) / 159.96

Check = 0.04

Input Data for Base Plate Bolting Calculations:

Total Number of Bolts per BasePlate	Nbolts	4	
Total Number of Bolts in Tension/Baseplate	Nbt	4	
Bolt Material Specification		C45E N	
Bolt Allowable Stress	Stba	113.34	MPa
Bolt Corrosion Allowance	Bca	0.0000	mm
Distance from Bolts to Edge	Edgedis	99.9998	mm
Nominal Bolt Diameter	Bnd	30.0000	mm
Thread Series	Series	TEMA Metric	
BasePlate Allowable Stress	S	204.17	MPa
Area Available in a Single Bolt	BltArea	502.9650	mm²
Saddle Load QO (Weight)	QO	62502.8	N
Saddle Load QL (Wind/Seismic contribution)	QL	6441.8	N
Maximum Transverse Force	Ft	14091.5	N
Maximum Longitudinal Force	Fl	28183.1	N
Saddle Bolted to Steel Foundation		No	

Bolt Area Calculation per Dennis R. Moss

Bolt Area Requirement Due to Longitudinal Load [Bltarearl]:

= 0.0 (QO > QL --> No Uplift in Longitudinal direction)

Bolt Area due to Shear Load [Bltarears]:

= Fl / (Stba * Nbolts)

= 28183.05 / (113.34 * 4.00)

= 62.1718 mm²

Bolt Area due to Transverse Load

Moment on Baseplate Due to Transverse Load [Rmom]:

= B * Ft + Sum of X Moments

= 2000.00 * 14091.53 + 0.00

= 28194480.00 N-mm

Eccentricity (e):

= Rmom / QO

= 28194480 / 62502.80

= 450.91 mm > Bplen/6 --> Uplift in Transverse direction

f = Bplen / 2 - Edgedis

= 2400.00 / 2 - 100.00

= 1100.00 mm

Modular Ratio Of Steel/Concrete (n1):

= ES / EC

= 203402.50 / 21526.32

= 9.45

K1 = 3 (e - 0.5 * Bplen)

= 3 (450.91 - 0.5*2400.00)

= -2247.27 mm

K2 = 6 * n1 * At / Bpwid * (f + e)

= 6 * 9.45 * 2011.86 / 400.00 * (1100.00 + 450.91)

= 442243.87 mm ^{2}

K3 = -K2 * (0.5 * Bplen + f)

= -442243.84 * (0.5 * 2400.00 + 1100.00)

= -1017160927.88 mm ^{3}

Iteratively Solving for the Effective Bearing Length:

Y^3 + K1 * Y^2 + K2 * Y + K3 = 0

Y^3 + -2247.27 * Y^2 + 442243.84 * Y + -0.1E+10 = 0

Y = 2251.50 mm

Num = (Bplen / 2 - Y / 3 - e)

= (2400.00 / 2 - 2251.50 / 3 - 450.91)

= -1.41

Denom = (Bplen / 2 - Y / 3 + f)

= (2400.00 / 2 - 2251.50 / 3 + 1100.00) = 1549.50

Total Bolt Tension Force [Tforce]:

= - QO * Num / Denom

= - 62502.80 * -1.41 / 1549.50

= 56.89 N

Bolt Area Required due to Transverse Load [Bltareart]

= Tforce / (Stba * Nbt)

= 56.89 / (113.34 * 4.00)

= 0.1255 mm²

Required of a Single Bolt [Bltarear]

= max[Bltarearl, Bltarears, Bltareart]

= max[0.0000 , 62.1718 , 0.1255]

= 62.1718 mm²

Baseplate Thickness Calculation per D. Moss:

Bearing Pressure (fc)

= 2 * (QO + Tforce) / (Y * Bplen)

= 2 * (62502.80 + 56.89) / (2251.50 * 2400.00)

= 0.02 MPa

Distance from Baseplate Edge to the Web [ADIST]:

= (Bplen - Weblngth) / 2

= (2400.00 - 2349.20) / 2

= 25.4000 mm

Overturning Moment due To Bolt Tension [Mt]:

= Tforce * Adist

= 56.89 * 25.40

= 1445.50 N-mm

Equivalent Bearing Pressure (f1):

= fc * (Y - Adist) / Y

= 0.02 * (2251.50 - 25.40) / 2251.50

= 0.02 MPa

Overturning Moment due to Bearing Pressure [Mc]:

= (Adist² * Bpwid / 6) * (f1 + 2 * fc)

= (25.40² * 400.00 / 6) * (0.02 + 2 * 0.02)

= 2977.68 N-mm

Baseplate Required Thickness [Treq]:

= (6 * max(Mt,Mc) / (Bpwid * Sba))½

= (6 *max(1445.50 ,2977.68 / (400.00 * 306.26))½

= 0.3818 mm

ASME Horizontal Vessel Analysis: Stresses for the Left Saddle

(per ASME Sec. VIII Div. 2 based on the Zick method.)

Horizontal Vessel Stress Calculations : Test Case

Input and Calculated Values:

Vessel Mean Radius	Rm	1507.00	mm
Stiffened Vessel Length per 4.15.6	L	10450.00	mm
Distance from Saddle to Vessel tangent	a	685.00	mm
Saddle Width	b	400.00	mm
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	500.00	mm
Wear Plate Bearing Angle	theta1	127.00	
Wear Plate Thickness	tr	14.0	mm
Wear Plate Allowable Stress	Sr	204.17	MPa
Inside Depth of Head	h2	750.00	mm
Shell Allowable Stress used in Calculation		204.17	MPa
Head Allowable Stress used in Calculation		204.17	MPa
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Test Case, no Ext. Forces		474750.47	N

Horizontal Vessel Analysis Results:	**Actual**	**Allowable**	
Long. Stress at Top of Midspan	73.33	204.17	MPa
Long. Stress at Bottom of Midspan	90.19	204.17	MPa
Long. Stress at Top of Saddles	81.89	204.17	MPa
Long. Stress at Bottom of Saddles	81.64	204.17	MPa
Tangential Shear in Shell	19.80	163.34	MPa
Tangential Shear in Head	19.80	163.34	MPa
Circ. Stress at Horn of Saddle	20.61	255.22	MPa
Addl. Stress in Head as Stiffener	171.79	255.22	MPa
Circ. Compressive Stress in Shell	4.11	204.17	MPa

Intermediate Results: Saddle Reaction Q due to Wind or Seismic

Saddle Reaction Force due to Wind Ft [Fwt]:

```
= Ftr * ( Ft/Num of Saddles + Z Force Load ) * B / E

= 3.00 * ( 4467.7 /2 + 0 ) * 2000.0000 / 2610.2007

= 5134.9 N
```

Saddle Reaction Force due to Wind Fl or Friction [Fwl]:

```
= Max( Fl, Friction Load, Sum of X Forces) * B / Ls

= Max( 4156.52 , 0.00 , 0 ) * 2000.0000 / 8750.0010

= 313.5 N
```

Load Combination Results for Q + Wind or Seismic [Q]:

```
= Saddle Load + Max( Fwl, Fwt, Fsl, Fst )

= 469615 + Max( 313 , 5134 , 0 , 0 )

= 474750.5 N
```

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	483099.19	N
Transverse Shear Load Saddle	2233.84	N
Longitudinal Shear Load Saddle	1371.65	N

Hydrostatic Test Pressure at center of Vessel: 1.519 MPa

Formulas and Substitutions for Horizontal Vessel Analysis:

Note: Wear Plate is Welded to the Shell, k = 0.1

The Computed K values from Table 4.15.1:

K1 = 0.1066	K2 = 1.1707	K3 = 0.8799	K4 = 0.4011
K5 = 0.7603	K6 = 0.0529	K7 = 0.0132	K8 = 0.3405
K9 = 0.2711	K10 = 0.0581	K1* = 0.1923	K6p = 0.0472
K7P = 0.0118			

The suffix 'p' denotes the values for a wear plate if it exists.

Note: Dimension a is less than Rm/2.

Moment per Equation 4.15.3 [M1]:

```
= -Q*a [1 - (1- a/L + (R²-h2²)/(2a*L))/(1+(4h2)/3L)]

= -474750*685.00[1-(1-685.00/10450.00+(1507.000²-750.000²)/
  (2*685.00*10450.00))/(1+(4*750.00)/(3*10450.00))]

= -12441862.0 N-mm
```

Moment per Equation 4.15.4 [M2]:

```
= Q*L/4(1+2(R²-h2²)/(L²))/(1+(4h2)/( 3L))-4a/L
```

= 474750*10450/4(1+2(1507²-750²)/(10450²))/(1+(4*750)/

(3*10450))-4*684/10450

= 842521984.0 N-mm

Longitudinal Stress at Top of Shell (4.15.6) [Sigma1]:

= P * Rm/(2t) - M2/(pi*Rm²t)

= 1.52 * 1507.000 /(2*14.00) - .84252E+09/(pi*1507.0²*14.00)

= 73.33 MPa

Longitudinal Stress at Bottom of Shell (4.15.7) [Sigma2]:

= P * Rm/(2t) + M2/(pi * Rm² * t)

= 1.52 * 1507.000 /(2 * 14.00) + .84252E+09/(pi * 1507.0² * 14.00)

= 90.19 MPa

Longitudinal Stress at Top of Shell at Support (4.15.8) [Sigma3]:

= P * Rm/(2t) - M1/(pi * Rm² * t)

= 1.52 * 1507.000 /(2 * 14.00) - -0.1E+08/(pi * 1507.0² * 14.00)

= 81.89 MPa

Longitudinal Stress at bottom of Shell at Support (4.15.9) [Sigma4]:

= P * Rm/(2t) + M1/(pi*Rm²t)

= 1.52 * 1507.000 /(2*14.00) + -0.1E+08/(pi*1507.0²*14.00)

= 81.64 MPa

Maximum Shear Force in the Saddle (4.15.5) [T]:

= Q(L-2a)/(L+(4*h2/3))

= 474750 (10450.00 - 2 * 685.00)/(10450.00 + (4 * 750.00 /3))

= 376483.3 N

Shear Stress in the shell no rings, stiffened (4.15.15) [tau3]:

= K3 * Q / (Rm * t)

= 0.8799 * 474750 / (1507.0000 * 14.0000)

= 19.80 MPa

Shear Stress in the head, shell stiffened (4.15.16) [tau3*]:

= K3 * Q / (Rm * th)

= 0.8799 * 474750 / (1507.0000 * 14.0000)

= 19.80 MPa

Membrane stress in the head as a stiffener (4.15.18) [sigma5]:

= K4 * Q/(Rm*th) + ((P*Ri)/(2*th)) * (Ri/h2)

= 0.4011 * 474750 /(1507.00 * 14.000) +

((1.52 * 1500.00)/(2 * 14.000))*(1500.00 / 750.00)

= 171.79 MPa

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(1507.000 * 14.000)

= 113.296 mm

Circumferential Stress in shell, no rings (4.15.23) [sigma6]:

= -K5 * Q * k / (t * (b + X1 + X2))

= -0.7603 * 474750 * 0.1 / (14.000 * (400.00 + 113.30 + 113.30))

= -4.11 MPa

Effective reinforcing plate width (4.15.1) [B1]:

= min(b + 1.56 * sqrt(Rm * t), 2a)

= min(400.00 + 1.56 * sqrt(1507.000 * 14.000), 2 * 685.000)

= 626.59 mm

Wear Plate/Shell Stress ratio (4.15.29) [eta]:

= min(Sr/S, 1)

= min(204.174 / 204.174 , 1)

= 1.0000

Circumferential Stress at wear plate (4.15.26) [sigma6,r]:

= -K5 * Q * k / (B1(t + eta * tr))

= -0.7603 * 474750 * 0.1 / (626.592 (14.000 + 1.000 * 14.000))

= -2.06 MPa

Circ. Comp. Stress at Horn of Saddle, L<8Rm (4.15.28) [sigma7,r*]:

= -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)²)

= -474750 /(4(14.000 + 1.000 * 14.000)626.592) -

12*0.013*474750*1507.000/(10450.00(14.000+1.000*14.000)²)

= -20.61 MPa

Results for Vessel Ribs, Web and Base:

Baseplate Length	Bplen	2400.0000	mm
Baseplate Thickness	Bpthk	20.0000	mm
Baseplate Width	Bpwid	400.0000	mm

Number of Ribs (inc. outside ribs)	Nribs	4	
Rib Thickness	Ribtk	20.0000	mm
Web Thickness	Webtk	20.0000	mm
Web Location	Webloc	Center	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	7.	10165.	71154.	664107.
Wearplate	21.	7000.	147000.	3201331.
Web	228.	8000.	1824000.	522538176.
BasePlate	438.	8000.	3504000.	1535017088.
Totals	694.	33165.	5546154.	2061420672.

Value C1 = Sumof(Ay)/Sumof(A) = 167. mm

Value I = Sumof(Io) - C1*Sumof(Ay) = 1133940736. mm**4

Value As = Sumof(A) - Ashell = 23000. mm²

K1 = (1+Cos(beta)-.5*Sin(beta)²)/(pi-beta+Sin(beta)*Cos(beta)) = 0.2035

Fh = K1 * Q = 0.2035 * 474750.469 = 96622.0234 N

Tension Stress, St = (Fh/As) = 4.2013 MPa

Allowed Stress, Sa = 0.6 * Yield Str = 143.9676 MPa

d = B - R*Sin(theta) / theta = 707.5100 mm

Bending Moment, M = Fh * d = 68388768.0000 N-mm

Bending Stress, Sb = (M * C1 / I) = 10.0825 MPa

Allowed Stress, Sa = 2/3 * Yield Str = 159.9640 MPa

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (4 * BasePlateLength *
AllStress))½

= (3 * (474750 + 8348) * 400.00 / (4 * 2400.000 * 159.964))½

= 19.430 mm

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

= (Bplen - Clearance) / (Nribs - 1)

= (2400.0000 - 25.4) / (4 - 1) = 791.5333 mm

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 791.5333 * 400.0000 / 2 = 0.2E+06 mm²

Axial Load [P]:

= Ap * Bp

= 158306.7 * 0.49 = 78287.7 N

Area of the Rib and Web [Ar]:

= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk

= (400.000 - 25.4 - 20.000) * 20.000 + 791.5333 /2 * 20.000

= 15007.332 mm²

Compressive Stress [Sc]:

= P/Ar

= 78287.7 / 15007.3320 = 5.2171 MPa

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	200.0	7346.0	1469200.0	0.0	96825736.0
Web	200.0	7915.3	1583066.5	0.0	527688.2
Values	200.0	15261.3	3052266.5	0.0	97353424.0

Bending Moment [Rm]:

= Fl /(2 * Bplen) * e * rl / 2

= 1371.7 /(2 * 2400.00) * 791.533 * 1191.00 / 2

= 134750.391 N-mm

KL/R < Cc (14.7873 < 128.2550) per AISC E2-1

Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)

Sca = (1-(14.79)²/(2 * 128.25²)) * 239 /

(5/3+3*(14.79)/(8* 128.25)-(14.79³)/(8*128.25³)

Sca = 139.41 MPa

AISC Unity Check on Outside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 5.22 / 139.41 + (134750.39 /486767.094) / 159.96

Check = 0.04

Check of Inside Ribs

Inertia of Saddle, Inner Ribs - Axial Direction

	Y	A	AY	Ay²	Io
Rib	187.3	7092.0	1328331.4	0.0	87609584.0
Web	187.3	15830.7	2965083.8	0.0	527688.2
Values	187.3	22922.7	4293415.0	0.0	88137272.0

KL/R < Cc (7.6142 < 128.2550) per AISC E2-1

Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)

Sca = (1-(7.61)²/(2 * 128.25²)) * 239 /

(5/3+3*(7.61)/(8* 128.25)-(7.61³)/(8*128.25³)

Sca = 141.82 MPa

AISC Unity Check on Inside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 6.83 / 141.82 + (106837.11 /470567.375) / 159.96

Check = 0.05

Input Data for Base Plate Bolting Calculations:

Total Number of Bolts per BasePlate	Nbolts	4	
Total Number of Bolts in Tension/Baseplate	Nbt	4	
Bolt Material Specification		C45E N	
Bolt Allowable Stress	Stba	113.34	MPa
Bolt Corrosion Allowance	Bca	0.0000	mm
Distance from Bolts to Edge	Edgedis	99.9998	mm
Nominal Bolt Diameter	Bnd	30.0000	mm
Thread Series	Series	TEMA Metric	
BasePlate Allowable Stress	S	204.17	MPa
Area Available in a Single Bolt	BltArea	502.9650	mm²
Saddle Load QO (Weight)	QO	477964.3	N
Saddle Load QL (Wind/Seismic contribution)	QL	313.5	N
Maximum Transverse Force	Ft	2233.8	N
Maximum Longitudinal Force	Fl	1371.7	N
Saddle Bolted to Steel Foundation		No	

Bolt Area Calculation per Dennis R. Moss

Bolt Area Requirement Due to Longitudinal Load [Bltarearl]:

= 0.0 (QO > QL --> No Uplift in Longitudinal direction)

Bolt Area due to Shear Load [Bltarears]:

= Fl / (Stba * Nbolts)

= 1371.65 / (113.34 * 4.00)

= 3.0259 mm²

Bolt Area due to Transverse Load

Moment on Baseplate Due to Transverse Load [Rmom]:

= B * Ft + Sum of X Moments

= 2000.00 * 2233.84 + 0.00

= 4469496.00 N-mm

Eccentricity (e):

= Rmom / QO

= 4469496 / 477964.31

= 9.35 mm < Bplen/6 --> No Uplift in Transverse direction

Bolt Area due to Transverse Load [Bltareart]:

= 0 (No Uplift)

Required of a Single Bolt [Bltarear]

= max[Bltarearl, Bltarears, Bltareart]

= max[0.0000 , 3.0259 , 0.0000]

= 3.0259 mm²

ASME Horizontal Vessel Analysis: Stresses for the Right Saddle

(per ASME Sec. VIII Div. 2 based on the Zick method.)

Input and Calculated Values:

Vessel Mean Radius	Rm	1507.00	mm
Stiffened Vessel Length per 4.15.6	L	10450.00	mm
Distance from Saddle to Vessel tangent	a	685.00	mm
Saddle Width	b	400.00	mm
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	500.00	mm
Wear Plate Bearing Angle	theta1	127.00	
Wear Plate Thickness	tr	14.0	mm

Wear Plate Allowable Stress	Sr	204.17	MPa
Inside Depth of Head	h2	750.00	mm
Shell Allowable Stress used in Calculation		204.17	MPa
Head Allowable Stress used in Calculation		204.17	MPa
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Test Case, no Ext. Forces		465130.22	N

Horizontal Vessel Analysis Results:	**Actual**	**Allowable**	
Long. Stress at Top of Midspan	73.50	204.17	MPa
Long. Stress at Bottom of Midspan	90.02	204.17	MPa
Long. Stress at Top of Saddles	81.88	204.17	MPa
Long. Stress at Bottom of Saddles	81.64	204.17	MPa
Tangential Shear in Shell	19.40	163.34	MPa
Tangential Shear in Head	19.40	163.34	MPa
Circ. Stress at Horn of Saddle	20.20	255.22	MPa
Addl. Stress in Head as Stiffener	171.61	255.22	MPa
Circ. Compressive Stress in Shell	4.03	204.17	MPa

Intermediate Results: Saddle Reaction Q due to Wind or Seismic

Saddle Reaction Force due to Wind Ft [Fwt]:

= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E

= 3.00 * (4467.7 /2 + 0) * 2000.0000 / 2610.2007

= 5134.9 N

Saddle Reaction Force due to Wind Fl or Friction [Fwl]:

= Max(Fl, Friction Load, Sum of X Forces) * B / Ls

= Max(4156.52 , 0.00 , 0) * 2000.0000 / 8750.0010

= 313.5 N

Load Combination Results for Q + Wind or Seismic [Q]:

= Saddle Load + Max(Fwl, Fwt, Fsl, Fst)

= 459995 + Max(313 , 5134 , 0 , 0)

= 465130.2 N

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	473478.94	N
Transverse Shear Load Saddle	2233.84	N
Longitudinal Shear Load Saddle	1371.65	N

Hydrostatic Test Pressure at center of Vessel: 1.519 MPa

Formulas and Substitutions for Horizontal Vessel Analysis:

Note: Wear Plate is Welded to the Shell, k = 0.1

The Computed K values from Table 4.15.1:

K1 = 0.1066 K2 = 1.1707 K3 = 0.8799 K4 = 0.4011

K5 = 0.7603 K6 = 0.0529 K7 = 0.0132 K8 = 0.3405

K9 = 0.2711 K10 = 0.0581 K1* = 0.1923 K6p = 0.0472

K7P = 0.0118

The suffix 'p' denotes the values for a wear plate if it exists.

Note: Dimension a is less than Rm/2.

Moment per Equation 4.15.3 [M1]:

$= -Q*a\ [1 - (1- a/L + (R^2-h2^2)/(2a*L))/(1+(4h2)/3L)]$

$= -465130*685.00[1-(1-685.00/10450.00+(1507.000^2-750.000^2)/$

$(2*685.00*10450.00))/(1+(4*750.00)/(3*10450.00))]$

$= -12189741.0$ N-mm

Moment per Equation 4.15.4 [M2]:

$= Q*L/4(1+2(R^2-h2^2)/(L^2))/(1+(4h2)/(3L))-4a/L$

$= 465130*10450/4(1+2(1507^2-750^2)/(10450^2))/(1+(4*750)/$

$(3*10450))-4*684/10450$

$= 825449280.0$ N-mm

Longitudinal Stress at Top of Shell (4.15.6) [Sigma1]:

$= P * Rm/(2t) - M2/(pi*Rm^2t)$

$= 1.52 * 1507.000 /(2*14.00) - .82545E+09/(pi*1507.0^2*14.00)$

$= 73.50$ MPa

Longitudinal Stress at Bottom of Shell (4.15.7) [Sigma2]:

$= P * Rm/(2t) + M2/(pi * Rm^2 * t)$

$= 1.52 * 1507.000 /(2 * 14.00) + .82545E+09/(pi * 1507.0^2 * 14.00)$

$= 90.02$ MPa

Longitudinal Stress at Top of Shell at Support (4.15.8) [Sigma3]:

= P * Rm/(2t) - M1/(pi * Rm² * t)

= 1.52 * 1507.000 /(2 * 14.00) - -0.1E+08/(pi * 1507.0² * 14.00)

= 81.88 MPa

Longitudinal Stress at bottom of Shell at Support (4.15.9) [Sigma4]:

= P * Rm/(2t) + M1/(pi*Rm²t)

= 1.52 * 1507.000 /(2*14.00) + -0.1E+08/(pi*1507.0²*14.00)

= 81.64 MPa

Maximum Shear Force in the Saddle (4.15.5) [T]:

= Q(L-2a)/(L+(4*h2/3))

= 465130 (10450.00 - 2 * 685.00)/(10450.00 + (4 * 750.00 /3))

= 368854.3 N

Shear Stress in the shell no rings, stiffened (4.15.15) [tau3]:

= K3 * Q / (Rm * t)

= 0.8799 * 465130 / (1507.0000 * 14.0000)

= 19.40 MPa

Shear Stress in the head, shell stiffened (4.15.16) [tau3*]:

= K3 * Q / (Rm * th)

= 0.8799 * 465130 / (1507.0000 * 14.0000)

= 19.40 MPa

Membrane stress in the head as a stiffener (4.15.18) [sigma5]:

= K4 * Q/(Rm*th) + ((P*Ri)/(2*th)) * (Ri/h2)

= 0.4011 * 465130 /(1507.00 * 14.000) +

((1.52 * 1500.00)/(2 * 14.000))*(1500.00 / 750.00)

= 171.61 MPa

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(1507.000 * 14.000)

= 113.296 mm

Circumferential Stress in shell, no rings (4.15.23) [sigma6]:

= -K5 * Q * k / (t * (b + X1 + X2))

= -0.7603 * 465130 * 0.1 / (14.000 * (400.00 + 113.30 + 113.30))

= -4.03 MPa

Effective reinforcing plate width (4.15.1) [B1]:

= min(b + 1.56 * sqrt(Rm * t), 2a)

= min(400.00 + 1.56 * sqrt(1507.000 * 14.000), 2 * 685.000)

= 626.59 mm

Wear Plate/Shell Stress ratio (4.15.29) [eta]:

= min(Sr/S, 1)

= min(204.174 / 204.174 , 1)

= 1.0000

Circumferential Stress at wear plate (4.15.26) [sigma6,r]:

= -K5 * Q * k / (B1(t + eta * tr))

= -0.7603 * 465130 * 0.1 / (626.592 (14.000 + 1.000 * 14.000))

= -2.02 MPa

Circ. Comp. Stress at Horn of Saddle, L<8Rm (4.15.28) [sigma7,r*]:

= -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)²)

= -465130 /(4(14.000 + 1.000 * 14.000)626.592) -

12*0.013*465130*1507.000/(10450.00(14.000+1.000*14.000)²)

= -20.20 MPa

Results for Vessel Ribs, Web and Base

Baseplate Length	Bplen	2400.0000	mm
Baseplate Thickness	Bpthk	20.0000	mm
Baseplate Width	Bpwid	400.0000	mm
Number of Ribs (inc. outside ribs)	Nribs	4	
Rib Thickness	Ribtk	20.0000	mm
Web Thickness	Webtk	20.0000	mm
Web Location	Webloc	Center	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	7.	10165.	71154.	664107.
Wearplate	21.	7000.	147000.	3201331.
Web	228.	8000.	1824000.	522538176.
BasePlate	438.	8000.	3504000.	1535017088.
Totals	694.	33165.	5546154.	2061420672.

Value C1 = Sumof(Ay)/Sumof(A) = 167. mm

Value I = Sumof(Io) - C1*Sumof(Ay) = 1133940736. mm**4

Value As = Sumof(A) - Ashell = 23000. mm²

K1 = (1+Cos(beta)-.5*Sin(beta)²)/(pi-beta+Sin(beta)*Cos(beta)) = 0.2035

Fh = K1 * Q = 0.2035 * 465130.219 = 94664.1016 N

Tension Stress, St = (Fh/As) = 4.1162 MPa

Allowed Stress, Sa = 0.6 * Yield Str = 143.9676 MPa

d = B - R*Sin(theta) / theta = 707.5100 mm

Bending Moment, M = Fh * d = 67002952.0000 N-mm

Bending Stress, Sb = (M * C1 / I) = 9.8782 MPa

Allowed Stress, Sa = 2/3 * Yield Str = 159.9640 MPa

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (4 * BasePlateLength * AllStress))½

= (3 * (465130 + 8348) * 400.00 / (4 * 2400.000 * 159.964))½

= 19.236 mm

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

= (Bplen - Clearance) / (Nribs - 1)

= (2400.0000 - 25.4) / (4 - 1) = 791.5333 mm

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 791.5333 * 400.0000 / 2 = 0.2E+06 mm²

Axial Load [P]:

= Ap * Bp

= 158306.7 * 0.48 = 76701.3 N

Area of the Rib and Web [Ar]:

= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk

= (400.000 - 25.4 - 20.000) * 20.000 + 791.5333 /2 * 20.000

= 15007.332 mm²

Compressive Stress [Sc]:

= P/Ar = 76701.3 / 15007.3320 = 5.1114 MPa

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	200.0	7346.0	1469200.0	0.0	96825736.0
Web	200.0	7915.3	1583066.5	0.0	527688.2
Values	200.0	15261.3	3052266.5	0.0	97353424.0

Bending Moment [Rm]:

= Fl /(2 * Bplen) * e * rl / 2

= 1371.7 /(2 * 2400.00) * 791.533 * 1191.00 / 2

= 134750.391 N-mm

KL/R < Cc (14.7873 < 128.2550) per AISC E2-1

Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)

Sca = (1-(14.79)²/(2 * 128.25²)) * 239 /

(5/3+3*(14.79)/(8* 128.25)-(14.79³)/(8*128.25³)

Sca = 139.41 MPa

AISC Unity Check on Outside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 5.11 / 139.41 + (134750.39 /486767.094) / 159.96

Check = 0.04

Check of Inside Ribs

Inertia of Saddle, Inner Ribs - Axial Direction

	Y	A	AY	Ay²	Io
Rib	187.3	7092.0	1328331.4	0.0	87609584.0
Web	187.3	15830.7	2965083.8	0.0	527688.2
Values	187.3	22922.7	4293415.0	0.0	88137272.0

KL/R < Cc (7.6142 < 128.2550) per AISC E2-1

Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)

Sca = (1-(7.61)²/(2 * 128.25²)) * 239 /

(5/3+3*(7.61)/(8* 128.25)-(7.61³)/(8*128.25³)

Sca = 141.82 MPa

AISC Unity Check on Inside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 6.69 / 141.82 + (106837.11 /470567.375) / 159.96

Check = 0.05

Input Data for Base Plate Bolting Calculations:

Total Number of Bolts per BasePlate	Nbolts	4	
Total Number of Bolts in Tension/Baseplate	Nbt	4	
Bolt Material Specification		C45E N	
Bolt Allowable Stress	Stba	113.34	MPa
Bolt Corrosion Allowance	Bca	0.0000	mm
Distance from Bolts to Edge	Edgedis	99.9998	mm
Nominal Bolt Diameter	Bnd	30.0000	mm
Thread Series	Series	TEMA Metric	
BasePlate Allowable Stress	S	204.17	MPa
Area Available in a Single Bolt	BltArea	502.9650	mm²
Saddle Load QO (Weight)	QO	468344.1	N
Saddle Load QL (Wind/Seismic contribution)	QL	313.5	N
Maximum Transverse Force	Ft	2233.8	N
Maximum Longitudinal Force	Fl	1371.7	N
Saddle Bolted to Steel Foundation		No	

Bolt Area Calculation per Dennis R. Moss

Bolt Area Requirement Due to Longitudinal Load [Bltarearl]:

= 0.0 (QO > QL --> No Uplift in Longitudinal direction)

Bolt Area due to Shear Load [Bltarears]:

= Fl / (Stba * Nbolts)

= 1371.65 / (113.34 * 4.00)

= 3.0259 mm²

Bolt Area due to Transverse Load

Moment on Baseplate Due to Transverse Load [Rmom]:

= B * Ft + Sum of X Moments

= 2000.00 * 2233.84 + 0.00

= 4469496.00 N-mm

Eccentricity (e):

= Rmom / QO

= 4469496 / 468344.06

= 9.54 mm < Bplen/6 --> No Uplift in Transverse direction

Bolt Area due to Transverse Load [Bltareart]:

= 0 (No Uplift)

Required of a Single Bolt [Bltarear]

= max[Bltarearl, Bltarears, Bltareart]

= max[0.0000 , 3.0259 , 0.0000]

= 3.0259 mm²

INPUT VALUES, Nozzle Description: GV1a From : 10

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	0.0000	mm

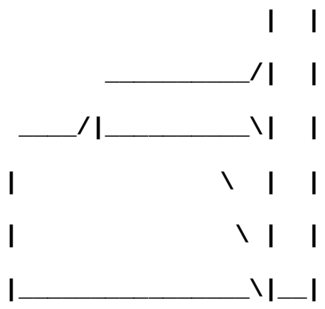
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		508.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P355NH	
Flange Type		Slip on	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	250.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	800.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		146.0000	mm
Class of attached Flange		10	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: GV1a

Actual Outside Diameter Used in Calculation		508.000	mm.
Actual Thickness Used in Calculation		10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 494.000 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.727 mm

EN13445 Section 9 - Pressure Area Design Method:

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((508.0000 - 7.0000)*7.0000 , 250.0000)

= 59.2199 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 59.220) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(0.000 /2710.900)-asin((0.000 -0.5*508.000)/2710.900)

= 0.0938 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.094 * 2710.900 = 254.3731 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(0.000)/2710.900) = 0.0000 radians

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +254.373)/(0.5*11.000 +2705.400) +

254.373 *(11.000 +14.000) = 679.4279 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(250.000 , 59.220)*494.000 *0.5

= 14627.3213 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 59.220 * 7.000 + 0.000 * 0.000

= 414.5395 mm²

Afp = Ip * eap = 146.000 * 14.000 = 2044.0001 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(2044.000 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(414.539 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 1088.7728 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb)

= 0.600 * (679427 + 14627.321) = 416.3977 X 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 11.9243 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 275.9242 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R1 From : 10

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	1100.0000	mm

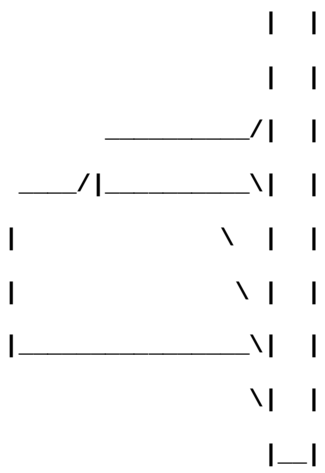
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		219.1000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	280.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	490.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		45.4500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, with Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R1

Actual Outside Diameter Used in Calculation	219.100	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 205.100 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.302 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((219.1000 - 7.0000)*7.0000 , 280.0000)

= 38.5318 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(490.000 , 0.50 * 38.532) = 19.2659 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(1100.000 /2710.900)-asin((1100.000 -0.5*219.100)/2710.900)

= 0.0438 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.044 * 2710.900 = 118.7445 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(1100.000)/2710.900) = 0.4178 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*205.100²*Tan(0.418) = 9337.8291 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +118.745)/(0.5*11.000 +2705.400) +

118.745 *(11.000 +14.000) = 492.9446 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(280.000 , 38.532)*205.100 *0.5

= 3951.4365 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 38.532 * 7.000 + 19.266 * 0.000

= 346.7862 mm²

Afp = Ip * eap = 45.450 * 14.000 = 636.3000 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(636.300 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(346.786 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 787.9920 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (492944.594 + 3951.437 + 0.5*0.000) = 300.9134 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 51.5879 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 836.8975 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R3 From : 10

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	1200.0000	mm

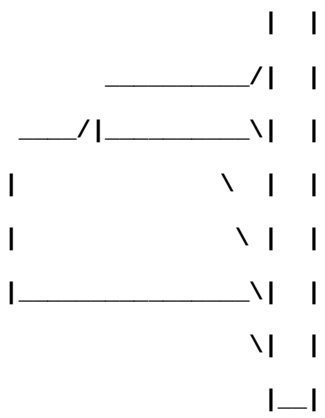
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		114.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	250.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	100.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		97.8500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, with Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R3

Actual Outside Diameter Used in Calculation	114.300	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 100.300 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.148 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((114.3000 - 7.0000)*7.0000 , 250.0000)

= 27.4062 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(100.000 , 0.50 * 27.406) = 13.7031 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(1200.000 /2710.900)-asin((1200.000 -0.5*114.300)/2710.900)

= 0.0234 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.023 * 2710.900 = 63.3744 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(1200.000)/2710.900) = 0.4586 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*100.300²*Tan(0.459) = 2483.1152 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +63.374)/(0.5*11.000 +2705.400) +

63.374 *(11.000 +14.000) = 416.8131 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(250.000 , 27.406)*100.300 *0.5

= 1374.4211 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 27.406 * 7.000 + 13.703 * 0.000

= 246.6558 mm²

Afp = Ip * eap = 97.850 * 14.000 = 1369.9000 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(1369.900 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(246.656 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 917.1290 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (416813.156 + 1374.421 + 0.5*0.000) = 251.6361 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 29.0538 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 394.6566 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: GV2a From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		550.0000	mm

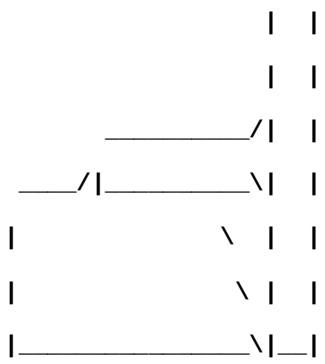
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		508.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P355NH	
Flange Type		Slip on	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	250.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	800.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	6.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	10.0000	mm
Reinforcing Pad Width		146.0000	mm
Class of attached Flange		10	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: GV2a

Actual Outside Diameter Used in Calculation	508.000	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 494.000 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.727 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((508.000 -2*0.000 -7.000)*7.000),250.000)

= 59.2199 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*59.220)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +247.000)*(2*1503.000 +(182.173 +247.000)*tan(0.00))

= 645047 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 146.000 * 14.000

= 2044.0001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 494.000² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 508.000 /2)*1503.000 + 20.000 /2*(11.000 +14.000)

= 661.9180 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 59.220 * 494.000 / 2

= 14.6273 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (800.000 -2.0*0.000 -508.000 /Cos(0.000), 0.0)/2.0, 182.173

= 146.0000 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=59.220 *7.000 +0.000 *(7.000 -3.000 +0.000

= 414.5395 mm²

Afp = Ip * eap = 4.174 * 14.000 = 2044.0001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 6.0000² + 0.0000²) / 2 = 116.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(204.174 , 204.174 ) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174 ) = 204.174 MPa
```

Force requirement per paragraph 9.5.2.1.1 [Fa]:

```
= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 116.000 ) * (204.174 - 0.5 * 0.600 ) +

  (2044.000 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

  (414.539 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

= 933.3454 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
= P * ( Aps + Apb + 0.5 * APpsi )

= 0.600 * ( 661918 + 14627.321 + 0.5*0.000 )

= 405.8927 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 21.6618 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 285.6618 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: GV2b From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		7999.9995	mm

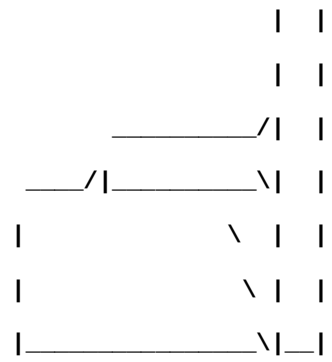
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		508.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P355NH	
Flange Type		Slip on	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	250.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	800.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	6.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	10.0000	mm
Reinforcing Pad Width		146.0000	mm
Class of attached Flange		10	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: GV2b

Actual Outside Diameter Used in Calculation		508.000	mm.
Actual Thickness Used in Calculation		10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 494.000 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.727 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((508.000 -2*0.000 -7.000)*7.000),250.000)

= 59.2199 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*59.220)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +247.000)*(2*1503.000 +(182.173 +247.000)*tan(0.00))

= 645047 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 146.000 * 14.000

= 2044.0001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 494.000² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 508.000 /2)*1503.000 + 20.000 /2*(11.000 +14.000)

= 661.9180 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 59.220 * 494.000 / 2

= 14.6273 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (800.000 -2.0*0.000 -508.000 /Cos(0.000), 0.0)/2.0, 182.173

= 146.0000 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=59.220 *7.000 +0.000 *(7.000 -3.000 +0.000

= 414.5395 mm²

Afp = Ip * eap = 4.174 * 14.000 = 2044.0001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 6.0000² + 0.0000²) / 2 = 116.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 116.000) * (204.174 - 0.5 * 0.600) +

(2044.000 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(414.539 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 933.3454 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (661918 + 14627.321 + 0.5*0.000)

= 405.8927 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 21.6618 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 285.6618 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: M1 From : 20

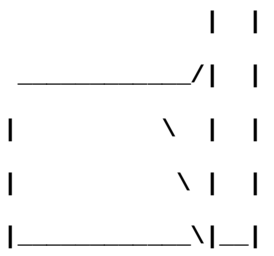
Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		3910.0002	mm

Type of Element Connected to the Shell : Nozzle

Nozzle Material		P285QH	
Allowable Stress at Temperature	Sn	162.51	MPa
Allowable Stress At Ambient	Sna	162.51	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		51.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.5000	mm
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	66.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: M1

Actual Outside Diameter Used in Calculation	51.000	mm.
Actual Thickness Used in Calculation	12.500	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 32.000 / (2 * 162.506 * 0.000 - 0.600) + 3.000

= -29.000 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((51.000 -2*0.000 -9.500)*9.500),66.000)

= 19.8557 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*19.856)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +16.000)*(2*1503.000 +(182.173 +16.000)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000 = 0.0000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 32.000² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 51.000 /2)*1503.000 + 2.008 /2*(11.000 +0.000)

= 312.4130 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 19.856 * 32.000 / 2

= 317.6917 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (0.000 -2.0*0.000 -51.000 /Cos(0.000), 0.0)/2.0, 182.173)

= 0.0000 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 9.500)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=19.856 *9.500 +0.000 *(9.500 -3.000 +0.000

= 188.6294 mm²

Afp = Ip * eap = 0.270 * 0.000 = 0.0000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 0.0000² + 0.0000²) / 2 = 98.0000 mm²

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 162.506) = 162.506 MPa

fop = Min(fs, fp) = Min(204.174 , 0.000) = 0.000 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 98.000) * (204.174 - 0.5 * 0.600) +

(0.000 * (Min(204.174 , 0.000) - 0.50 * 0.600) +

(188.629 * (Min(204.174 , 162.506) - 0.50 * 0.600)

= 459.0808 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (312413.000 + 317.692 + 0.5*0.000)

= 187.6225 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.2168 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 80.2168 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R8 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		6990.0000	mm

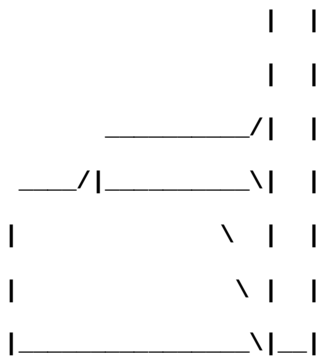
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		168.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	145.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		70.8500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R8

Actual Outside Diameter Used in Calculation	168.300	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 154.300 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -151.300 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((168.300 -2*0.000 -7.000)*7.000),145.000)

= 33.6021 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*33.602) = 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +77.150)*(2*1503.000 +(182.173 +77.150)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 70.850 * 14.000

= 991.9000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 154.300² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 168.300 /2)*1503.000 + 6.626 /2*(11.000 +14.000)

= 402.3872 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 33.602 * 154.300 / 2

= 2.5924 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (310.000 -2.0*0.000 -168.300 /Cos(0.000), 0.0)/2.0, 182.173

= 70.8500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=33.602 *7.000 +0.000 *(7.000 -3.000 +0.000

= 235.2146 mm²

Afp = Ip * eap = 1.304 * 14.000 = 991.9000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(991.900 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(235.215 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 698.6199 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (402387.219 + 2592.401 + 0.5*0.000)

= 242.9671 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 2.3623 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 161.3623 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R2 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		9270.0000	mm

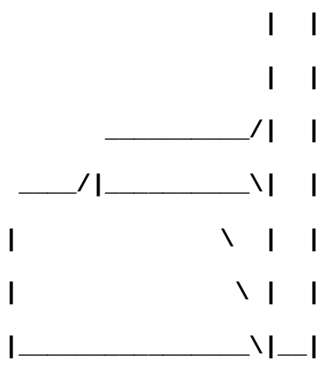
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		168.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	145.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		70.8500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R2

Actual Outside Diameter Used in Calculation	168.300	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 154.300 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -151.300 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((168.300 -2*0.000 -7.000)*7.000),145.000)

= 33.6021 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*33.602)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +77.150)*(2*1503.000 +(182.173 +77.150)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 70.850 * 14.000

= 991.9000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 154.300² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 168.300 /2)*1503.000 + 6.626 /2*(11.000 +14.000)

= 402.3872 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 33.602 * 154.300 / 2

= 2.5924 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (310.000 -2.0*0.000 -168.300 /Cos(0.000), 0.0)/2.0, 182.173

= 70.8500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=33.602 *7.000 +0.000 *(7.000 -3.000 +0.000

= 235.2146 mm²

Afp = Ip * eap = 1.304 * 14.000 = 991.9000 mm²

Afw = (wshell² + wpad² + winside²) / 2 = (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(204.174 , 204.174 ) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174 ) = 204.174 MPa
```

Force requirement per paragraph 9.5.2.1.1 [Fa]:

```
= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000 ) * (204.174 - 0.5 * 0.600 ) +

  (991.900 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

  (235.215 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

= 698.6199 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
= P * ( Aps + Apb + 0.5 * APpsi )

= 0.600 * ( 402387.219 + 2592.401 + 0.5*0.000 )

= 242.9671 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 2.3623 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 161.3623 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R6 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		10000.0010	mm

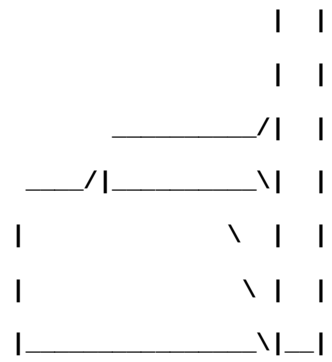
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		219.1000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	145.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	400.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		90.4500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R6

Actual Outside Diameter Used in Calculation	219.100	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 205.100 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -202.100 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((219.100 -2*0.000 -7.000)*7.000),145.000)

= 38.5318 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*38.532)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +102.550)*(2*1503.000 +(182.173 +102.550)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 90.450 * 14.000

= 1266.3000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 205.100² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 219.100 /2)*1503.000 + 8.626 /2*(11.000 +14.000)

= 441.1984 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 38.532 * 205.100 / 2

= 3.9514 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (400.000 -2.0*0.000 -219.100 /Cos(0.000), 0.0)/2.0, 182.173

= 90.4500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=38.532 *7.000 +0.000 *(7.000 -3.000 +0.000

= 269.7226 mm²

Afp = Ip * eap = 1.733 * 14.000 = 1266.3000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(1266.300 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(269.723 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 761.5928 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (441198.406 + 3951.437 + 0.5*0.000)

= 267.0672 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 4.0058 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 163.0058 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R7c From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		300.0000	mm

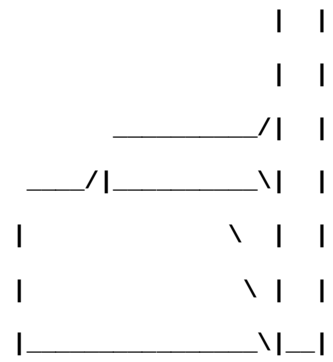
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		168.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	100.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		70.8500	mm
Class of attached Flange		40	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R7c

Actual Outside Diameter Used in Calculation	168.300	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 154.300 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -151.300 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((168.300 -2*0.000 -7.000)*7.000),100.000)

= 33.6021 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*33.602)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +77.150)*(2*1503.000 +(182.173 +77.150)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 70.850 * 14.000

= 991.9000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 154.300² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 168.300 /2)*1503.000 + 6.626 /2*(11.000 +14.000)

= 402.3872 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 33.602 * 154.300 / 2

= 2.5924 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (310.000 -2.0*0.000 -168.300 /Cos(0.000), 0.0)/2.0, 182.173

= 70.8500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=33.602 *7.000 +0.000 *(7.000 -3.000 +0.000

= 235.2146 mm²

Afp = Ip * eap = 1.304 * 14.000 = 991.9000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(991.900 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(235.215 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 698.6199 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (402387.219 + 2592.401 + 0.5*0.000)

= 242.9671 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 2.3623 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 116.3623 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R7b From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		2750.0000	mm

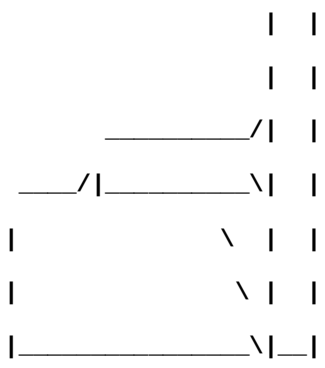
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		168.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	100.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		70.8500	mm
Class of attached Flange		40	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R7b

Actual Outside Diameter Used in Calculation		168.300	mm.
Actual Thickness Used in Calculation		10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 154.300 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -151.300 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((168.300 -2*0.000 -7.000)*7.000),100.000) = 33.6021 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*33.602)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +77.150)*(2*1503.000 +(182.173 +77.150)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 70.850 * 14.000

= 991.9000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 154.300² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 168.300 /2)*1503.000 + 6.626 /2*(11.000 +14.000)

= 402.3872 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 33.602 * 154.300 / 2

= 2.5924 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (310.000 -2.0*0.000 -168.300 /Cos(0.000), 0.0)/2.0, 182.173

= 70.8500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=33.602 *7.000 +0.000 *(7.000 -3.000 +0.000

= 235.2146 mm²

Afp = Ip * eap = 1.304 * 14.000 = 991.9000 mm²

Afw = (wshell² + wpad² + winside²) / 2 = (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(204.174 , 204.174 ) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174 ) = 204.174 MPa
```

Force requirement per paragraph 9.5.2.1.1 [Fa]:

```
= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000 ) * (204.174 - 0.5 * 0.600 ) +

  (991.900 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

  (235.215 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

= 698.6199 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
= P * ( Aps + Apb + 0.5 * APpsi )

= 0.600 * ( 402387.219 + 2592.401 + 0.5*0.000 )

= 242.9671 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 2.3623 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 116.3623 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R7a From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		7700.0000	mm

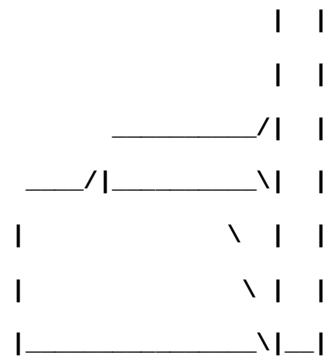
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		168.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	100.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		70.8500	mm
Class of attached Flange		40	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R7a

Actual Outside Diameter Used in Calculation	168.300	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 154.300 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -151.300 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((168.300 -2*0.000 -7.000)*7.000),100.000)

= 33.6021 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*33.602)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +77.150)*(2*1503.000 +(182.173 +77.150)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 70.850 * 14.000

= 991.9000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 154.300² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 168.300 /2)*1503.000 + 6.626 /2*(11.000 +14.000)

= 402.3872 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 33.602 * 154.300 / 2

= 2.5924 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (310.000 -2.0*0.000 -168.300 /Cos(0.000), 0.0)/2.0, 182.173

= 70.8500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=33.602 *7.000 +0.000 *(7.000 -3.000 +0.000

= 235.2146 mm²

Afp = Ip * eap = 1.304 * 14.000 = 991.9000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(991.900 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(235.215 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 698.6199 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (402387.219 + 2592.401 + 0.5*0.000)

= 242.9671 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 2.3623 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 116.3623 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R5 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		8960.0000	mm

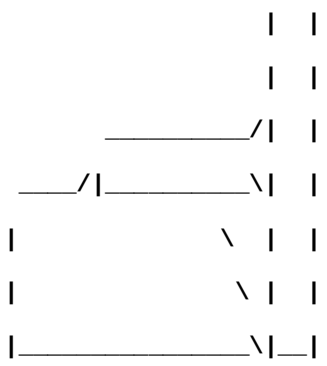
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		219.1000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	140.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	400.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		90.4500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R5

Actual Outside Diameter Used in Calculation	219.100	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 205.100 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -202.100 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((219.100 -2*0.000 -7.000)*7.000),140.000)

= 38.5318 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*38.532) = 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +102.550)*(2*1503.000 +(182.173 +102.550)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 90.450 * 14.000

= 1266.3000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 205.100² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 219.100 /2)*1503.000 + 8.626 /2*(11.000 +14.000)

= 441.1984 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 38.532 * 205.100 / 2

= 3.9514 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (400.000 -2.0*0.000 -219.100 /Cos(0.000), 0.0)/2.0, 182.173

= 90.4500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=38.532 *7.000 +0.000 *(7.000 -3.000 +0.000

= 269.7226 mm²

Afp = Ip * eap = 1.733 * 14.000 = 1266.3000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

```
  fop = Min(fs, fp) = Min(204.174 , 204.174 ) = 204.174 MPa
```

Force requirement per paragraph 9.5.2.1.1 [Fa]:

```
  = (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

  = (2003.903 + 196.000 ) * (204.174 - 0.5 * 0.600 ) +

    (1266.300 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

    (269.723 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

  = 761.5928 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
  = P * ( Aps + Apb + 0.5 * APpsi )

  = 0.600 * ( 441198.406 + 3951.437 + 0.5*0.000 )

  = 267.0672 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 4.0058 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 158.0058 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R4 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		10150.0010	mm

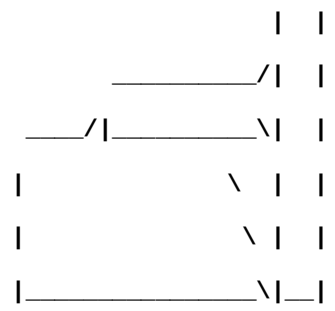
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		168.3000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	145.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		70.8500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R4

Actual Outside Diameter Used in Calculation	168.300	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 154.300 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -151.300 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((168.300 -2*0.000 -7.000)*7.000),145.000)

= 33.6021 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*33.602)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +77.150)*(2*1503.000 +(182.173 +77.150)*tan(0.00))

= 0.4E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 70.850 * 14.000

= 991.9000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 154.300² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 168.300 /2)*1503.000 + 6.626 /2*(11.000 +14.000)

= 402.3872 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 33.602 * 154.300 / 2

= 2.5924 x 10^3 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (310.000 -2.0*0.000 -168.300 /Cos(0.000), 0.0)/2.0, 182.173

= 70.8500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 7.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=33.602 *7.000 +0.000 *(7.000 -3.000 +0.000

= 235.2146 mm²

Afp = Ip * eap = 1.304 * 14.000 = 991.9000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(204.174 , 204.174 ) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174 ) = 204.174 MPa
```

Force requirement per paragraph 9.5.2.1.1 [Fa]:

```
= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000 ) * (204.174 - 0.5 * 0.600 ) +

  (991.900 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

  (235.215 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

= 698.6199 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
= P * ( Aps + Apb + 0.5 * APpsi )

= 0.600 * ( 402387.219 + 2592.401 + 0.5*0.000 )

= 242.9671 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 2.3623 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 161.3623 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R17b From : 20

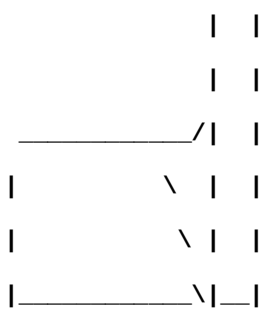
Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		8700.0000	mm

Type of Element Connected to the Shell : Nozzle

Nozzle Material		P285QH	
Allowable Stress at Temperature	Sn	162.51	MPa
Allowable Stress At Ambient	Sna	162.51	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		51.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.5000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	60.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Class of attached Flange		40	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R17b

Actual Outside Diameter Used in Calculation	51.000	mm.
Actual Thickness Used in Calculation	12.500	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 32.000 / (2 * 162.506 * 0.000 - 0.600) + 3.000

= -29.000 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((51.000 -2*0.000 -9.500)*9.500),60.000)

= 19.8557 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*19.856)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +16.000)*(2*1503.000 +(182.173 +16.000)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 32.000² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 51.000 /2)*1503.000 + 2.008 /2*(11.000 +0.000)

= 312.4130 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 19.856 * 32.000 / 2

= 317.6917 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (0.000 -2.0*0.000 -51.000 /Cos(0.000), 0.0)/2.0, 182.173)

= 0.0000 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 9.500)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=19.856 *9.500 +0.000 *(9.500 -3.000 +0.000

= 188.6294 mm²

Afp = Ip * eap = 0.270 * 0.000 = 0.0000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 0.0000² + 0.0000²) / 2 = 98.0000 mm²

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 162.506) = 162.506 MPa

fop = Min(fs, fp) = Min(204.174 , 0.000) = 0.000 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

```
  = (2003.903 + 98.000 ) * (204.174 - 0.5 * 0.600 ) +
    (0.000 * (Min(204.174 , 0.000 ) - 0.50 * 0.600 ) +
    (188.629 * (Min(204.174 , 162.506 ) - 0.50 * 0.600 )
  = 459.0808 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
  = P * ( Aps + Apb + 0.5 * APpsi )
  = 0.600 * ( 312413.000 + 317.692 + 0.5*0.000 )
  = 187.6225 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.2168 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 74.2168 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R17d From : 20

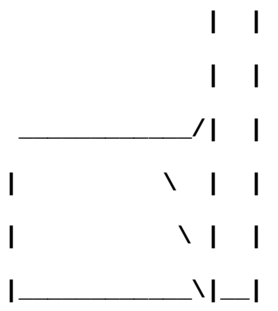
Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Cylinder/Cone Centerline	L1	500.0000	mm
Distance from Bottom/Left Tangent		10290.0010	mm

Type of Element Connected to the Shell : Nozzle

Nozzle Material		P285QH	
Allowable Stress at Temperature	Sn	162.51	MPa
Allowable Stress At Ambient	Sna	162.51	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		-161.00	deg
Diameter		51.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.5000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	38.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Class of attached Flange		40	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R17d

Actual Outside Diameter Used in Calculation	51.000	mm.
Actual Thickness Used in Calculation	12.500	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 32.000 / (2 * 162.506 * 0.000 - 0.600) + 3.000

= -29.000 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((51.000 -2*0.000 -9.500)*9.500),38.000)

= 19.8557 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*19.856)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +16.000)*(2*1503.000 +(182.173 +16.000)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000 = 0.0000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 32.000² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 51.000 /2)*1503.000 + 2.008 /2*(11.000 +0.000)

= 312.4130 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 19.856 * 32.000 / 2

= 317.6917 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (0.000 -2.0*0.000 -51.000 /Cos(0.000), 0.0)/2.0, 182.173)

= 0.0000 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 9.500)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=19.856 *9.500 +0.000 *(9.500 -3.000 +0.000

= 188.6294 mm²

Afp = Ip * eap = 0.270 * 0.000 = 0.0000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 0.0000² + 0.0000²) / 2 = 98.0000 mm²

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 162.506) = 162.506 MPa

fop = Min(fs, fp) = Min(204.174 , 0.000) = 0.000 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 98.000) * (204.174 - 0.5 * 0.600) +

(0.000 * (Min(204.174 , 0.000) - 0.50 * 0.600) +

(188.629 * (Min(204.174 , 162.506) - 0.50 * 0.600)

= 459.0808 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (312413.000 + 317.692 + 0.5*0.000)

= 187.6225 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

Checking the Nozzle Reinforcement at Right Angle to the Vessel Axis:

Points where Nozzle Inside Diameter Cuts ris [x1,y1 : x2,y2]:

(484.0000 , 1422.9381 : 516.0000 , 1411.6490)

Area [APsi]

= 178.4259 mm²

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((500.000 + 51.000 /2) / 1503.000) - asin((500.000 - 51.000 /2)

= 0.0360 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 7.172 / 59.173 = 0.1212 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.036 +0.121)*1503.000²/2

= 0.2E+06 mm²

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 98.000) * (204.174 - 0.5 * 0.600) +

(0.000 * (Min(204.174 , 0.000) - 0.50 * 0.600) +

(188.629 * (Min(204.174 , 162.506) - 0.50 * 0.600)

= 459.0808 x 10^3 N

Force Term per 9.5.2.1.1 [Fa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (177547.281 + 317.692 + 0.5 * 178.426)

= 106.7635 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 9.2759 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 62.1166 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R11 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		9150.0000	mm

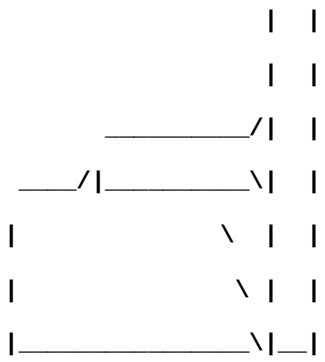
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	150.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R11

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -75.900 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((88.900 -2*0.000 -5.000)*5.000),150.000)

= 20.4817 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*20.482) = 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +39.450)*(2*1503.000 +(182.173 +39.450)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 55.550 * 14.000

= 777.7001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 78.900² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 88.900 /2)*1503.000 + 3.500 /2*(11.000 +14.000)

= 341.7256 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 20.482 * 78.900 / 2

= 808.0030 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (200.000 -2.0*0.000 -88.900 /Cos(0.000), 0.0)/2.0, 182.173)

= 55.5500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 5.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=20.482 *5.000 +0.000 *(5.000 -3.000 +0.000

= 102.4085 mm²

Afp = Ip * eap = 0.667 * 14.000 = 777.7001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

```
  fop = Min(fs, fp) = Min(204.174 , 204.174 ) = 204.174 MPa
```

Force requirement per paragraph 9.5.2.1.1 [Fa]:

```
  = (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

  = (2003.903 + 196.000 ) * (204.174 - 0.5 * 0.600 ) +

    (777.700 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

    (102.408 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

  = 627.8804 x 10^3 N
```

Force Term per 9.5.2.1.1 [Pa]:

```
  = P * ( Aps + Apb + 0.5 * APpsi )

  = 0.600 * ( 341725.625 + 808.003 + 0.5*0.000 )

  = 205.5027 x 10^3 N
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.6588 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 164.6588 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R9 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Cylinder/Cone Centerline	L1	150.0000	mm
Distance from Bottom/Left Tangent		8850.0000	mm

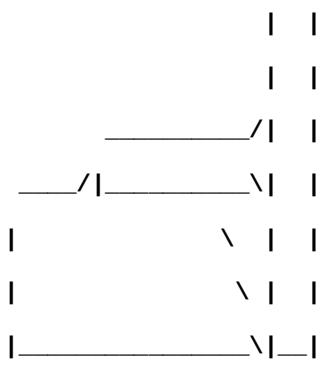
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		95.69	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	138.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R9

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -75.900 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((88.900 -2*0.000 -5.000)*5.000),138.000)

= 20.4817 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*20.482) = 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +39.450)*(2*1503.000 +(182.173 +39.450)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 55.550 * 14.000

= 777.7001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 78.900² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 88.900 /2)*1503.000 + 3.500 /2*(11.000 +14.000)

= 341.7256 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 20.482 * 78.900 / 2

= 808.0030 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (200.000 -2.0*0.000 -88.900 /Cos(0.000), 0.0)/2.0, 182.173)

= 55.5500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 5.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=20.482 *5.000 +0.000 *(5.000 -3.000 +0.000

= 102.4085 mm²

Afp = Ip * eap = 0.667 * 14.000 = 777.7001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (341725.625 + 808.003 + 0.5*0.000)

= 205.5027 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

Checking the Nozzle Reinforcement at Right Angle to the Vessel Axis:

Points where Nozzle Inside Diameter Cuts ris [x1,y1 : x2,y2]:

(110.5500 , 1498.9288 : 189.4500 , 1491.0122)

Area [APsi]

= 284.6544 mm²

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((150.000 + 88.900 /2) / 1503.000) - asin((150.000 - 88.900 /2)

= 0.0595 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 7.172 / 59.173 = 0.1212 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.059 +0.121)*1503.000²/2

= 0.2E+06 mm²

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Fa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (204056.750 + 808.003 + 0.5 * 284.654)

= 122.9938 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 5.1382 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 157.2080 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R18a From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Cylinder/Cone Centerline	L1	600.0000	mm
Distance from Bottom/Left Tangent		9000.0000	mm

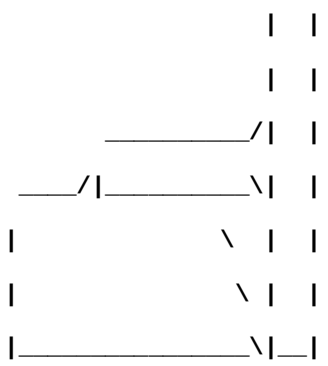
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		113.35	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	135.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa

Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm
Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R18a

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -75.900 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((88.900 -2*0.000 -5.000)*5.000),135.000) = 20.4817 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*20.482)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +39.450)*(2*1503.000 +(182.173 +39.450)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 55.550 * 14.000

= 777.7001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 78.900² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 88.900 /2)*1503.000 + 3.500 /2*(11.000 +14.000)

= 341.7256 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 20.482 * 78.900 / 2

= 808.0030 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (200.000 -2.0*0.000 -88.900 /Cos(0.000), 0.0)/2.0, 182.173)

= 55.5500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 5.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=20.482 *5.000 +0.000 *(5.000 -3.000 +0.000

= 102.4085 mm²

Afp = Ip * eap = 0.667 * 14.000 = 777.7001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (341725.625 + 808.003 + 0.5*0.000)

= 205.5027 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

Checking the Nozzle Reinforcement at Right Angle to the Vessel Axis:

Points where Nozzle Inside Diameter Cuts ris [x1,y1 : x2,y2]:

(560.5500 , 1394.5582 : 639.4500 , 1360.1885)

Area [APsi] = 1320.5806 mm²

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((600.000 + 88.900 /2) / 1503.000) - asin((600.000 - 88.900 /2)

= 0.0645 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 7.172 / 59.173 = 0.1212 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.065 +0.121)*1503.000²/2

= 0.2E+06 mm²

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600) = 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Fa]:

```
= P * ( Aps + Apb + 0.5 * APpsi )

= 0.600 * ( 209789.047 + 808.003 + 0.5 * 1320.581 )

= 126.7436 x 10^3 N
```

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 20.2675 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 170.5293 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R10 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Cylinder/Cone Centerline	L1	1200.0000	mm
Distance from Bottom/Left Tangent		9150.0000	mm

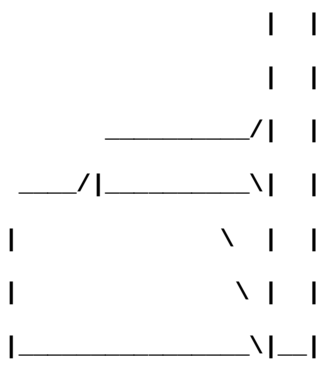
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		142.43	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	157.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R10

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -75.900 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((88.900 -2*0.000 -5.000)*5.000),157.000)

= 20.4817 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*20.482) = 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +39.450)*(2*1503.000 +(182.173 +39.450)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 55.550 * 14.000

= 777.7001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 78.900² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 88.900 /2)*1503.000 + 3.500 /2*(11.000 +14.000)

= 341.7256 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 20.482 * 78.900 / 2

= 808.0030 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (200.000 -2.0*0.000 -88.900 /Cos(0.000), 0.0)/2.0, 182.173)

= 55.5500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 5.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=20.482 *5.000 +0.000 *(5.000 -3.000 +0.000

= 102.4085 mm²

Afp = Ip * eap = 0.667 * 14.000 = 777.7001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (341725.625 + 808.003 + 0.5*0.000)

= 205.5027 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

Checking the Nozzle Reinforcement at Right Angle to the Vessel Axis:

Points where Nozzle Inside Diameter Cuts ris [x1,y1 : x2,y2]:

(1160.5499 , 955.0564 : 1239.4500 , 850.1604)

Area [APsi] = 4012.7544 mm²

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((1200.000 + 88.900 /2) / 1503.000) - asin((1200.000 - 88.900 /2

= 0.0985 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 7.172 / 59.173 = 0.1212 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.098 +0.121)*1503.000²/2

= 0.2E+06 mm²

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Fa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (248140.219 + 808.003 + 0.5 * 4012.754) = 150.5600 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 62.5371 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 242.6817 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R12 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Cylinder/Cone Centerline	L1	1000.0000	mm
Distance from Bottom/Left Tangent		8850.0000	mm

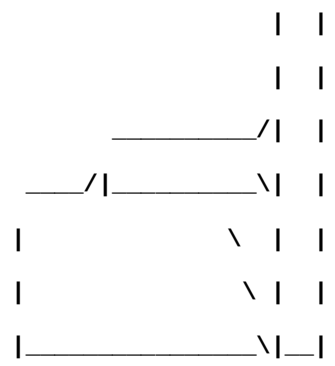
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		131.34	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	109.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R12

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 0.000 - 0.600) + 3.000

= -75.900 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((88.900 -2*0.000 -5.000)*5.000),109.000)

= 20.4817 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*20.482) = 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +39.450)*(2*1503.000 +(182.173 +39.450)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 55.550 * 14.000

= 777.7001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 78.900² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 88.900 /2)*1503.000 + 3.500 /2*(11.000 +14.000)

= 341.7256 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 20.482 * 78.900 / 2

= 808.0030 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (200.000 -2.0*0.000 -88.900 /Cos(0.000), 0.0)/2.0, 182.173)

= 55.5500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 5.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=20.482 *5.000 +0.000 *(5.000 -3.000 +0.000

= 102.4085 mm²

Afp = Ip * eap = 0.667 * 14.000 = 777.7001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (341725.625 + 808.003 + 0.5*0.000)

= 205.5027 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

Checking the Nozzle Reinforcement at Right Angle to the Vessel Axis:

Points where Nozzle Inside Diameter Cuts ris [x1,y1 : x2,y2]:

(960.5500 , 1156.0072 : 1039.4500 , 1085.6116)

Area [APsi]

= 2711.5723 mm²

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((1000.000 + 88.900 /2) / 1503.000) - asin((1000.000 - 88.900 /2

= 0.0793 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 7.172 / 59.173 = 0.1212 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.079 +0.121)*1503.000²/2

= 0.2E+06 mm²

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 627.8804 x 10^3 N

Force Term per 9.5.2.1.1 [Fa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (226472.625 + 808.003 + 0.5 * 2711.572)

= 137.1702 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 41.4076 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 169.1217 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R17a From : 20

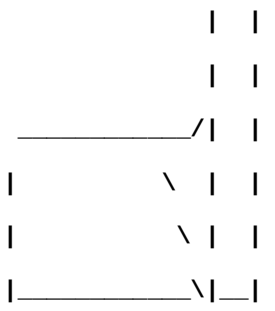
Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Cylinder/Cone Centerline	L1	1000.0000	mm
Distance from Bottom/Left Tangent		8700.0000	mm

Type of Element Connected to the Shell : Nozzle

Nozzle Material		P285QH	
Allowable Stress at Temperature	Sn	162.51	MPa
Allowable Stress At Ambient	Sna	162.51	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		283.00	deg
Diameter		51.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.5000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	132.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Class of attached Flange		40	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R17a

Actual Outside Diameter Used in Calculation	51.000	mm.
Actual Thickness Used in Calculation	12.500	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 32.000 / (2 * 162.506 * 0.000 - 0.600) + 3.000

= -29.000 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((51.000 -2*0.000 -9.500)*9.500),132.000)

= 19.8557 mm

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*19.856)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +16.000)*(2*1503.000 +(182.173 +16.000)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000 = 0.0000 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 32.000² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 51.000 /2)*1503.000 + 2.008 /2*(11.000 +0.000)

= 312.4130 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 19.856 * 32.000 / 2

= 317.6917 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (0.000 -2.0*0.000 -51.000 /Cos(0.000), 0.0)/2.0, 182.173)

= 0.0000 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 9.500)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=19.856 *9.500 +0.000 *(9.500 -3.000 +0.000

= 188.6294 mm²

Afp = Ip * eap = 0.270 * 0.000 = 0.0000 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 0.0000² + 0.0000²) / 2 = 98.0000 mm²

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 162.506) = 162.506 MPa

fop = Min(fs, fp) = Min(204.174 , 0.000) = 0.000 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 98.000) * (204.174 - 0.5 * 0.600) +

(0.000 * (Min(204.174 , 0.000) - 0.50 * 0.600) +

(188.629 * (Min(204.174 , 162.506) - 0.50 * 0.600) = 459.0808 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (312413.000 + 317.692 + 0.5*0.000)

= 187.6225 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

Checking the Nozzle Reinforcement at Right Angle to the Vessel Axis:

Points where Nozzle Inside Diameter Cuts ris [x1,y1 : x2,y2]:

(984.0000 , 1136.1130 : 1016.0000 , 1107.5889)

Area [APsi]

= 452.0270 mm²

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((1000.000 + 51.000 /2) / 1503.000) - asin((1000.000 - 51.000 /2

= 0.0455 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 7.172 / 59.173 = 0.1212 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.045 +0.121)*1503.000²/2 = 0.2E+06 mm²

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 98.000) * (204.174 - 0.5 * 0.600) +

(0.000 * (Min(204.174 , 0.000) - 0.50 * 0.600) +

(188.629 * (Min(204.174 , 162.506) - 0.50 * 0.600)

= 459.0808 x 10^3 N

Force Term per 9.5.2.1.1 [Fa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (188256.531 + 317.692 + 0.5 * 452.027)

= 113.2705 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 23.3424 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 174.0564 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R20 From : 20

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Cylindrical Shell	D	3000.00	mm
Shell Finished (Minimum) Thickness	t	14.0000	mm
Shell Internal Corrosion Allowance	c	3.0000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		8970.0000	mm

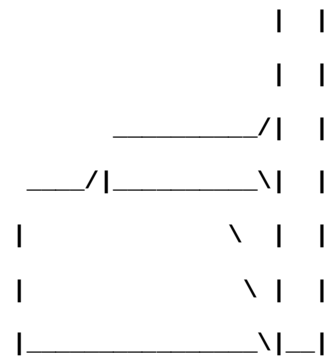
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P285QH	
Allowable Stress at Temperature	Sn	162.51	MPa
Allowable Stress At Ambient	Sna	162.51	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	150.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm
Thickness of Pad	te	14.0000	mm

Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R20

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 162.506 * 0.000 - 0.600) + 3.000

= -75.900 mm

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (3000.000 + 2 * 3.000) / 2

= 1503.0000 mm

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

= min(sqrt((deb - 2 * cext - eab) * eab), ho)

= min(sqrt((88.900 -2*0.000 -5.000)*5.000),150.000)

= 20.4817 mm

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*20.482)

= 0.0000 mm

Compute cone pressure area per Equation 9.5.36 [Aps]:

= 0.5*(Iso+a)*(2*ris+(Iso+a)*tan(Alpha))

= 0.5*(182.173 +39.450)*(2*1503.000 +(182.173 +39.450)*tan(0.00))

= 0.3E+06 mm²

Compute area in the re-pad [Afp]:

= Ip * ep = 55.550 * 14.000

= 777.7001 mm²

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 78.900² * tan(0.000)

= 0.0000 mm²

Calculate the Pressure Area per 9.5-29 [Aps]:

Note: do (nozzle O/Dia.) taken as the diameter of the hole in the shell

= ris * (Iso + do / 2) * ris + do/2 *(eas + eap)

= ris * (182.173 + 88.900 /2)*1503.000 + 3.500 /2*(11.000 +14.000)

= 341.7256 x 10^3 mm²

Pressure Area of Nozzle per using dib and Ibo [Apb]:

(This is an inserted nozzle)

= Ibo * dib / 2 = 20.482 * 78.900 / 2

= 808.0030 mm²

Compute the effective re-pad width [Ip]:

= Min(Max(Dp - 2 * cext - do/Cos(Phi), 0) / 2, Iso))

= Min(Max (200.000 -2.0*0.000 -88.900 /Cos(0.000), 0.0)/2.0, 182.173)

= 55.5500 mm

Available Metal Areas per 9.5-78 to 9.5-81 [Afs, Afb, Afp, Afw]:

Note: The welds are considered in the corroded condition

Afs = (Iso + eab)*eas = (182.173 + 5.000)*11.000 = 2003.9032 mm²

Afb = Ibo*eb+Ibi*(eb-ci+co)=20.482 *5.000 +0.000 *(5.000 -3.000 +0.000

= 102.4085 mm²

Afp = Ip * eap = 0.667 * 14.000 = 777.7001 mm²

Afw = (wshell² + wpad² + winside²) / 2

= (14.0000² + 14.0000² + 0.0000²) / 2 = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(204.174 , 162.506) = 162.506 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Force requirement per paragraph 9.5.2.1.1 [Fa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2003.903 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 162.506) - 0.50 * 0.600)

= 623.6136 x 10^3 N

Force Term per 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + 0.5 * APpsi)

= 0.600 * (341725.625 + 808.003 + 0.5*0.000)

= 205.5027 x 10^3 N

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.6588 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 164.6588 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: GV1b From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	0.0000	mm

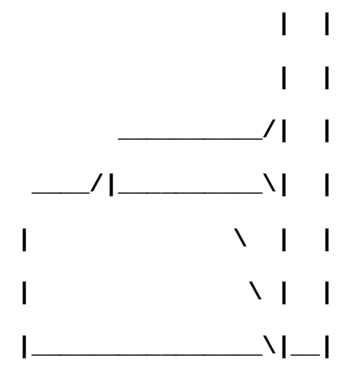
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		508.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P355NH	
Flange Type		Slip on	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	250.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	800.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		136.0000	mm
Class of attached Flange		10	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: GV1b

Actual Inside Diameter Used in Calculation	508.000	mm.
Actual Thickness Used in Calculation	10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 514.000 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.756 mm

EN13445 Section 9 - Pressure Area Design Method:

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((528.0000 - 7.0000)*7.0000 , 250.0000)

= 60.3904 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 60.390) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(0.000 /2710.900)-asin((0.000 -0.5*528.000)/2710.900)

= 0.0975 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.098 * 2710.900 = 264.4191 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(0.000)/2710.900) = 0.0000 radians

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +264.419)/(0.5*11.000 +2705.400) +

264.419 *(11.000 +14.000) = 693.2406 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(250.000 , 60.390)*514.000 *0.5

= 15520.3320 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 60.390 * 7.000 + 0.000 * 0.000

= 422.7327 mm²

Afp = Ip * eap = 136.000 * 14.000 = 1904.0001 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

```
= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000 ) * (204.174 - 0.5 * 0.600 ) +

  (1904.000 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 ) +

  (422.733 * (Min(204.174 , 204.174 ) - 0.50 * 0.600 )

= 1061.9032 x 10^3 N
```

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

```
= P * ( Aps + Apb )

= 0.600 * ( 693240 + 15520.332 ) = 425.2205 X 10^3 N
```

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 12.8839 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 276.8838 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R19 From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	850.0001	mm

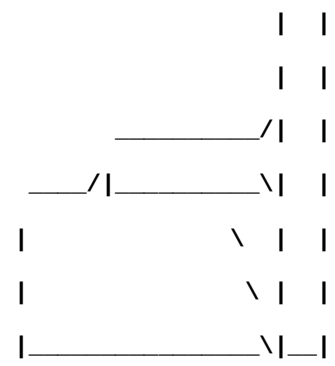
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		ID	
Layout Angle		180.00	deg
Diameter		219.1000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	10.0000	mm
Flange Material		P285QH	
Flange Type		Slip on	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	250.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	310.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		35.4500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R19

Actual Inside Diameter Used in Calculation		219.100	mm.
Actual Thickness Used in Calculation		10.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 225.100 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.331 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((239.1000 - 7.0000)*7.0000 , 250.0000)

= 40.3076 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 40.308) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(850.000 /2710.900)-asin((850.000 -0.5*239.100)/2710.900)

= 0.0461 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.046 * 2710.900 = 124.9917 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(850.000)/2710.900) = 0.3189 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*225.100²*Tan(0.319) = 8365.6270 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +124.992)/(0.5*11.000 +2705.400) +

124.992 *(11.000 +14.000) = 501.5342 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(250.000 , 40.308)*225.100 *0.5

= 4536.6162 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 40.308 * 7.000 + 0.000 * 0.000

= 282.1529 mm²

Afp = Ip * eap = 35.450 * 14.000 = 496.3000 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(496.300 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(282.153 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 746.2762 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (501534 + 4536.616 + 0.5*0.000) = 306.1262 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 42.5988 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 307.3380 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R15 From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	700.0000	mm

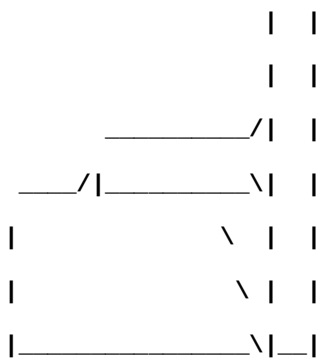
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	163.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R15

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.116 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((88.9000 - 5.0000)*5.0000 , 163.0000)

= 20.4817 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 20.482) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(700.000 /2710.900)-asin((700.000 -0.5*88.900)/2710.900)

= 0.0169 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.017 * 2710.900 = 45.9087 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(700.000)/2710.900) = 0.2612 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*78.900²*Tan(0.261) = 831.9406 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +45.909)/(0.5*11.000 +2705.400) +

45.909 *(11.000 +14.000) = 392.7986 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(163.000 , 20.482)*78.900 *0.5

= 808.0030 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 20.482 * 5.000 + 0.000 * 0.000

= 102.4085 mm²

Afp = Ip * eap = 55.550 * 14.000 = 777.7001 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 766.9993 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (392798.594 + 808.003 + 0.5*0.000) = 236.3935 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 12.2853 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 189.7740 mm

For possible nozzle interference - See Nozzle Summary

NPUT VALUES, Nozzle Description: R18b From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	860.0000	mm

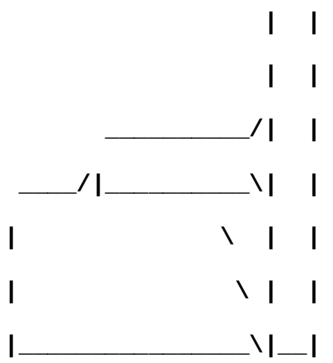
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		126.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	167.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R18b

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.116 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((88.9000 - 5.0000)*5.0000 , 167.0000)

= 20.4817 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 20.482) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(860.000 /2710.900)-asin((860.000 -0.5*88.900)/2710.900)

= 0.0172 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.017 * 2710.900 = 46.7386 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(860.000)/2710.900) = 0.3228 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*78.900²*Tan(0.323) = 1041.2191 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +46.739)/(0.5*11.000 +2705.400) +

46.739 *(11.000 +14.000) = 393.9397 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(167.000 , 20.482)*78.900 *0.5

= 808.0030 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 20.482 * 5.000 + 0.000 * 0.000

= 102.4085 mm²

Afp = Ip * eap = 55.550 * 14.000 = 777.7001 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 766.9993 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (393939.719 + 808.003 + 0.5*0.000) = 237.1408 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 15.2971 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 197.0551 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R16 From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	1100.0000	mm

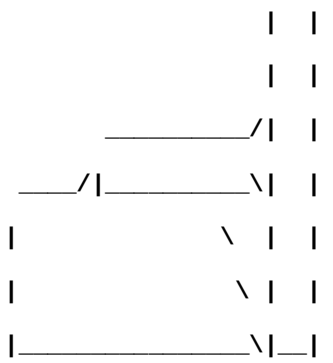
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		141.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	167.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R16

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.116 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((88.9000 - 5.0000)*5.0000 , 167.0000)

= 20.4817 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 20.482) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(1100.000 /2710.900)-asin((1100.000 -0.5*88.900)/2710.900)

= 0.0179 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.018 * 2710.900 = 48.4440 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(1100.000)/2710.900) = 0.4178 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*78.900²*Tan(0.418) = 1381.8744 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +48.444)/(0.5*11.000 +2705.400) +

48.444 *(11.000 +14.000) = 396.2846 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(167.000 , 20.482)*78.900 *0.5

= 808.0030 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 20.482 * 5.000 + 0.000 * 0.000

= 102.4085 mm²

Afp = Ip * eap = 55.550 * 14.000 = 777.7001 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 766.9993 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (396284.594 + 808.003 + 0.5*0.000) = 238.6498 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 20.2125 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 202.5221 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R14 From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	1086.0000	mm

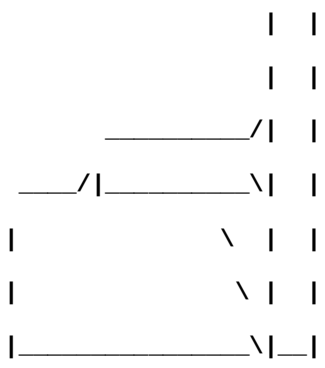
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P355NH	
Allowable Stress at Temperature	Sn	204.17	MPa
Allowable Stress At Ambient	Sna	204.17	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		158.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	167.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P355NH	
Pad Allowable Stress at Temperature	Sp	204.17	MPa
Pad Allowable Stress At Ambient	Spa	204.17	MPa
Diameter of Pad along vessel surface	Dp	200.0000	mm

Thickness of Pad	te	14.0000	mm
Weld leg size between Pad and Shell	Wp	14.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	14.0000	mm
Reinforcing Pad Width		55.5500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R14

Actual Outside Diameter Used in Calculation	88.900	mm.
Actual Thickness Used in Calculation	8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 204.174 * 1.000 - 0.600) + 3.000

= 3.116 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((88.9000 - 5.0000)*5.0000 , 167.0000)

= 20.4817 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 20.482) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(1086.000 /2710.900)-asin((1086.000 -0.5*88.900)/2710.900)

= 0.0178 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.018 * 2710.900 = 48.3271 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(1086.000)/2710.900) = 0.4122 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*78.900²*Tan(0.412) = 1360.8990 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +48.327)/(0.5*11.000 +2705.400) +

48.327 *(11.000 +14.000) = 396.1237 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(167.000 , 20.482)*78.900 *0.5

= 808.0030 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 20.482 * 5.000 + 0.000 * 0.000

= 102.4085 mm²

Afp = Ip * eap = 55.550 * 14.000 = 777.7001 mm²

Afw = 196.0000 mm²

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 204.174) = 204.174 MPa

fop = Min(fs, fp) = Min(204.174 , 204.174) = 204.174 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 196.000) * (204.174 - 0.5 * 0.600) +

(777.700 * (Min(204.174 , 204.174) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 204.174) - 0.50 * 0.600)

= 766.9993 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (396123.750 + 808.003 + 0.5*0.000) = 238.5471 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 19.9094 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 202.1812 mm

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R13 From : 30

Pressure for Reinforcement Calculations	P	0.6000	MPa
Temperature for Internal Pressure	Temp	60	C
Shell Material		P355NH	
Shell Allowable Stress at Temperature	S	204.17	MPa
Shell Allowable Stress At Ambient	Sa	204.17	MPa
Inside Diameter of Elliptical Head	D	3000.00	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	14.0000	mm
Head Internal Corrosion Allowance	c	3.0000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	1011.0000	mm

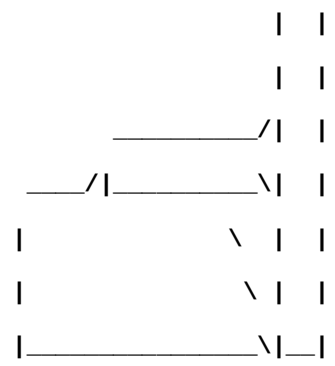
Type of Element Connected to the Shell : Nozzle

Nozzle Material		P285QH	
Allowable Stress at Temperature	Sn	162.51	MPa
Allowable Stress At Ambient	Sna	162.51	MPa
Diameter Basis (for tr calc only)		OD	
Layout Angle		81.00	deg
Diameter		88.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	8.0000	mm
Flange Material		P285QH	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.0000	mm
Outside Projection	ho	167.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	14.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.0000	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
Pad Material		P235GH	
Pad Allowable Stress at Temperature	Sp	135.21	MPa
Pad Allowable Stress At Ambient	Spa	150.01	MPa
Diameter of Pad along vessel surface	Dp	0.0000	mm

Thickness of Pad	te	0.0000	mm
Weld leg size between Pad and Shell	Wp	0.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	0.0000	mm
Reinforcing Pad Width		-44.4500	mm
Class of attached Flange		16	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle With Pad, no Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R13

Actual Outside Diameter Used in Calculation		88.900	mm.
Actual Thickness Used in Calculation		8.000	mm

Required Thickness of Nozzle Neck due to Internal Pressure:

= P * Di / (2 * f * z - P) + c EN-13445 Equation: 7.4.2:

= 0.600 * 78.900 / (2 * 162.506 * 1.000 - 0.600) + 3.000

= 3.146 mm

EN13445 Section 9 - Pressure Area Design Method:

Note: This Is a Hillside Nozzle (Offset)

Get the head depth from the head dimensions [h]:

Ar = Aspect ratio of the ellipse head

= D/2 * Ar + ci = 3000.000 / 2*2.000 +3.000 = 753.0000 mm

Compute the spherical radius per 9.5.1 [ris]:

= Di*(0.44 * Ar + 0.02) = 3050.800 * (0.44*2.000 +0.02) = 2705.3999 mm

Credit Distance Along the Shell per 9.5.1 [Iso]:

= Sqrt((2*ris+eas)*eas) = Sqrt(2*2705.400 + 11.000) * 11.000)

= 244.2126 mm

Credit Distance Along the Nozzle outside per 9.5.7.1 [Ibo]:

= min(sqrt((de - eab)*eab), ho)

= min(sqrt((88.9000 - 5.0000)*5.0000 , 167.0000)

= 20.4817 mm

Credit Distance Along the Nozzle per inside 9.5.7.1 [Ibi]:

= Min(hi, 0.50 * Ibo) = Min(0.000 , 0.50 * 20.482) = 0.0000 mm

Mean radius of Head per Figure 9.4-10 [rm]:

= ris + eas / 2 = 2705.400 + 11.000 / 2 = 2710.8999 mm

Angle subtending 'a' in figure 9.5-3 [Alpha]:

= asin(Offset / Rm) - asin((Offset - 0.5 * dib) / Rm)

= asin(1011.000 /2710.900)-asin((1011.000 -0.5*88.900)/2710.900)

= 0.0176 radians

The distance as depicted in figure 9.5-3 [a]:

= Alpha * rms = 0.018 * 2710.900 = 47.7396 mm

Angle between nozzle centreling and head centrline [Beta]:

= Asin(Offset / rms) = Asin(1011.000)/2710.900) = 0.3822 radians

Small triangular area fig 9.5-3 [Ap_psi]:

= 0.5*dib²*tab(Beta) = 0.5*78.900²*Tan(0.382) = 1251.0686 mm²

Pressure area inside shell/head per 9.5-56 [Aps]:

= 0.5 * ris² * (Iso + a) / (0.5 * eas + ris) + a * (eas + eap)

= 0.5*2705.400 **2*(244.213 +47.740)/(0.5*11.000 +2705.400) +

47.740 *(11.000 +0.000) = 394.6477 x 10^3 mm²

Area in the nozzle [Apb]:

= min(ho, Ibo)*dib*0.5 = min(167.000 , 20.482)*78.900 *0.5

= 808.0030 mm²

Afs = Iso * eas = 244.213 * 11.000 = 2686.3389 mm²

Afb = Ibo * eab + Ibi * Max(eab - cn + cnext, 0)

= 20.482 * 5.000 + 0.000 * 0.000

= 102.4085 mm²

Afp = Ip * eap = 0.000 * 0.000 = 0.0000 mm²

Afw = 98.0000 mm²

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]:

fob = Min(fs, fb) = Min(204.174 , 162.506) = 162.506 MPa

fop = Min(fs, fp) = Min(204.174 , 135.206) = 135.206 MPa

Pressure Area Check Term per paragraph 9.5.2.1.1 [Pa]:

= (Afs+Afw)*(fs-0.5P)+Afp*(Min(fs,fp) - 0.5P) + Afb(Min(fs,fb) - 0.5P)

= (2686.339 + 98.000) * (204.174 - 0.5 * 0.600) +

(0.000 * (Min(204.174 , 135.206) - 0.50 * 0.600) +

(102.408 * (Min(204.174 , 162.506) - 0.50 * 0.600)

= 584.2154 x 10^3 N

Stress Area term per paragraph 9.5.2.1.1 [Pa]:

= P * (Aps + Apb + .5 * APpsi)

= 0.600 * (394647.656 + 808.003 + 0.5*0.000) = 237.6285 x 10^3 N

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 18.3233 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 200.4051 mm

For possible nozzle interference - See Nozzle Summary

Nozzle Schedule:

Description	Nominal Size mm	Flange Sch/Type Cls		Noz. O/Dia mm	Wall Thk mm	Re-Pad ODia mm	Re-Pad Thick mm	Cut Length mm
M1	51	-	None	51.000	12.500	-	-	80
R17b	51	40	WNF	51.000	12.500	-	-	74
R17d	51	40	WNF	51.000	12.500	-	-	62
R17a	51	40	WNF	51.000	12.500	-	-	174
R11	88	16	WNF	88.900	8.000	200.00	14.00	164
R9	88	16	WNF	88.900	8.000	200.00	14.00	157
R18a	88	16	WNF	88.900	8.000	200.00	14.00	170
R10	88	16	WNF	88.900	8.000	200.00	14.00	242
R12	88	16	WNF	88.900	8.000	200.00	14.00	169
R20	88	16	WNF	88.900	8.000	200.00	14.00	164
R15	88	16	WNF	88.900	8.000	200.00	14.00	189
R18b	88	16	WNF	88.900	8.000	200.00	14.00	197
R16	88	16	WNF	88.900	8.000	200.00	14.00	202
R14	88	16	WNF	88.900	8.000	200.00	14.00	202
R13	88	16	WNF	88.900	8.000	-	-	200
R3	114	16	WNF	114.300	10.000	310.00	14.00	394
R8	168	16	WNF	168.300	10.000	310.00	14.00	161
R2	168	16	WNF	168.300	10.000	310.00	14.00	161
R7c	168	40	WNF	168.300	10.000	310.00	14.00	116
R7b	168	40	WNF	168.300	10.000	310.00	14.00	116
R7a	168	40	WNF	168.300	10.000	310.00	14.00	116
R4	168	16	WNF	168.300	10.000	310.00	14.00	161
R1	219	16	WNF	219.100	10.000	310.00	14.00	836
R6	219	16	WNF	219.100	10.000	400.00	14.00	163
R5	219	16	WNF	219.100	10.000	400.00	14.00	158
R19	219	16	SlipOn	239.100	10.000	310.00	14.00	307
GV1a	508	10	SlipOn	508.000	10.000	800.00	14.00	275
GV2a	508	10	SlipOn	508.000	10.000	800.00	14.00	285

GV2b	508	10	SlipOn508.000	10.000	800.00	14.00	285
GV1b	508	10	SlipOn528.000	10.000	800.00	14.00	276

Note on the Cut Length Calculation:

The Cut Length is the Outside Projection + Inside Projection + Drop +

In Plane Shell Thickness. This value does not include weld gaps,

nor does it account for shrinkage.

Please Note: In the case of Oblique Nozzles, the Outside Diameter must

be increased. The Re-Pad WIDTH around the nozzle is calculated as follows:

Width of Pad = (Pad Outside Dia. (per above) - Nozzle Outside Dia.)/2

Nozzle Material and Weld Fillet Leg Size Details:

Nozzle	Material	Shl Grve Weld mm	Noz Shl/Pad Weld mm	Pad OD Weld mm	Pad Grve Weld mm	Inside Weld mm
M1	P285QH	14.000	14.000	-	-	-
R17b	P285QH	14.000	14.000	-	-	-
R17d	P285QH	14.000	14.000	-	-	-
R17a	P285QH	14.000	14.000	-	-	-
R11	P355NH	14.000	14.000	14.000	14.000	-
R9	P355NH	14.000	14.000	14.000	14.000	-
R18a	P355NH	14.000	14.000	14.000	14.000	-
R10	P355NH	14.000	14.000	14.000	14.000	-
R12	P355NH	14.000	14.000	14.000	14.000	-
R20	P285QH	14.000	14.000	14.000	14.000	-
R15	P355NH	14.000	14.000	14.000	14.000	-
R18b	P355NH	14.000	14.000	14.000	14.000	-
R16	P355NH	14.000	14.000	14.000	14.000	-
R14	P355NH	14.000	14.000	14.000	14.000	-
R13	P285QH	14.000	14.000	-	-	-
R3	P355NH	14.000	14.000	14.000	14.000	-

R8	P355NH	14.000	14.000	14.000	14.000	-
R2	P355NH	14.000	14.000	14.000	14.000	-
R7c	P355NH	14.000	14.000	14.000	14.000	-
R7b	P355NH	14.000	14.000	14.000	14.000	-
R7a	P355NH	14.000	14.000	14.000	14.000	-
R4	P355NH	14.000	14.000	14.000	14.000	-
R1	P355NH	14.000	14.000	14.000	14.000	-
R6	P355NH	14.000	14.000	14.000	14.000	-
R5	P355NH	14.000	14.000	14.000	14.000	-
R19	P355NH	14.000	14.000	14.000	14.000	-
GV1a	P355NH	14.000	14.000	14.000	14.000	-
GV2a	P355NH	14.000	14.000	6.000	10.000	-
GV2b	P355NH	14.000	14.000	6.000	10.000	-
GV1b	P355NH	14.000	14.000	14.000	14.000	-

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

Nozzle Miscellaneous Data:

Nozzle	Elevation/Distance From Datum mm	Layout Angle deg.	Projection Outside mm	Projection Inside mm	Installed In Component
M1	3910.000	0.00	66.00	0.00	VIROLA
R17b	8700.001	180.00	60.00	0.00	VIROLA
R17d	10290.001	-161.00	38.00	0.00	VIROLA
R17a	8700.001	283.00	132.00	0.00	VIROLA
R11	9150.000	90.00	150.00	0.00	VIROLA
R9	8850.000	95.69	138.00	0.00	VIROLA
R18a	9000.000	113.35	135.00	0.00	VIROLA
R10	9150.000	142.43	157.00	0.00	VIROLA
R12	8850.000	131.34	109.00	0.00	VIROLA
R20	8970.000	0.00	150.00	0.00	VIROLA
R15		90.00	163.00	0.00	FUND ELIPSOI

R18b		126.00	167.00	0.00	FUND ELIPSOI
R16		141.00	167.00	0.00	FUND ELIPSOI
R14		158.00	167.00	0.00	FUND ELIPSOI
R13		81.00	167.00	0.00	FUND ELIPSOI
R3		180.00	250.00	100.00	FUND ELIPSOI
R8	6990.000	0.00	145.00	0.00	VIROLA
R2	9270.001	0.00	145.00	0.00	VIROLA
R7c	300.000	180.00	100.00	0.00	VIROLA
R7b	2750.000	180.00	100.00	0.00	VIROLA
R7a	7700.000	180.00	100.00	0.00	VIROLA
R4	10150.001	180.00	145.00	0.00	VIROLA
R1		0.00	280.00	490.00	FUND ELIPSOI
R6	10000.001	0.00	145.00	0.00	VIROLA
R5	8960.000	180.00	140.00	0.00	VIROLA
R19		180.00	250.00	0.00	FUND ELIPSOI
GV1a		0.00	250.00	0.00	FUND ELIPSOI
GV2a	550.000	0.00	250.00	0.00	VIROLA
GV2b	8000.000	0.00	250.00	0.00	VIROLA
GV1b		0.00	250.00	0.00	FUND ELIPSOI

Nozzle Calculation Summary:

Per EN 13445 Section 9:

Description	Pressure Area Result
GV1a	Pressure Area Passed
R1	Pressure Area Passed
R3	Pressure Area Passed
GV2a	Pressure Area Passed
GV2b	Pressure Area Passed
M1	Pressure Area Passed
R8	Pressure Area Passed
R2	Pressure Area Passed
R6	Pressure Area Passed
R7c	Pressure Area Passed
R7b	Pressure Area Passed
R7a	Pressure Area Passed
R5	Pressure Area Passed
R4	Pressure Area Passed
R17b	Pressure Area Passed
R17d	Pressure Area Passed
R11	Pressure Area Passed
R9	Pressure Area Passed
R18a	Pressure Area Passed
R10	Pressure Area Passed
R12	Pressure Area Passed
R17a	Pressure Area Passed
R20	Pressure Area Passed
GV1b	Pressure Area Passed
R19	Pressure Area Passed
R15	Pressure Area Passed
R18b	Pressure Area Passed
R16	Pressure Area Passed
R14	Pressure Area Passed

R13 Pressure Area Passed

Check the Spatial Relationship between the Nozzles

From Node	Nozzle Description	X Coordinate,	Layout Angle,	Mean Radius
10	GV1a	0.000	0.000	250.500
10	R1	0.000	0.000	106.050
10	R3	0.000	180.000	53.650
20	GV2a	550.000	0.000	250.500
20	GV2b	8000.000	0.000	250.500
20	M1	3910.000	0.000	20.750
20	R8	6990.000	0.000	80.650
20	R2	9270.000	0.000	80.650
20	R6	10000.001	0.000	106.050
20	R7c	300.000	180.000	80.650
20	R7b	2750.000	180.000	80.650
20	R7a	7700.000	180.000	80.650
20	R5	8960.000	180.000	106.050
20	R4	10150.001	180.000	80.650
20	R17b	8700.001	180.000	20.750
20	R17d	10290.001	-161.000	20.750
20	R11	9150.000	90.000	41.950
20	R9	8850.000	95.686	41.950
20	R18a	9000.000	113.347	41.950
20	R10	9150.000	142.429	41.950
20	R12	8850.000	131.338	41.950
20	R17a	8700.001	283.000	20.750
20	R20	8970.000	0.000	41.950
30	GV1b	0.000	0.000	260.500
30	R19	0.000	180.000	116.050
30	R15	0.000	90.000	41.950
30	R18b	0.000	126.000	41.950
30	R16	0.000	141.000	41.950
30	R14	0.000	158.000	41.950

30	R13	0.000	81.000	41.950

If any interferences/violations are found, they will be noted below.

Note: Items not derived explicitly will be found in the individual nozzle

calculation. These items include such values as Afls etc.

Nozzles R2 and R20 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In a Cylinder

ris = (ris1 + ris2)/2 = (1503.000 + 1503.000) / 2 = 1503.0000 mm

Lb = 300.0003 mm (= Inside center to center distance)

a1 = deb1/2 = 84.1500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (300.000 + 84.150 + 44.450)/(182.173 + 182.173) = 0.8236

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 300.000 + 84.150 + 44.450 + 0.824 * (182.173 + 182.173)

= 728.6920 mm

psi = atan(ris * abs(Angle2 - Angle1) / abs(y2 - y1)

= atan(1503.000 * abs(0.000 - 0.000) / abs(9220.001 - 8920.000)

= 0.0000 Deg

Apls = 0.5*ris²*Lb * (1 + cos(psi))/(ris+0.5 * eas * sin(psi))

= 0.5*1503.00²*300.00 *(1+cos(0.00))/(1503.00 +0.5*11.00 * sin(0.

= 450.9004 x 10^3 mm²

Metal area

Afb1 = 235.2146 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (300.000 - 84.150 - 44.450) = 1885.4032 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 0.0000 and APpsi2 = 0.0000 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (1885.403 + 392.000) * (204.174 - 0.5 * 0.600)

+ 235.215 * (204.174 - 0.5 * 0.600)

+ 102.408 * (162.506 - 0.5 * 0.600)

+ 991.900 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 889.5678 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(450900.438+2592.401 + .5*0.000 +808.003 +0.50* 0.000)

= 272.5573 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R5 and R17b are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In a Cylinder

ris = (ris1 + ris2)/2 = (1503.000 + 1503.000) / 2 = 1503.0000 mm

Lb = 259.9996 mm (= Inside center to center distance)

a1 = deb1/2 = 109.5500 and a2 = deb2/2 = 25.5000 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (260.000 + 109.550 + 25.500)/(182.173 + 182.173) = 0.9157

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 260.000 + 109.550 + 25.500 + 0.916 * (182.173 + 182.173)

= 728.6920 mm

psi = atan(ris * abs(Angle2 - Angle1) / abs(y2 - y1)

= atan(1503.000 * abs(180.000 - 180.000) / abs(8910.000 - 8650.0

= 0.0000 Deg

Apls = 0.5*ris²*Lb * (1 + cos(psi))/(ris+0.5 * eas * sin(psi))

= 0.5*1503.00²*260.00 *(1+cos(0.00))/(1503.00 +0.5*11.00 * sin(0.

= 390.7794 x 10^3 mm²

Metal area

Afb1 = 269.7226 , Afb2 = 188.6294 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (260.000 - 109.550 - 25.500) = 1374.4460 mm²

Afw = Afw1 + Afw2 = 196.000 + 98.000 = 294.0000 mm²

APsil = 0.0000 and APpsi2 = 0.0000 mm²

```
  f1 = (Afls + Afw ) * (fs - 0.5 * p)
       + Afb1 * (fob1 - 0.5 * p)
       + Afb2 * (fob2 - 0.5 * p)
       + Afp1 * (fop1 - 0.5 * p)
       + Afp2 * (fop2 - 0.5 * p)
     = (1374.446 + 294.000 ) * (204.174 - 0.5 * 0.600 )
       + 269.723 * (204.174 - 0.5 * 0.600 )
       + 188.629 * (162.506 - 0.5 * 0.600 )
       + 1266.300 * (204.174 - 0.5 * 0.600 )
       + 0.000 * (0.000 - 0.5 * 0.600 )
     = 683.8460 x 10^3 N
  f2 = P * ( Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)
     = 0.600 *(390779.438+3951.437 + .5*0.000 +317.692 +0.50* 0.000 )
     = 237.0090 x 10^3 N
```

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R11 and R9 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In a Cylinder

```
  ris  = (ris1 + ris2)/2 = (1503.000 + 1503.000 ) / 2 = 1503.0000 mm
  Lb   = 335.0330 mm (= Inside center to center distance)
  a1   = deb1/2 = 44.4500 and a2 = deb2/2 = 44.4500 mm
  k    = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)
       = 2 - (335.033 + 44.450 + 44.450 )/(182.173 + 182.173 ) = 0.8365
  Lb1  = Lb + a1 + a2 + k * (Iso1 + Iso2)
       = 335.033 + 44.450 + 44.450 + 0.836 * (182.173 + 182.173 )
       = 728.6920 mm
  psi  = atan(ris * abs(Angle2 - Angle1) / abs( y2 - y1 )
       = atan(1503.000 * abs(90.000 - 95.686 ) / abs( 9100.000 - 8800.000
       = 26.4357 Deg
  Apls = 0.5*ris²*Lb * (1 + cos(psi))/(ris+0.5 * eas * sin(psi))
       = 0.5*1503.00²*335.03 *(1+cos(26.44 ))/(1503.00 +0.5*11.00 * sin(2
       = 476.4514 x 10^3 mm²
```

Metal area

Afb1 = 102.4085 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (335.033 - 44.450 - 44.450) = 2707.4636 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 0.0000 and APpsi2 = 0.0000 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (2707.464 + 392.000) * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 990.6776 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(476451.344+808.003 + .5*0.000 +808.003 +0.50* 0.000)

= 286.8160 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R10 and R12 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In a Cylinder

ris = (ris1 + ris2)/2 = (1503.000 + 1503.000) / 2 = 1503.0000 mm

Lb = 417.9088 mm (= Inside center to center distance)

a1 = deb1/2 = 44.4500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (417.909 + 44.450 + 44.450)/(182.173 + 182.173) = 0.6090

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 417.909 + 44.450 + 44.450 + 0.609 * (182.173 + 182.173)

= 728.6920 mm

psi = atan(ris * abs(Angle2 - Angle1) / abs(y2 - y1)

= atan(1503.000 * abs(142.429 - 131.338) / abs(9100.000 - 8800.0

= 44.1219 Deg

Apls = 0.5*ris²*Lb * (1 + cos(psi))/(ris+0.5 * eas * sin(psi))

= 0.5*1503.00²*417.91 *(1+cos(44.12))/(1503.00 +0.5*11.00 * sin(4

= 538.1377 x 10^3 mm²

Metal area

Afb1 = 102.4085 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (417.909 - 44.450 - 44.450) = 3619.0962 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 0.0000 and APpsi2 = 0.0000 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (3619.096 + 392.000) * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 1176.5198 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(538137 +808.003 + .5*0.000 +808.003 +0.50* 0.000)

= 323.8247 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles GV1b and R19 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 264.0000 and a2 = deb2/2 = 119.5500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (864.645 + 264.000 + 119.550)/(244.213 + 244.213) = -0.555

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 864.645 + 264.000 + 119.550 + -0.556 * (244.213 + 244.213)

= 976.8505 mm

Lb = 864.6447 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 864.645 / (2 * 2705.400 + 0.433)

= 1167.2319 x 10^3 mm²

Metal area

Afb1 = 422.7327 , Afb2 = 282.1529 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (864.645 - 264.000 - 119.550) = 5292.0420 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 0.0000 and APpsi2 = 8365.6270 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (5292.042 + 392.000) * (204.174 - 0.5 * 0.600)

+ 422.733 * (204.174 - 0.5 * 0.600)

+ 282.153 * (204.174 - 0.5 * 0.600)

+ 1904.000 * (204.174 - 0.5 * 0.600)

+ 496.300 * (204.174 - 0.5 * 0.600)

= 1791.7412 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(1167231 +18347.332 + .5*0.000 +5774.667 +0.50* 8365.627)

= 717.2611 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles GV1b and R15 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 264.0000 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (708.056 + 264.000 + 44.450)/(244.213 + 244.213) = -0.0812

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 708.056 + 264.000 + 44.450 + -0.081 * (244.213 + 244.213)

= 976.8505 mm

Lb = 708.0556 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 708.056 / (2 * 2705.400 + 0.433)

= 955.8436 x 10^3 mm²

Metal area

Afb1 = 422.7327 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (708.056 - 264.000 - 44.450) = 4395.6621 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 0.0000 and APpsi2 = 831.9406 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (4395.662 + 392.000) * (204.174 - 0.5 * 0.600)

+ 422.733 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 1904.000 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 1629.7316 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(955843 +18347.332 + .5*0.000 +1241.953 +0.50* 831.941)

= 585.4596 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R19 and R14 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 119.5500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (436.511 + 119.550 + 44.450)/(244.213 + 244.213) = 0.7705

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 436.511 + 119.550 + 44.450 + 0.771 * (244.213 + 244.213)

= 976.8505 mm

Lb = 436.5111 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 436.511 / (2 * 2705.400 + 0.433)

= 589.2706 x 10^3 mm²

Metal area

Afb1 = 282.1529 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (436.511 - 119.550 - 44.450) = 2997.6223 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 8365.6270 and APpsi2 = 1360.8990 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (2997.622 + 392.000) * (204.174 - 0.5 * 0.600)

+ 282.153 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 496.300 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 1029.1052 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(589270 +5774.667 + .5*8365.627 +1241.953 +0.50* 1360.899)

= 360.6596 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R15 and R18b are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 44.4500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (506.251 + 44.450 + 44.450)/(244.213 + 244.213) = 0.7815

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 506.251 + 44.450 + 44.450 + 0.781 * (244.213 + 244.213)

= 976.8505 mm

Lb = 506.2511 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 506.251 / (2 * 2705.400 + 0.433)

= 683.4164 x 10^3 mm²

Metal area

Afb1 = 102.4085 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (506.251 - 44.450 - 44.450) = 4590.8618 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 831.9406 and APpsi2 = 1041.2191 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (4590.862 + 392.000) * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 1374.6206 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(683416 +1241.953 + .5*831.941 +1241.953 +0.50* 1041.219)

= 412.0671 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R15 and R13 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 44.4500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (338.076 + 44.450 + 44.450)/(244.213 + 244.213) = 1.1258

as k > 1, set k to 1.00

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 338.076 + 44.450 + 44.450 + 1.000 * (244.213 + 244.213)

= 915.4014 mm

Lb = 338.0761 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 338.076 / (2 * 2705.400 + 0.433)

= 456.3878 x 10^3 mm²

Metal area

Afb1 = 102.4085 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (338.076 - 44.450 - 44.450) = 2740.9377 mm²

Afw = Afw1 + Afw2 = 196.000 + 98.000 = 294.0000 mm²

APsil = 831.9406 and APpsi2 = 1251.0686 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (2740.938 + 294.000) * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 102.408 * (162.506 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

+ 0.000 * (135.206 - 0.5 * 0.600)

= 814.7175 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(456387.750+1241.953 + .5*831.941 +1241.953 +0.50* 1251.069

= 275.9245 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R18b and R16 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 44.4500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (349.626 + 44.450 + 44.450)/(244.213 + 244.213) = 1.1022

as k > 1, set k to 1.00

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 349.626 + 44.450 + 44.450 + 1.000 * (244.213 + 244.213)

= 926.9514 mm

Lb = 349.6261 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 349.626 / (2 * 2705.400 + 0.433)

= 471.9797 x 10^3 mm²

Metal area

Afb1 = 102.4085 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (349.626 - 44.450 - 44.450) = 2867.9873 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 1041.2191 and APpsi2 = 1381.8744 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (2867.987 + 392.000) * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 1023.4013 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(471979.688+1241.953 + .5*1041.219 +1241.953 +0.50* 1381.87

= 285.3809 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

Nozzles R16 and R14 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In an Ellipsoidal Head

ris = (ris1 + ris2)/2 = (2705.400 + 2705.400) / 2 = 2705.3999 mm

a1 = deb1/2 = 44.4500 and a2 = deb2/2 = 44.4500 mm

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (323.601 + 44.450 + 44.450)/(244.213 + 244.213) = 1.1554

as k > 1, set k to 1.00

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 323.601 + 44.450 + 44.450 + 1.000 * (244.213 + 244.213)

= 900.9262 mm

Lb = 323.6009 mm

Apls = 0.25 * (2 * ris)² * Lb / (2 * ris + eas)

= 0.25 * (2 * 2705.400)² * 323.601 / (2 * 2705.400 + 0.433)

= 436.8469 x 10^3 mm²

Metal area

Afb1 = 102.4085 , Afb2 = 102.4085 mm²

Afls = eas * (Lb - a1 - a2)

= 11.000 * (323.601 - 44.450 - 44.450) = 2581.7104 mm²

Afw = Afw1 + Afw2 = 196.000 + 196.000 = 392.0000 mm²

APsil = 1381.8744 and APpsi2 = 1360.8990 mm²

f1 = (Afls + Afw) * (fs - 0.5 * p)

+ Afb1 * (fob1 - 0.5 * p)

+ Afb2 * (fob2 - 0.5 * p)

+ Afp1 * (fop1 - 0.5 * p)

+ Afp2 * (fop2 - 0.5 * p)

= (2581.710 + 392.000) * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 102.408 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

+ 777.700 * (204.174 - 0.5 * 0.600)

= 965.0420 x 10^3 N

f2 = P * (Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

= 0.600 *(436846.844+1241.953 + .5*1381.874 +1241.953 +0.50* 1360.89

= 264.3988 x 10^3 N

Because f1 > f2: The Group Is Adequately Reinforced

No interference violations have been detected !

Please refer to the nozzles treated as isolated openings for more information

Design Code: European Std: EN13445-3 2009(E) Issue 1 (2009-07)

Diameter Spec : 3000.000 mm ID		
Vessel Design Length, Tangent to Tangent	10450.00	mm
Specified Datum Line Distance	0.00	mm
Shell Material Specification	P355NH	
Nozzle Material Specification	P285QH	
Nozzle Material Specification	P355NH	
Re-Pad Material Specification	P355NH	
Re-Pad Material Specification	P235GH	
Internal Design Temperature	60	C
Internal Design Pressure	0.600	MPa
External Design Temperature	-20	C
External Design Pressure	2.180	MPa
Maximum Allowable Working Pressure	1.093	MPa
Hydrostatic Test Pressure	1.504	MPa
Wind Design Code	ASCE-93	
Earthquake Design Code	UBC-97	

Element Pressures and MAWP: MPa

Element Desc	Design Pres. + Stat. head	External Pressure	M.A.W.P	Corrosion Allowance
FUND ELIPSOIDAL 1	0.600	0.000	1.093	3.0000
VIROLA	0.600	0.000	1.489	3.0000
FUND ELIPSOIDAL 2	0.600	0.000	1.294	3.0000

Element Type	"To" Elev mm	Length mm	Element Thk mm	R e q d T h k Int.	Ext.	Joint Eff Long	Circ
Ellipse	50.0	50.0	14.0	9.5	No Calc	1.00	1.00
Cylinder	10400.0	10350.0	14.0	7.4	No Calc	1.00	1.00
Ellipse	10450.0	50.0	14.0	8.9	No Calc	1.00	1.00

Element thicknesses are shown as Nominal if specified, otherwise are Minimum

Saddle Parameters:

Saddle Width	400.000	mm
Saddle Bearing Angle	120.000	deg.
Centerline Dimension	2000.000	mm
Wear Pad Width	500.000	mm
Wear Pad Thickness	14.000	mm
Wear Pad Bearing Angle	127.000	deg.
Distance from Saddle to Tangent	685.000	mm
Baseplate Length	2400.000	mm
Baseplate Thickness	20.000	mm
Baseplate Width	400.000	mm
Number of Ribs (including outside ribs)	4	
Rib Thickness	20.000	mm
Web Thickness	20.000	mm
Height of Center Web	448.000	mm

Summary of Maximum Saddle Loads, Operating Case :

Maximum Vertical Saddle Load	95112.34	N
Maximum Transverse Saddle Shear Load	14091.53	N
Maximum Longitudinal Saddle Shear Load	28183.05	N

Summary of Maximum Saddle Loads, Hydrotest Case :

Maximum Vertical Saddle Load	483099.19	N
Maximum Transverse Saddle Shear Load	2233.84	N
Maximum Longitudinal Saddle Shear Load	1371.65	N

Weights:

Fabricated - Bare W/O Removable Internals	15602.6	kg
Shop Test - Fabricated + Water (Full)	96503.0	kg
Shipping - Fab. + Rem. Intls.+ Shipping App.	15602.6	kg
Erected - Fab. + Rem. Intls.+ Insul. (etc)	15602.6	kg
Empty - Fab. + Intls. + Details + Wghts.	15602.6	kg
Operating - Empty + Operating Liquid (No CA)	15602.6	kg
Field Test - Empty Weight + Water (Full)	96503.0	kg