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

CAMPINA

Proiect: VAS INJECTIE METANOL

BREVIAR DE CALCUL

Cod. P4059-BC

2011

0	25.11.2011	Emis pentru executie	G.Colea	A.Stoica	G.Miloiu
Rev.	**Data**	**Descriere**	**Intocmit**	**Verificat**	**Aprobat**

Table of Contents

DESIGN CALCULATION

In Accordance with European Code EN-13445

Analysis Performed by : CONFIND S.R.L.

Job File : C:\USERS\GCOLEA\DOCUMENTS\PVELITE\P4059-00\P4059

Date of Analysis : Dec 8,2011

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)	6.0000	bars
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	-29	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)	Y	
Select t for External Pressure (Flag)	N	
Select t for Axial Stress (Flag)	Y	
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	bars
User defined MAWP	0.0000	bars
User defined MAPnc	0.0000	bars

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+EW
Load Case 17	NP+VO+OW
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 94
UBC Seismic Zone (1=1,2=2a,3=2b,4=3,5=4)	0.000
UBC Importance Factor	1.000

UBC Soil Type	S1
UBC Horizontal Force Factor	3.000
UBC Percent Seismic for Hydrotest	0.000
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		
Distance "FROM" to "TO"	50.000	mm.
Inside Diameter	700.00	mm.
Element Thickness	6.0000	mm.
Internal Corrosion Allowance	0.0000	mm.
Nominal Thickness	6.0000	mm.
External Corrosion Allowance	0.0000	mm.
Design Internal Pressure	6.0000	bars
Design Temperature Internal Pressure	60	C
Design External Pressure	0.0000	bars
Design Temperature External Pressure	20	C
Effective Diameter Multiplier	1.2	
Material Name	X5CrNi18-10	
Allowable Stress, Ambient	180.01	N./mm^2
Allowable Stress, Operating	165.01	N./mm^2
Material Density	0.007840	kg./cm^3

Elliptical Head Factor	2.	

Element From Node	20	
Element To Node	30	
Element Type	Cylinder	
Description		
Distance "FROM" to "TO"	1500.0	mm.
Inside Diameter	700.00	mm.
Element Thickness	5.0000	mm.
Internal Corrosion Allowance	0.0000	mm.
Nominal Thickness	5.0000	mm.
External Corrosion Allowance	0.0000	mm.
Design Internal Pressure	6.0000	bars
Design Temperature Internal Pressure	60	C
Design External Pressure	0.0000	bars
Design Temperature External Pressure	20	C
Effective Diameter Multiplier	1.2	
Material Name	X5CrNi18-10	

Element From Node	20	
Detail Type	Saddle	
Detail ID	Lft Sdl	
Dist. from "FROM" Node / Offset dist	300.00	mm.
Width of Saddle	150.00	mm.
Height of Saddle at Bottom	700.00	mm.
Saddle Contact Angle	120.	
Height of Composite Ring Stiffener	0.0000	mm.
Width of Wear Plate	150.00	mm.
Thickness of Wear Plate	5.0000	mm.

Contact Angle, Wear Plate (degrees)	132.	
Element From Node	20	
Detail Type	Saddle	
Detail ID	Sdl 2 Fr20	
Dist. from "FROM" Node / Offset dist	1200.0	mm.
Width of Saddle	150.00	mm.
Height of Saddle at Bottom	700.00	mm.
Saddle Contact Angle	120.	
Height of Composite Ring Stiffener	0.0000	mm.
Width of Wear Plate	150.00	mm.
Thickness of Wear Plate	5.0000	mm.
Contact Angle, Wear Plate (degrees)	132.	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R1-intrare meta	
Dist. from "FROM" Node / Offset dist	1420.0	mm.
Nozzle Diameter	60.299999	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	122.358	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	8.9234	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R2-retur supape	
Dist. from "FROM" Node / Offset dist	1420.0	mm.

Nozzle Diameter	60.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	57.641701	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	4.4033	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R6-SS	
Dist. from "FROM" Node / Offset dist	100.00	mm.
Nozzle Diameter	33.700001	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	1.9984	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R3-Iesire metan	
Dist. from "FROM" Node / Offset dist	420.00	mm.
Nozzle Diameter	33.700001	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	0.	
Blind Flange (Y/N)	N	

Weight of Nozzle (Used if > 0)	3.1312	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R4-iesire metan	
Dist. from "FROM" Node / Offset dist	1080.0	mm.
Nozzle Diameter	33.700001	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	3.1312	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R7	
Dist. from "FROM" Node / Offset dist	1080.0	mm.
Nozzle Diameter	33.700001	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	270.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	1.9984	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	
Element From Node	20	

Detail Type	Nozzle	
Detail ID	R5-evacuare gaz	
Dist. from "FROM" Node / Offset dist	500.00	mm.
Nozzle Diameter	33.700001	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	4.4033	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R8-aerisire	
Dist. from "FROM" Node / Offset dist	700.00	mm.
Nozzle Diameter	35.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	1.8550	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R9-intrare azot	
Dist. from "FROM" Node / Offset dist	1200.0	mm.
Nozzle Diameter	35.	mm
Nozzle Schedule	40	

Nozzle Class	150	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	1.8550	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	r10	
Dist. from "FROM" Node / Offset dist	880.00	mm.
Nozzle Diameter	20.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	4.4033	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R11	
Dist. from "FROM" Node / Offset dist	880.00	mm.
Nozzle Diameter	20.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	270.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	4.4033	Kgf
Grade of Attached Flange	GR 1.1	

Nozzle Matl	X5CrNi18-10	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R13	
Dist. from "FROM" Node / Offset dist	940.00	mm.
Nozzle Diameter	20.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	50.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	4.4033	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R12	
Dist. from "FROM" Node / Offset dist	300.00	mm.
Nozzle Diameter	35.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	50.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	1.9674	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	R14	

Dist. from "FROM" Node / Offset dist	940.00	mm.
Nozzle Diameter	35.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	330.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	1.9674	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R15	
Dist. from "FROM" Node / Offset dist	500.00	mm.
Nozzle Diameter	25.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.3000	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R16	
Dist. from "FROM" Node / Offset dist	800.00	mm.
Nozzle Diameter	25.	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	0.	

Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.3000	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	R17	
Dist. from "FROM" Node / Offset dist	800.00	mm.
Nozzle Diameter	323.89999	mm
Nozzle Schedule	40	
Nozzle Class	150	
Layout Angle	180.	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	102.84	Kgf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	X5CrNi18-10	

Element From Node	30	
Element To Node	40	
Element Type	Elliptical	
Description		
Distance "FROM" to "TO"	50.000	mm.
Inside Diameter	700.00	mm.
Element Thickness	6.0000	mm.
Internal Corrosion Allowance	0.0000	mm.
Nominal Thickness	6.0000	mm.
External Corrosion Allowance	0.0000	mm.
Design Internal Pressure	6.0000	bars

Design Temperature Internal Pressure	60	C
Design External Pressure	0.0000	bars
Design Temperature External Pressure	20	C
Effective Diameter Multiplier	1.2	
Material Name	X5CrNi18-10	
Elliptical Head Factor	2.	

XY Coordinate Calculations

From	To	X (Horiz.) mm.	Y (Vert.) mm.	DX (Horiz.) mm.	DY (Vert.) mm.
10	20	50.0000	...	50.0000	...
20	30	1550.00	...	1500.00	...
30	40	1600.00	...	50.0000	...

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd bars	Nominal Thickness mm.	Total Corr Allowance mm.	Element Diameter mm.	Allowable Stress(SE) N./mm^2
10	20	6.0000	6.0000	...	700.00	165.01
20	30	6.0000	5.0000	...	700.00	165.01
30	40	6.0000	6.0000	...	700.00	165.01

Element Required Thickness and MAWP :

From	To	Design Pressure bars	M.A.W.P. Corroded bars	M.A.P. New & Cold bars	Minimum Thickness mm.	Required Thickness mm.
10	20	6.00000	26.9686	29.4199	6.00000	1.95802
20	30	6.00000	23.4040	25.5313	5.00000	1.27506
30	40	6.00000	26.9686	29.4199	6.00000	1.95802
Minimum			18.960	19.650		

Internal Pressure Calculation Results :

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

Elliptical Head From 10 To 20 X5CrNi18-10 at 60 C

Design Stress at Ambient Temperature = 180.006 N./mm^2

Required thickness = 1.958 mm.

Required thickness in the crown = 1.147 mm.

This is an Elliptical Head

The Material is Austenitic Steel which affects value of fb:

Buckling Strs at ope. fb = Yield/1.5 = 193.534 /1.5 = 129.023 N./mm^2

Buckling Strs at amb. fb = Yield/1.5 = 230.008 /1.5 = 153.339 N./mm^2

Although head is Austenititic Steel, Rp0,20% is used

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

Pressure including hydro head	P	: 6.0000 bars
Inside Head Diameter (new)	Di	: 700.0000 mm.
Head Thickness (new)	e	: 6.0000 mm.
Head Aspect Ratio (new)	Di/2h	: 2.0000
Head Corrosion Allowance Internal	ci	: 0.0000 mm.
Head Corrosion Allowance External	co	: 0.0000 mm.
Joint Efficiency	Z	: 1.0000

hi = 0.5 * Di/AR + c = 0.5 * 700.00/2.000+0.00 = 175.0000 mm.

K = Di / (2 * hi) = 700.000 / (2 * 175.000) = 2.0000

r = Di((0.5 / K) - 0.08) = 700.000((0.5/2.000)-0.08) = 119.0000 mm.

R = Di(0.44*K+ 0.02) = 700.000 (0.44*2.000+0.02) = 630.0000 mm.

Y = Min(e/R, 0.04) = Min(1.95802/630.0000, 0.04) = 0.0031080

Z = Log10(1 / Y) = Log10(1 / 0.003) = 2.5075

X = r / Di = 119.0000 / 700.0000 = 0.17000

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

= 1.006-1 / (6.2+(90*0.0031)^4) = 0.84487

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

= 0.845 (-.1833*2.508^3 + 2.2124*2.508^2 - 3.2937*2.508 + 1.887

= 1.0392

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

= max (0.95 * (0.56 - 1.94 * 0.003 - 82.5 * 0.003^2), 0.5)

= 0.5255

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

= 10 ((0.2 - 0.1700) * 1.0392 + (0.1700 - 0.1) * 0.5255

= 0.6796

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)

= 6.000 * 630.0 /(2 * 1649.986 * 1.00 - 0.5 * 6.000)

= 1.1465 mm.

ey = Beta*P(0.75*R+0.2*Di)/f =0.68*6.0(0.75*630.0+0.2*700.0)/

1649.9856 = 1.5137 mm.

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

= (0.75*630.00+0.2*700.00) *

$(6.00/111 *129.02)(700.00/119.00)^{0.825})^{1/1.5}$

= 1.9580 mm.

Computed Head Thickness per EN13445 - 7.5.4:

= Max(es,eb,ey)+c+cext = Max(1.1465,1.9580,1.5137) + 0.0000 + 0.0000

= 1.9580 + 0.0000 +0.0000 = 1.9580 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 = 26.9686 - 0.0000 = 26.9686 bars

Computed Maximum Pressure New and Cold [MAPNC]:

= 29.420 bars

Uncorrected (for liquid) Hydrotest Pressure:

= 32.186 bars

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(854.400 /(700.000 - 2 * 6.000)) = 19.932 %

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

= 100 * e / R = 100 * 0.236 / 13.898 = 1.700 %

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

to EN 13445 Part 4 Table 9.4.1

Required Thickness of Straight Flange = 1.275 mm.

Cylindrical Shell From 20 To 30 X5CrNi18-10 at 60 C

Design Stress at Ambient Temperature = 180.006 N./mm^2

Thickness due to internal pressure [e]:

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

= 6.00 * 700.00 / ( 2 * 165.008 * 1.000 - 0.600 ) + c + cext

= 1.2751 + 0.0000 + 0.0000 = 1.2751 mm.
```

The shell is suitable for the design pressure.

Maximum Working Pressure Hot and Corroded [MAWP]:

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

= ( 2 * 165.01 * 5.0000 * 1.000 ) / (700.00 + 5.0000 )-0.00

= 2.341 N./mm^2
```

Maximum Pressure New and Cold [MAPNC]:

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

= ( 2 * 180.01 * 5.00 * 1.000 ) / ( 700.00 + 5.00 )

= 2.553 N./mm^2
```

Stress at Design Pressure [Stres]:

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

= 6.000 * (700.000 + 5.0000 ) / (2 * 5.0000 * 1.000 )

= 42.302 N./mm^2
```

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

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

= ( 2 * 219.06 * 5.00 * 1.000 ) / ( 700.00 + 5.00 )

= 3.107 N./mm^2
```

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

```
= 50*Max(e, enom) / Rm = 50*Max(5.000 ,5.000 )/352.500 = 0.709 %
```

Elliptical Head From 30 To 40 X5CrNi18-10 at 60 C

Design Stress at Ambient Temperature = 180.006 N./mm^2

```
     Required thickness              =      1.958 mm.
     Required thickness in the crown =      1.147 mm.
```

This is an Elliptical Head

The Material is Austenitic Steel which affects value of fb:

```
 Buckling Strs at ope. fb = Yield/1.5 = 193.534 /1.5 = 129.023 N./mm^2
 Buckling Strs at amb. fb = Yield/1.5 = 230.008 /1.5 = 153.339 N./mm^2
```

Although head is Austenititic Steel, Rp0,20% is used

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

```
  Pressure including hydro head              P : 6.0000 bars
  Inside Head Diameter     (new)            Di : 700.0000 mm.
  Head Thickness           (new)             e : 6.0000 mm.
  Head Aspect Ratio        (new)         Di/2h : 2.0000
  Head Corrosion Allowance Internal         ci : 0.0000 mm.
  Head Corrosion Allowance External         co : 0.0000 mm.
  Joint Efficiency                           Z : 1.0000

  hi = 0.5 * Di/AR + c = 0.5 * 700.00/2.000+0.00 = 175.0000  mm.
  K  = Di / (2 * hi) = 700.000 / (2 * 175.000) = 2.0000
  r  = Di((0.5 / K) - 0.08) = 700.000((0.5/2.000)-0.08) = 119.0000  mm.
  R  = Di(0.44*K+ 0.02) = 700.000 (0.44*2.000+0.02) = 630.0000  mm.

  Y  = Min(e/R, 0.04) = Min(1.95802/630.0000, 0.04) = 0.0031080
  Z  = Log10(1 / Y) = Log10(1 /  0.003) = 2.5075
  X  = r / Di = 119.0000 / 700.0000 = 0.17000
```

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

= 1.006-1 / (6.2+(90*0.0031)^4) = 0.84487

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

= 0.845 (-.1833*2.508^3 + 2.2124*2.508^2 - 3.2937*2.508 + 1.887

= 1.0392

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

= max (0.95 * (0.56 - 1.94 * 0.003 - 82.5 * 0.003^2), 0.5)

= 0.5255

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

= 10 ((0.2 - 0.1700) * 1.0392 + (0.1700 - 0.1) * 0.5255

= 0.6796

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)

= 6.000 * 630.0 /(2 * 1649.986 * 1.00 - 0.5 * 6.000)

= 1.1465 mm.

ey = Beta*P(0.75*R+0.2*Di)/f =0.68*6.0(0.75*630.0+0.2*700.0)/

1649.9856 = 1.5137 mm.

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

= $(0.75*630.00+0.2*700.00)$ *

$(6.00/111 *129.02)(700.00/119.00)^{0.825})^{1/1.5}$

= 1.9580 mm.

Computed Head Thickness per EN13445 - 7.5.4:

= Max(es,eb,ey)+c+cext = Max(1.1465,1.9580,1.5137) + 0.0000 + 0.0000

= 1.9580 + 0.0000 +0.0000 = 1.9580 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 = 26.9686 - 0.0000 = 26.9686 bars

Computed Maximum Pressure New and Cold [MAPNC]:

= 29.420 bars

Uncorrected (for liquid) Hydrotest Pressure:

= 32.186 bars

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(854.400 /(700.000 - 2 * 6.000)) = 19.932 %

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

= 100 * e / R = 100 * 0.236 / 13.898 = 1.700 %

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

to EN 13445 Part 4 Table 9.4.1

Required Thickness of Straight Flange = 1.275 mm.

Hydrostatic Test Pressure Results:

Note: The Hydrotest Pressure Derivation is an Iterative Process

Limited by: Cylinder Node: 20 to 30

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
      = 230.008 / 1.05 = 219.055 N./mm^2
```

```
Test Pressure = Calc Test Press - Liquid Head
              = 31.070 - 0.069 = 31.001 bars
```

Elements Suitable for Internal Pressure.

External Pressure Calculation Results :

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

Elliptical Head From 10 to 20

Determine the Stress Yield point [Py]:

= 2 * Sfact * S * ea / R

= 2 * 1.0 * 184.002 * 6.000 / 712.00

= 3.101 N./mm^2

Determine the Elastic Instability Pressure [Pm]:

= 1.21 * E * ea² / R²

= 1.21 * .19999E+09 * 6.000² / 712.00²

= 171.843 N./mm^2

External Allowable Pressure [Pmax]:

= (Pr/Py)/1.5 * Py

= 0.373 * 31.010

= 11.580 bars

Cylindrical Shell From 20 to 30

Determine the Stress Yield point [Py]:

= Sfact * S * ea / R

= 1.0 * 184.002 * 5.000 / 352.50

= 2.610 N./mm^2

Strain Factor [Z]:

= pi * R / L

= 3.141 * 352.500 / 1716.67

= 0.645

Determine the ratio Pm/Py:

= Pm / Py

= 0.937 / 2.610

= 0.359

From the Curve, determine Pr/Py:

= 0.179

Determine the critical Strain [strain]:

$= 1/(n^2-1+Z^2)[1/(n^2/Z^2+1)^2+ea^2/(12R^2(.91))*(n^2-1+Z^2)^2]$

= 0.0003302

Where n is the expected number of lobes [n]:

= 4

Determine the Elastic Instability Pressure [Pm]:

= E * ea * strain / R

= .19999E+09 * 5.000 * 0.000330 / 352.50

= 9.366 bars

External Allowable Pressure [Pmax]:

= (Pr/Py)/1.5 * Py

= 0.120 * 26.098

= 3.121 bars

Elliptical Head From 30 to 40

Determine the Stress Yield point [Py]:

= 2 * Sfact * S * ea / R

= 2 * 1.0 * 184.002 * 6.000 / 712.00

= 3.101 N./mm^2

Determine the Elastic Instability Pressure [Pm]:

= 1.21 * E * ea^2 / R^2

= 1.21 * .19999E+09 * 6.000^2 / 712.00^2

= 171.843 N./mm^2

External Allowable Pressure [Pmax]:

= (Pr/Py)/1.5 * Py

= 0.373 * 31.010

= 11.580 bars

External Pressure Calculations

From	To	Section Length mm.	Outside Diameter mm.	Corroded Thickness mm.	Factor A	Factor B N./mm^2
10	20	No Calc	712.000	6.00000	No Calc	No Calc
20	30	1716.67	710.000	5.00000	No Calc	No Calc
30	40	No Calc	712.000	6.00000	No Calc	No Calc

External Pressure Calculations

From	To	External Actual T. mm.	External Required T. mm.	External Des. Press. bars	External M.A.W.P. bars

10	20	6.00000	No Calc	...	11.5796
20	30	5.00000	No Calc	...	3.12095
30	40	6.00000	No Calc	...	11.5796
Minimum					3.121

External Pressure Calculations

From	To	Actual Len. Bet. Stiff. mm.	Allow. Len. Bet. Stiff. mm.	Ring Inertia Required cm**4	Ring Inertia Available cm**4
10	20	No Calc	No Calc	No Calc	No Calc
20	30	1716.67	No Calc	No Calc	No Calc
30	40	No Calc	No Calc	No Calc	No Calc

Elements Suitable for External 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	33.2791	64152.3	33.2791	64152.3	...
20	30	130.234	577371.	130.234	577371.	...
30	40	33.2791	64152.3	33.2791	64152.3	...
Total		196	705675.75	196	705675.75	0

Weight of Details

From	Type	Weight of Detail kg.	X Offset, Dtl. Cent. mm.	Y Offset, Dtl. Cent. mm.	Description
20	Sadl	37.6574	300.000	520.000	Lft Sdl
20	Sadl	37.6574	1200.00	520.000	Sdl 2 Fr20
20	Nozl	8.92336	1420.00	380.150	R1-intrare meta
20	Nozl	4.40331	1420.00	380.000	R2-retur supape
20	Nozl	1.99842	100.000	366.850	R6-SS
20	Nozl	3.13118	420.000	366.850	R3-Iesire metan
20	Nozl	3.13118	1080.00	366.850	R4-iesire metan
20	Nozl	1.99842	1080.00	366.850	R7
20	Nozl	4.40331	500.000	366.850	R5-evacuare gaz
20	Nozl	1.85496	700.000	367.500	R8-aerisire
20	Nozl	1.85496	1200.00	367.500	R9-intrare azot
20	Nozl	4.40331	880.000	360.000	r10

20|Nozl|	4.40331 |	880.000 |	360.000 |	R11
20|Nozl|	4.40331 |	940.000 |	360.000 |	R13
20|Nozl|	1.96736 |	300.000 |	367.500 |	R12
20|Nozl|	1.96736 |	940.000 |	367.500 |	R14
20|Nozl|	0.30000 |	500.000 |	362.500 |	R15
20|Nozl|	0.30000 |	800.000 |	362.500 |	R16
20|Nozl|	102.837 |	800.000 |	511.950 |	R17

Total Weight of Each Detail Type

Total Weight of Saddles	75.3
Total Weight of Nozzles	152.3
Sum of the Detail Weights	227.6 kg.

Weight Summary

Fabricated Wt.	- Bare Weight W/O Removable Internals	424.4 kg.
Shop Test Wt.	- Fabricated Weight + Water (Full)	1129.6 kg.
Shipping Wt.	- Fab. Wt + Rem. Intls.+ Shipping App.	424.4 kg.
Erected Wt.	- Fab. Wt + Rem. Intls.+ Insul. (etc)	424.4 kg.
Ope. Wt. no Liq	- Fab. Wt + Intls. + Details + Wghts.	424.4 kg.
Operating Wt.	- Empty Wt + Operating Liq. Uncorroded	424.4 kg.
Oper. Wt. + CA	- Corr Wt. + Operating Liquid	424.4 kg.
Field Test Wt.	- Empty Weight + Water (Full)	1129.6 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 cm^2
10	20	6613.61
20	30	33458.0
30	40	6613.61
Total		46685.172 cm^2

Nozzle Flange MAWP Results :

Nozzle Description	----- Flange Rating Operating bars	Ambient bars	Temperature C	Class	Grade|Group
R1-intrare meta	19.0	19.6	60	150	GR 1.1
R2-retur supape	19.0	19.6	60	150	GR 1.1
R6-SS	19.0	19.6	60	150	GR 1.1
R3-Iesire metan	19.0	19.6	60	150	GR 1.1
R4-iesire metan	19.0	19.6	60	150	GR 1.1
R7	19.0	19.6	60	150	GR 1.1
R5-evacuare gaz	19.0	19.6	60	150	GR 1.1
R8-aerisire	19.0	19.6	60	150	GR 1.1
R9-intrare azot	19.0	19.6	60	150	GR 1.1
r10	19.0	19.6	60	150	GR 1.1
R11	19.0	19.6	60	150	GR 1.1
R13	19.0	19.6	60	150	GR 1.1
R12	19.0	19.6	60	150	GR 1.1
R14	19.0	19.6	60	150	GR 1.1
R15	19.0	19.6	60	150	GR 1.1
R16	19.0	19.6	60	150	GR 1.1
R17	19.0	19.6	60	150	GR 1.1
Minimum Rating	18.960	19.650	bars		

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	1.416	
Shape Factor (Cf) for the Vessel is	0.526	
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)*(2.563 - 1) / (7 - 1)

= 0.526

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

= 700.000 + 0.000 = 700.000 mm.

but: z = Max(4572.000 , 700.000) = 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

= 1781.000 (^2) / 12374.158

= 2.563

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]

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

$= 2.35 * Sqrt(0.005 / 1781.000)^{1/9144.000}$

= 0.210

Compute [Gh]

= 0.65 + 3.65 * tz

= 0.65 + 3.65 * 0.210 = 1.416

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 Kgs/m^2

Force on the First Element [Fz]

= qz * Gh * CF * Wind Area

= 49.052 * 1.416 * 0.526 * 1439.358

= 5.260 Kgf

Element	z mm.	GH	Area cm^2	qz Kgs/m^2	Force Kgf
Node 10 to 20	700.0	1.416	1439.4	49.1	5.3
Node 20 to 30	700.0	1.416	12780.0	49.1	46.7
Node 30 to 40	700.0	1.416	1439.4	49.1	5.3

Wind Load Calculation

From	To	Wind Height mm.	Wind Diameter mm.	Wind Area cm^2	Height Factor Kgs/m^2	Element Wind Load Kgf
10	20	700.000	854.400	1439.36	49.0518	5.25994
20	30	700.000	852.000	12780.0	49.0518	46.7028
30	40	700.000	854.400	1439.36	49.0518	5.25994

Earthquake Analysis Results

The UBC Zone Factor for the Vessel is	0.0000	
The Importance Factor as Specified by the User is .	1.000	
The UBC Frequency and Soil Factor (C) is	2.750	
The UBC Force Factor as Specified by the User is ..	3.000	
The UBC Total Weight (W) for the Vessel is	424.4	Kgf
The UBC Total Shear (V) for the Vessel is	0.0	Kgf
The UBC Top Shear (Ft) for the Vessel is	0.0	Kgf

Earthquake Load Calculation

From	To	Earthquake Height mm.	Earthquake Weight Kgf	Element Ope Load Kgf
10	20	350.000	84.8776	...
20	Sadl	350.000	84.8776	...
Sadl	30	350.000	84.8776	...
20	30	350.000	84.8776	...
30	40	350.000	84.8776	...

Shop/Field Installation Options :

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

Center of Gravity of Saddles	800.000 mm.
Center of Gravity of Nozzles	895.103 mm.
Center of Gravity of Bare Shell New and Cold	800.000 mm.
Center of Gravity of Bare Shell Corroded	800.000 mm.
Vessel CG in the Operating Condition	834.125 mm.
Vessel CG in the Fabricated (Shop/Empty) Condition	834.125 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	352.50	mm.
Stiffened Vessel Length per 4.15.6	L	1600.00	mm.
Distance from Saddle to Vessel tangent	a	225.80	mm.
Saddle Width	b	150.00	mm.
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	150.00	mm.
Wear Plate Bearing Angle	theta1	132.00	
Wear Plate Thickness	tr	5.0	mm.
Wear Plate Allowable Stress	Sr	95.15	N./mm^2
Inside Depth of Head	h2	175.00	mm.
Shell Allowable Stress used in Calculation		165.01	N./mm^2
Head Allowable Stress used in Calculation		165.01	N./mm^2
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Operating Case		256.85	Kgf

Horizontal Vessel Analysis Results: Actual Allowable

Long. Stress at Top of Midspan	20.96	165.01	N./mm^2
Long. Stress at Bottom of Midspan	21.34	165.01	N./mm^2
Long. Stress at Top of Saddles	21.53	165.01	N./mm^2
Long. Stress at Bottom of Saddles	20.94	165.01	N./mm^2
Tangential Shear in Shell	1.05	99.00	N./mm^2
Circ. Stress at Horn of Saddle	2.98	206.26	N./mm^2
Circ. Compressive Stress in Shell	0.18	165.01	N./mm^2

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 * (57.2 /2 + 0) * 700.0000 / 610.5480

= 98.4 Kgf

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

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

= Max(23.30 , 0.00 , 0) * 700.0000 / 900.0001

= 18.1 Kgf

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

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

= 158 + Max(18 , 98 , 0 , 0)

= 256.9 Kgf

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	294.51	Kgf
Transverse Shear Load Saddle	28.61	Kgf
Longitudinal Shear Load Saddle	23.30	Kgf

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 = 0.0244 K8 = 0.3405

K9 = 0.2711 K10 = 0.0581 K1* = 0.1923 K6p = 0.0434

K7P = 0.0200

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

Note: Dimension a is greater than or equal to Rm / 2.

Moment per Equation 4.15.3 [M1]:

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

= -256*225.80[1-(1-225.80/1600.00+(352.500²-175.000²)/

(2*225.80*1600.00))/(1+(4*175.00)/(3*1600.00))]

= -8.0 Kg-m.

Moment per Equation 4.15.4 [M2]:

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

= 256*1600/4(1+2(352²-175²)/(1600²))/(1+(4*175)/

(3*1600))-4*225/1600

= 38.2 Kg-m.

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

= P * Rm/(2t) - M2/(pi*Rm²t)

= 6.00 * 352.500 /(2*5.00) - 38.2 /(pi*352.5²*5.00)

= 20.96 N./mm^2

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

= P * Rm/(2t) + M2/(pi * Rm² * t)

= 6.00 * 352.500 /(2 * 5.00) + 38.2 /(pi * 352.5² * 5.00)

= 21.34 N./mm^2

Longitudinal Stress at Top of Shell at Support (4.15.10) [Sigma*3]:

= P * Rm/(2t) - M1/(K1*pi*Rm²t)

= 6.00 * 352.500 /(2*5.00) - -8.0 /(0.1066 *pi*352.5²*5.00)

= 21.53 N./mm^2

Longitudinal Stress at Bottom of Shell at Support (4.15.11) [Sigma*4]:

= P * Rm/(2t) + M1/(K1* * pi * Rm² * t)

= 6.00 * 352.500 /(2*5.00) + -8.0 /(0.1923 * pi * 352.5² * 5.00)

= 20.94 N./mm^2

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

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

= 256 (1600.00 - 2 * 225.80)/(1600.00 + (4 * 175.00 /3))

= 160.9 Kgf

Shear Stress in the shell no rings, not stiffened (4.15.14) [tau2]:

= K2 * T / (Rm * t)

= 1.1707 * 160.89 / (352.5000 * 5.0000)

= 1.05 N./mm^2

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(352.500 * 5.000)

= 32.746 mm.

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

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

= -0.7603 * 256 * 0.1 / (5.000 * (150.00 + 32.75 + 32.75))

= -0.18 N./mm^2

Effective reinforcing plate width (4.15.1) [B1]:

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

= min(150.00 + 1.56 * sqrt(352.500 * 5.000), 2 * 225.800)

= 215.49 mm.

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

= min(Sr/S, 1)

= min(95.151 / 165.008 , 1)

= 0.5766

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

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

= -0.7603 * 256 * 0.1 / (215.492 (5.000 + 0.577 * 5.000))

= -0.11 N./mm^2

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)

= -256 /(4(5.000 + 0.577 * 5.000)215.492) -

12*0.024*256*352.500/(1600.00(5.000+0.577*5.000)²)

= -2.98 N./mm^2

Results for Vessel Ribs, Web and Base:

Baseplate Length	Bplen	700.0000	mm.
Baseplate Thickness	Bpthk	10.0000	mm.
Baseplate Width	Bpwid	150.0000	mm.
Number of Ribs (inc. outside ribs)	Nribs	2	
Rib Thickness	Ribtk	8.0000	mm.

Web Thickness	Webtk	8.0000	mm.
Web Location	Webloc	Side	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	2.	11.	2691.	1.
Wearplate	7.	8.	5625.	4.
Web	152.	23.	347228.	6832.
BasePlate	300.	15.	449700.	13483.
Totals	462.	56.	805244.	20320.

Value C1 = Sumof(Ay)/Sumof(A)	=	144.	mm.
Value I = Sumof(Io) - C1*Sumof(Ay)	=	8751.	cm**4
Value As = Sumof(A) - Ashell	=	45.	cm^2

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

Fh = K1 * Q = 0.2035 * 256.855 = 52.2755 Kgf

Tension Stress, St = (Fh/As)	=	0.1132	N./mm^2
Allowed Stress, Sa = 0.6 * Yield Str	=	143.9676	N./mm^2
d = B - R*Sin(theta) / theta	=	365.3523	mm.
Bending Moment, M = Fh * d	=	19.0994	Kg-m.
Bending Stress, Sb = (M * C1 / I)	=	0.3075	N./mm^2
Allowed Stress, Sa = 2/3 * Yield Str	=	159.9640	N./mm^2

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (2 * BasePlateLength *

AllStress))½

= (3 * (256 + 37) * 150.00 / (2 * 700.000 * 159.964))½

= 2.409 mm.

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

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

= (700.0000 - 25.4) / (2 - 1) = 674.6000 mm.

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 674.6000 * 150.0000 / 2 = 505.9500 cm^2

Axial Load [P]:

= Ap * Bp

= 506.0 * 0.24 = 123.8 Kgf

Area of the Rib and Web [Ar]:

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

= (150.000 - 25.4 - 8.000) * 8.000 + 674.6000 /2 * 8.000

= 36.312 cm^2

Compressive Stress [Sc]:

= P/Ar

= 123.8 / 36.3120 = 0.3343 N./mm^2

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	66.3	10.3	68580.7	209.8	172.6

Web	4.0	27.0	10793.6	80.4	2.9
Values	21.3	37.3	79374.3	290.2	175.4

Bending Moment [Rm]:

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

= 23.3 /(2 * 700.00) * 674.600 * 477.30 / 2

= 2.680 Kg-m.

KL/R < Cc (13.3286 < 128.2549) per AISC E2-1

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

Sca = $(1-(13.33)^2/(2 * 128.25^2)) * 239 /$

$(5/3+3*(13.33)/(8* 128.25)-(13.33^3)/(8*128.25^3)$

Sca = 139.93 N./mm^2

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

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

Check = 0.33 / 139.93 + (2.68 /4.506) / 159.96

Check = 0.01

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	352.50	mm.
Stiffened Vessel Length per 4.15.6	L	1600.00	mm.
Distance from Saddle to Vessel tangent	a	225.80	mm.
Saddle Width	b	150.00	mm.
Saddle Bearing Angle	theta	120.00	

Wear Plate Width	b1	150.00	mm.
Wear Plate Bearing Angle	theta1	132.00	
Wear Plate Thickness	tr	5.0	mm.
Wear Plate Allowable Stress	Sr	95.15	N./mm^2
Inside Depth of Head	h2	175.00	mm.
Shell Allowable Stress used in Calculation		165.01	N./mm^2
Head Allowable Stress used in Calculation		165.01	N./mm^2
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Operating Case		289.04	Kgf

Horizontal Vessel Analysis Results:

	Actual	Allowable	
Long. Stress at Top of Midspan	20.94	165.01	N./mm^2
Long. Stress at Bottom of Midspan	21.37	165.01	N./mm^2
Long. Stress at Top of Saddles	21.57	165.01	N./mm^2
Long. Stress at Bottom of Saddles	20.92	165.01	N./mm^2
Tangential Shear in Shell	1.18	99.00	N./mm^2
Circ. Stress at Horn of Saddle	3.35	206.26	N./mm^2
Circ. Compressive Stress in Shell	0.20	165.01	N./mm^2

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 * (57.2 /2 + 0) * 700.0000 / 610.5480

= 98.4 Kgf

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

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

= Max(23.30 , 0.00 , 0) * 700.0000 / 900.0001

= 18.1 Kgf

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

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

= 190 + Max(18 , 98 , 0 , 0)

= 289.0 Kgf

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	326.70	Kgf
Transverse Shear Load Saddle	28.61	Kgf
Longitudinal Shear Load Saddle	23.30	Kgf

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 = 0.0244	K8 = 0.3405
K9 = 0.2711	K10 = 0.0581	K1* = 0.1923	K6p = 0.0434
K7P = 0.0200			

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

Note: Dimension a is greater than or equal to Rm / 2.

Moment per Equation 4.15.3 [M1]:

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

= -289*225.80[1-(1-225.80/1600.00+(352.500²-175.000²)/

(2*225.80*1600.00))/(1+(4*175.00)/(3*1600.00))]

= -9.0 Kg-m.

Moment per Equation 4.15.4 [M2]:

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

= 289*1600/4(1+2(352²-175²)/(1600²))/(1+(4*175)/

(3*1600))-4*225/1600

= 43.0 Kg-m.

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

= P * Rm/(2t) - M2/(pi*Rm²t)

= 6.00 * 352.500 /(2*5.00) - 43.0 /(pi*352.5²*5.00)

= 20.94 N./mm^2

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

= P * Rm/(2t) + M2/(pi * Rm² * t)

= 6.00 * 352.500 /(2 * 5.00) + 43.0 /(pi * 352.5² * 5.00)

= 21.37 N./mm^2

Longitudinal Stress at Top of Shell at Support (4.15.10) [Sigma*3]:

= P * Rm/(2t) - M1/(K1*pi*Rm²t)

= 6.00 * 352.500 /(2*5.00) - -9.0 /(0.1066 *pi*352.5²*5.00)

= 21.57 N./mm^2

Longitudinal Stress at Bottom of Shell at Support (4.15.11) [Sigma*4]:

= P * Rm/(2t) + M1/(K1* * pi * Rm² * t)

= 6.00 * 352.500 /(2*5.00) + -9.0 /(0.1923 * pi * 352.5² * 5.00)

= 20.92 N./mm^2

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

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

= 289 ( 1600.00 - 2 * 225.80 )/(1600.00 + ( 4 * 175.00 /3))

= 181.1 Kgf
```

Shear Stress in the shell no rings, not stiffened (4.15.14) [tau2]:

```
= K2 * T / ( Rm * t )

= 1.1707 * 181.05 / ( 352.5000 * 5.0000 )

= 1.18 N./mm^2
```

Decay Length (4.15.22) [x1,x2]:

```
= 0.78 * sqrt( Rm * t )

= 0.78 * sqrt( 352.500 * 5.000 )

= 32.746 mm.
```

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

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

= -0.7603 * 289 * 0.1 / ( 5.000 * ( 150.00 + 32.75 + 32.75 ) )

= -0.20 N./mm^2
```

Effective reinforcing plate width (4.15.1) [B1]:

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

= min( 150.00 + 1.56 * sqrt( 352.500 * 5.000 ), 2 * 225.800 )

= 215.49 mm.
```

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

```
= min( Sr/S, 1 )

= min( 95.151 / 165.008 , 1 )

= 0.5766
```

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

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

= -0.7603 * 289 * 0.1 / (215.492 (5.000 + 0.577 * 5.000))

= -0.13 N./mm^2

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

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

= -289 /(4(5.000 + 0.577 * 5.000)215.492) -

$12*0.024*289*352.500/(1600.00(5.000+0.577*5.000)^2)$

= -3.35 N./mm^2

Results for Vessel Ribs, Web and Base

Baseplate Length	Bplen	700.0000	mm.
Baseplate Thickness	Bpthk	10.0000	mm.
Baseplate Width	Bpwid	150.0000	mm.
Number of Ribs (inc. outside ribs)	Nribs	2	
Rib Thickness	Ribtk	8.0000	mm.
Web Thickness	Webtk	8.0000	mm.
Web Location	Webloc	Side	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	2.	11.	2691.	1.
Wearplate	7.	8.	5625.	4.
Web	152.	23.	347228.	6832.
BasePlate	300.	15.	449700.	13483.
Totals	462.	56.	805244.	20320.

Value C1 = Sumof(Ay)/Sumof(A) = 144. mm.

Value I = Sumof(Io) - C1*Sumof(Ay) = 8751. cm**4

Value As = Sumof(A) - Ashell = 45. cm^2

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

Fh = K1 * Q = 0.2035 * 289.038 = 58.8255 Kgf

Tension Stress, St = (Fh/As) = 0.1274 N./mm^2

Allowed Stress, Sa = 0.6 * Yield Str = 143.9676 N./mm^2

d = B - R*Sin(theta) / theta = 365.3523 mm.

Bending Moment, M = Fh * d = 21.4924 Kg-m.

Bending Stress, Sb = (M * C1 / I) = 0.3460 N./mm^2

Allowed Stress, Sa = 2/3 * Yield Str = 159.9640 N./mm^2

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (2 * BasePlateLength *
AllStress))½

= (3 * (289 + 37) * 150.00 / (2 * 700.000 * 159.964))½

= 2.537 mm.

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

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

= (700.0000 - 25.4) / (2 - 1) = 674.6000 mm.

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 674.6000 * 150.0000 / 2 = 505.9500 cm^2

Axial Load [P]:

= Ap * Bp

= 506.0 * 0.28 = 139.3 Kgf

Area of the Rib and Web [Ar]:

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

= (150.000 - 25.4 - 8.000) * 8.000 + 674.6000 /2 * 8.000

= 36.312 cm^2

Compressive Stress [Sc]:

= P/Ar

= 139.3 / 36.3120 = 0.3761 N./mm^2

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	66.3	10.3	68580.7	209.8	172.6
Web	4.0	27.0	10793.6	80.4	2.9
Values	21.3	37.3	79374.3	290.2	175.4

Bending Moment [Rm]:

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

= 23.3 /(2 * 700.00) * 674.600 * 477.30 / 2

= 2.680 Kg-m.

KL/R < Cc (13.3286 < 128.2549) per AISC E2-1

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

Sca = (1-(13.33)²/(2 * 128.25²)) * 239 /

(5/3+3*(13.33)/(8* 128.25)-(13.33³)/(8*128.25³)

Sca = 139.93 N./mm^2

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

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

Check = 0.38 / 139.93 + (2.68 /4.506) / 159.96

Check = 0.01

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	352.50	mm.
Stiffened Vessel Length per 4.15.6	L	1600.00	mm.
Distance from Saddle to Vessel tangent	a	225.80	mm.
Saddle Width	b	150.00	mm.
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	150.00	mm.
Wear Plate Bearing Angle	theta1	132.00	
Wear Plate Thickness	tr	5.0	mm.
Wear Plate Allowable Stress	Sr	95.15	N./mm^2
Inside Depth of Head	h2	175.00	mm.
Shell Allowable Stress used in Calculation		180.01	N./mm^2
Head Allowable Stress used in Calculation		180.01	N./mm^2
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Test Case, no Ext. Forces		543.54	Kgf

Horizontal Vessel Analysis Results: Actual Allowable

Long. Stress at Top	of Midspan	109.00	180.01	N./mm^2
Long. Stress at Bottom	of Midspan	109.81	180.01	N./mm^2
Long. Stress at Top	of Saddles	110.20	180.01	N./mm^2
Long. Stress at Bottom	of Saddles	108.97	180.01	N./mm^2

Tangential Shear in Shell	2.22	108.00	N./mm^2
Circ. Stress at Horn of Saddle	6.69	225.01	N./mm^2
Circ. Compressive Stress in Shell	0.38	180.01	N./mm^2

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 * (18.9 /2 + 0) * 700.0000 / 610.5480

= 32.5 Kgf

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

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

= Max(23.30 , 0.00 , 0) * 700.0000 / 900.0001

= 6.0 Kgf

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

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

= 511 + Max(5 , 32 , 0 , 0)

= 543.5 Kgf

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	581.20	Kgf
Transverse Shear Load Saddle	9.44	Kgf
Longitudinal Shear Load Saddle	7.69	Kgf

Hydrostatic Test Pressure at center of Vessel: 31.036 bars

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 = 0.0244 K8 = 0.3405

K9 = 0.2711 K10 = 0.0581 K1* = 0.1923 K6p = 0.0434

K7P = 0.0200

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

Note: Dimension a is greater than or equal to Rm / 2.

Moment per Equation 4.15.3 [M1]:

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

= -543*225.80[1-(1-225.80/1600.00+(352.500²-175.000²)/

(2*225.80*1600.00))/(1+(4*175.00)/(3*1600.00))]

= -16.9 Kg-m.

Moment per Equation 4.15.4 [M2]:

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

= 543*1600/4(1+2(352²-175²)/(1600²))/(1+(4*175)/

(3*1600))-4*225/1600

= 80.9 Kg-m.

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

= P * Rm/(2t) - M2/(pi*Rm²t)

= 31.04 * 352.500 /(2*5.00) - 80.9 /(pi*352.5²*5.00)

= 109.00 N./mm^2

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

= P * Rm/(2t) + M2/(pi * Rm² * t)

= 31.04 * 352.500 /(2 * 5.00) + 80.9 /(pi * 352.5² * 5.00)

= 109.81 N./mm^2

Longitudinal Stress at Top of Shell at Support (4.15.10) [Sigma*3]:

= P * Rm/(2t) - M1/(K1*pi*Rm²t)

= 31.04 * 352.500 /(2*5.00) - -16.9 /(0.1066 *pi*352.5²*5.00)

= 110.20 N./mm^2

Longitudinal Stress at Bottom of Shell at Support (4.15.11) [Sigma*4]:

= P * Rm/(2t) + M1/(K1* * pi * Rm² * t)

= 31.04 * 352.500 /(2*5.00) + -16.9 /(0.1923 * pi * 352.5² * 5.00)

= 108.97 N./mm^2

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

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

= 543 (1600.00 - 2 * 225.80)/(1600.00 + (4 * 175.00 /3))

= 340.5 Kgf

Shear Stress in the shell no rings, not stiffened (4.15.14) [tau2]:

= K2 * T / (Rm * t)

= 1.1707 * 340.48 / (352.5000 * 5.0000)

= 2.22 N./mm^2

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(352.500 * 5.000)

= 32.746 mm.

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

```
= -K5 * Q * k / ( t * ( b + X1 + X2 ) )
= -0.7603 * 543 * 0.1 / ( 5.000 * ( 150.00 + 32.75 + 32.75 ) )
= -0.38 N./mm^2
```

Effective reinforcing plate width (4.15.1) [B1]:

```
= min( b + 1.56 * sqrt( Rm * t ), 2a  )
= min( 150.00 + 1.56 * sqrt( 352.500 * 5.000 ), 2 * 225.800 )
= 215.49 mm.
```

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

```
= min( Sr/S, 1 )
= min( 95.151 / 180.006 , 1 )
= 0.5286
```

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

```
= -K5 * Q * k / ( B1( t + eta * tr ) )
= -0.7603 * 543 * 0.1 / ( 215.492 ( 5.000 + 0.529 * 5.000 ) )
= -0.25 N./mm^2
```

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)
= -543 /(4(5.000 + 0.529 * 5.000 )215.492 ) -
   12*0.024*543*352.500/(1600.00(5.000+0.529*5.000)²)
= -6.69 N./mm^2
```

Results for Vessel Ribs, Web and Base:

Baseplate Length	Bplen	700.0000	mm.
Baseplate Thickness	Bpthk	10.0000	mm.
Baseplate Width	Bpwid	150.0000	mm.

Number of Ribs (inc. outside ribs)	Nribs	2	
Rib Thickness	Ribtk	8.0000	mm.
Web Thickness	Webtk	8.0000	mm.
Web Location	Webloc	Side	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	2.	11.	2691.	1.
Wearplate	7.	8.	5625.	4.
Web	152.	23.	347228.	6832.
BasePlate	300.	15.	449700.	13483.
Totals	462.	56.	805244.	20320.

Value C1 = Sumof(Ay)/Sumof(A)	=	144.	mm.
Value I = Sumof(Io) - C1*Sumof(Ay)	=	8751.	cm**4
Value As = Sumof(A) - Ashell	=	45.	cm^2

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

Fh = K1 * Q = 0.2035 * 543.543 = 110.6228 Kgf

Tension Stress, St = (Fh/As)	=	0.2396	N./mm^2
Allowed Stress, Sa = 0.6 * Yield Str	=	143.9676	N./mm^2
d = B - R*Sin(theta) / theta	=	365.3523	mm.
Bending Moment, M = Fh * d	=	40.4171	Kg-m.
Bending Stress, Sb = (M * C1 / I)	=	0.6507	N./mm^2
Allowed Stress, Sa = 2/3 * Yield Str	=	159.9640	N./mm^2

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (2 * BasePlateLength *
AllStress))½

= (3 * (543 + 37) * 150.00 / (2 * 700.000 * 159.964))½

= 3.384 mm.

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

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

= (700.0000 - 25.4) / (2 - 1) = 674.6000 mm.

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 674.6000 * 150.0000 / 2 = 505.9500 cm^2

Axial Load [P]:

= Ap * Bp

= 506.0 * 0.52 = 261.9 Kgf

Area of the Rib and Web [Ar]:

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

= (150.000 - 25.4 - 8.000) * 8.000 + 674.6000 /2 * 8.000

= 36.312 cm^2

Compressive Stress [Sc]:

= P/Ar

= 261.9 / 36.3120 = 0.7073 N./mm^2

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	66.3	10.3	68580.7	209.8	172.6
Web	4.0	27.0	10793.6	80.4	2.9
Values	21.3	37.3	79374.3	290.2	175.4

Bending Moment [Rm]:

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

= 7.7 /(2 * 700.00) * 674.600 * 477.30 / 2

= 0.884 Kg-m.

KL/R < Cc (13.3286 < 128.2549) per AISC E2-1

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

Sca = (1-(13.33)²/(2 * 128.25²)) * 239 /

(5/3+3*(13.33)/(8* 128.25)-(13.33³)/(8*128.25³)

Sca = 139.93 N./mm^2

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

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

Check = 0.71 / 139.93 + (0.88 /4.506) / 159.96

Check = 0.01

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	352.50	mm.
Stiffened Vessel Length per 4.15.6	L	1600.00	mm.
Distance from Saddle to Vessel tangent	a	225.80	mm.

Saddle Width	b	150.00	mm.
Saddle Bearing Angle	theta	120.00	
Wear Plate Width	b1	150.00	mm.
Wear Plate Bearing Angle	theta1	132.00	
Wear Plate Thickness	tr	5.0	mm.
Wear Plate Allowable Stress	Sr	95.15	N./mm^2
Inside Depth of Head	h2	175.00	mm.
Shell Allowable Stress used in Calculation		180.01	N./mm^2
Head Allowable Stress used in Calculation		180.01	N./mm^2
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Test Case, no Ext. Forces		575.73	Kgf

Horizontal Vessel Analysis Results:

	Actual	Allowable	
Long. Stress at Top of Midspan	108.98	180.01	N./mm^2
Long. Stress at Bottom of Midspan	109.84	180.01	N./mm^2
Long. Stress at Top of Saddles	110.25	180.01	N./mm^2
Long. Stress at Bottom of Saddles	108.94	180.01	N./mm^2
Tangential Shear in Shell	2.35	108.00	N./mm^2
Circ. Stress at Horn of Saddle	7.08	225.01	N./mm^2
Circ. Compressive Stress in Shell	0.40	180.01	N./mm^2

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 * (18.9 /2 + 0) * 700.0000 / 610.5480

= 32.5 Kgf

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

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

= Max(23.30 , 0.00 , 0) * 700.0000 / 900.0001

= 6.0 Kgf

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

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

= 543 + Max(5 , 32 , 0 , 0)

= 575.7 Kgf

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	613.38	Kgf
Transverse Shear Load Saddle	9.44	Kgf
Longitudinal Shear Load Saddle	7.69	Kgf

Hydrostatic Test Pressure at center of Vessel: 31.036 bars

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 = 0.0244	K8 = 0.3405
K9 = 0.2711	K10 = 0.0581	K1* = 0.1923	K6p = 0.0434
K7P = 0.0200			

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

Note: Dimension a is greater than or equal to Rm / 2.

Moment per Equation 4.15.3 [M1]:

```
= -Q*a [1 - (1- a/L + (R²-h2²)/(2a*L))/(1+(4h2)/3L)]
= -575*225.80[1-(1-225.80/1600.00+(352.500²-175.000²)/
  (2*225.80*1600.00))/(1+(4*175.00)/(3*1600.00))]
= -17.9 Kg-m.
```

Moment per Equation 4.15.4 [M2]:

```
= Q*L/4(1+2(R²-h2²)/(L²))/(1+(4h2)/( 3L))-4a/L
= 575*1600/4(1+2(352²-175²)/(1600²))/(1+(4*175)/
  (3*1600))-4*225/1600
= 85.7 Kg-m.
```

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

```
= P * Rm/(2t) - M2/(pi*Rm²t)
= 31.04 * 352.500 /(2*5.00 ) - 85.7 /(pi*352.5²*5.00 )
= 108.98 N./mm^2
```

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

```
= P * Rm/(2t) + M2/(pi * Rm² * t)
= 31.04 * 352.500 /(2 * 5.00 ) + 85.7 /(pi * 352.5² * 5.00 )
= 109.84 N./mm^2
```

Longitudinal Stress at Top of Shell at Support (4.15.10) [Sigma*3]:

```
= P * Rm/(2t) - M1/(K1*pi*Rm²t)
= 31.04 * 352.500 /(2*5.00 ) - -17.9 /(0.1066 *pi*352.5²*5.00 )
= 110.25 N./mm^2
```

Longitudinal Stress at Bottom of Shell at Support (4.15.11) [Sigma*4]:

= P * Rm/(2t) + M1/(K1* * pi * Rm² * t)

= 31.04 * 352.500 /(2*5.00) + -17.9 /(0.1923 * pi * 352.5² * 5.00)

= 108.94 N./mm^2

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

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

= 575 (1600.00 - 2 * 225.80)/(1600.00 + (4 * 175.00 /3))

= 360.6 Kgf

Shear Stress in the shell no rings, not stiffened (4.15.14) [tau2]:

= K2 * T / (Rm * t)

= 1.1707 * 360.63 / (352.5000 * 5.0000)

= 2.35 N./mm^2

Decay Length (4.15.22) [x1,x2]:

= 0.78 * sqrt(Rm * t)

= 0.78 * sqrt(352.500 * 5.000)

= 32.746 mm.

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

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

= -0.7603 * 575 * 0.1 / (5.000 * (150.00 + 32.75 + 32.75))

= -0.40 N./mm^2

Effective reinforcing plate width (4.15.1) [B1]:

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

= min(150.00 + 1.56 * sqrt(352.500 * 5.000), 2 * 225.800)

= 215.49 mm.

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

= min(Sr/S, 1)

= min(95.151 / 180.006 , 1)

= 0.5286

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

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

= -0.7603 * 575 * 0.1 / (215.492 (5.000 + 0.529 * 5.000))

= -0.26 N./mm^2

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)

= -575 /(4(5.000 + 0.529 * 5.000)215.492) -

12*0.024*575*352.500/(1600.00(5.000+0.529*5.000)²)

= -7.08 N./mm^2

Results for Vessel Ribs, Web and Base

Baseplate Length	Bplen	700.0000	mm.
Baseplate Thickness	Bpthk	10.0000	mm.
Baseplate Width	Bpwid	150.0000	mm.
Number of Ribs (inc. outside ribs)	Nribs	2	
Rib Thickness	Ribtk	8.0000	mm.
Web Thickness	Webtk	8.0000	mm.
Web Location	Webloc	Side	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	2.	11.	2691.	1.
Wearplate	7.	8.	5625.	4.
Web	152.	23.	347228.	6832.

BasePlate	300.	15.	449700.	13483.
Totals	462.	56.	805244.	20320.

Value C1 = Sumof(Ay)/Sumof(A) = 144. mm.

Value I = Sumof(Io) - C1*Sumof(Ay) = 8751. cm**4

Value As = Sumof(A) - Ashell = 45. cm^2

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

Fh = K1 * Q = 0.2035 * 575.726 = 117.1727 Kgf

Tension Stress, St = (Fh/As) = 0.2538 N./mm^2

Allowed Stress, Sa = 0.6 * Yield Str = 143.9676 N./mm^2

d = B - R*Sin(theta) / theta = 365.3523 mm.

Bending Moment, M = Fh * d = 42.8102 Kg-m.

Bending Stress, Sb = (M * C1 / I) = 0.6893 N./mm^2

Allowed Stress, Sa = 2/3 * Yield Str = 159.9640 N./mm^2

Minimum Thickness of Baseplate per Moss :

= (3 * (Q + Saddle_Wt) * BasePlateWidth / (2 * BasePlateLength *
AllStress))½

= (3 * (575 + 37) * 150.00 / (2 * 700.000 * 159.964))½

= 3.477 mm.

Calculation of Axial Load, Intermediate Values and Compressive Stress

Effective Baseplate Length [e]:

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

= (700.0000 - 25.4) / (2 - 1) = 674.6000 mm.

Baseplate Pressure Area [Ap]:

= e * Bpwid / 2

= 674.6000 * 150.0000 / 2 = 505.9500 cm^2

Axial Load [P]:

= Ap * Bp

= 506.0 * 0.55 = 277.4 Kgf

Area of the Rib and Web [Ar]:

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

= (150.000 - 25.4 - 8.000) * 8.000 + 674.6000 /2 * 8.000

= 36.312 cm^2

Compressive Stress [Sc]:

= P/Ar

= 277.4 / 36.3120 = 0.7492 N./mm^2

Check of Outside Ribs:

Inertia of Saddle, Outer Ribs - Longitudinal Direction

	Y	A	AY	Ay²	Io
Rib	66.3	10.3	68580.7	209.8	172.6
Web	4.0	27.0	10793.6	80.4	2.9
Values	21.3	37.3	79374.3	290.2	175.4

Bending Moment [Rm]:

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

= 7.7 /(2 * 700.00) * 674.600 * 477.30 / 2

= 0.884 Kg-m.

KL/R < Cc (13.3286 < 128.2549) per AISC E2-1

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

Sca = (1-(13.33)²/(2 * 128.25²)) * 239 /

(5/3+3*(13.33)/(8* 128.25)-(13.33³)/(8*128.25³)

Sca = 139.93 N./mm^2

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

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

Check = 0.75 / 139.93 + (0.88 /4.506) / 159.96

Check = 0.01

INPUT VALUES, Nozzle Description: R1-intrare meta From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Cylinder/Cone Centerline	L1	190.0000	mm.
Distance from Bottom/Left Tangent		1470.0000	mm.

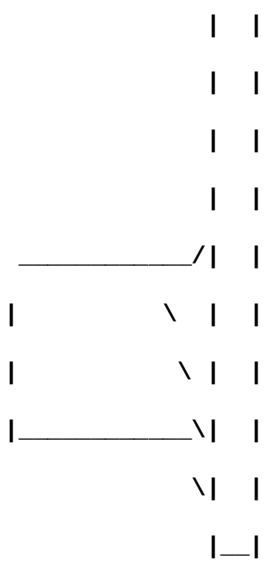
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		122.36	deg
Diameter		60.3000	mm.
Size and Thickness Basis		Actual	

Actual Thickness	tn	5.6000	mm.
Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	500.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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, with Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R1-intrare meta

Actual Outside Diameter Used in Calculation	60.300	mm.
Actual Thickness Used in Calculation	5.600	mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 49.100 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.089 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((60.300 -2*0.000 -5.600)*5.600),150.000)

= 17.5020 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(500.000 , 05*17.502)

= 8.7510 mm.

Compute cone pressure area per Equation 9.5.36 [Aps]:

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

= 0.5*(59.372 +24.550)*(2*350.000 +(59.372 +24.550)*tan(0.00))

= 293.7260 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 49.100² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 60.300 /2)*350.000 + 2.374 /2*(5.000 +0.000)

= 314.8335 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 17.502 * 49.100 / 2

= 4.2967 cm^2

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 -60.300 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 5.600)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=17.502 *5.600 +8.751 *(5.600 -0.000 +0.000

= 1.4702 cm^2

Afp = Ip * eap = 1.782 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(165.008 , 165.008) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000) = 0.000 N./mm^2

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)

= (2.969 + 0.454) * (165.008 - 0.5 * 6.000) +

(0.000 * (Min(165.008 , 0.000) - 0.50 * 6.000) +

(1.470 * (Min(165.008 , 165.008) - 0.50 * 6.000)

= 8.2169 x 10^3 Kgf

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * (314.833 + 4.297 + 0.5*0.000)

= 1.9526 x 10^3 Kgf

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]:

(165.4500 , 308.4255 : 214.5500 , 276.5290)

Area [APsi]

= 7.3517 cm^2

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((190.000 + 60.300 /2) / 350.000) - asin((190.000 - 60.300 /2) /

= 0.2060 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 2.337 / 13.780 = 0.1696 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.206 +0.170)*350.000²/2

= 230.0559 cm^2

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)

= (2.969 + 0.454) * (165.008 - 0.5 * 6.000) +

(0.000 * (Min(165.008 , 0.000) - 0.50 * 6.000) +

(1.470 * (Min(165.008 , 165.008) - 0.50 * 6.000)

= 8.2169 x 10^3 Kgf

Force Term per 9.5.2.1.1 [Fa]:

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

= 6.000 * (230.056 + 4.297 + 0.5 * 7.352)

= 1.4564 x 10^3 Kgf

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 21.8469 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 677.7831 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R2-retur supape From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Cylinder/Cone Centerline	L1	190.0000	mm.
Distance from Bottom/Left Tangent		1470.0000	mm.

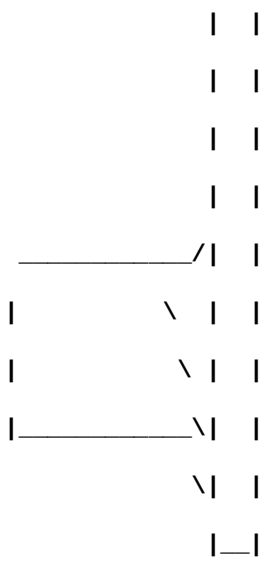
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		57.64	deg
Diameter		60.0000	mm.
Size and Thickness Basis		Actual	

Actual Thickness	tn	3.2000	mm.
Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	500.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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, with Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R2-retur supape

Actual Outside Diameter Used in Calculation	60.000	mm.
Actual Thickness Used in Calculation	3.200	mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 53.600 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.098 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((60.000 -2*0.000 -3.200)*3.200),150.000)

= 13.4818 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(500.000 , 05*13.482)

= 6.7409 mm.

Compute cone pressure area per Equation 9.5.36 [Aps]:

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

= 0.5*(59.372 +26.800)*(2*350.000 +(59.372 +26.800)*tan(0.00))

= 301.6010 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 53.600² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 60.000 /2)*350.000 + 2.362 /2*(5.000 +0.000)

= 314.3010 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 13.482 * 53.600 / 2

= 3.6131 cm^2

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 -60.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 3.200)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=13.482 *3.200 +6.741 *(3.200 -0.000 +0.000

= 0.6471 cm^2

Afp = Ip * eap = 1.945 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(165.008 , 165.008) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000) = 0.000 N./mm^2

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)

= (2.969 + 0.454) * (165.008 - 0.5 * 6.000) +

(0.000 * (Min(165.008 , 0.000) - 0.50 * 6.000) +

(0.647 * (Min(165.008 , 165.008) - 0.50 * 6.000)

= 6.8346 x 10^3 Kgf

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * (314.301 + 3.613 + 0.5*0.000)

= 1.9452 x 10^3 Kgf

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]:

(163.2000 , 309.6220 : 216.8000 , 274.7686)

Area [APsi]

= 8.7169 cm^2

Angle Nozzle Outside Diameter Subtends Inside Radius of Head [Alpha]:

= asin((190.000 + 60.000 /2) / 350.000) - asin((190.000 - 60.000 /2) /

= 0.2049 Radians

Angle Subtended By Iso [Beta]

= Iso / ris = 2.337 / 13.780 = 0.1696 Radians

Area [Aps]:

= (Alpha + Beta) * ris² / 2 = (0.205 +0.170)*350.000²/2

= 229.4232 cm^2

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)

= (2.969 + 0.454) * (165.008 - 0.5 * 6.000) +

(0.000 * (Min(165.008 , 0.000) - 0.50 * 6.000) +

(0.647 * (Min(165.008 , 165.008) - 0.50 * 6.000)

= 6.8346 x 10^3 Kgf

Force Term per 9.5.2.1.1 [Fa]:

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

= 6.000 * (229.423 + 3.613 + 0.5 * 8.717)

= 1.4525 x 10^3 Kgf

Since Pa >= Fa, Code Requirements are satisfied.

The Drop for this Nozzle is : 21.7256 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 677.6618 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R6-SS From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		150.0000	mm.

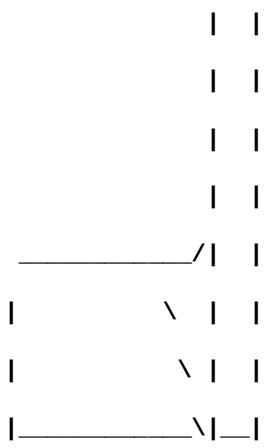
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		33.7000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R6-SS

Actual Outside Diameter Used in Calculation 33.700 mm.

Actual Thickness Used in Calculation 4.500 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 24.700 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.045 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((33.700 -2*0.000 -4.500)*4.500),100.000)

= 11.4630 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*11.463)

= 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*(59.372 +12.350)*(2*350.000 +(59.372 +12.350)*tan(0.00))

= 251.0260 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 24.700² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 33.700 /2)*350.000 + 1.327 /2*(5.000 +0.000)

= 267.6185 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.463 * 24.700 / 2

= 1.4157 cm^2

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 -33.700 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.463 *4.500 +0.000 *(4.500 -0.000 +0.000

= 0.5158 cm^2

Afp = Ip * eap = 0.896 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.516 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.6140 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 267.618 + 1.416 + 0.5*0.000 )

= 1.6461 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4058 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 105.4058 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R3-Iesire metan From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		470.0000	mm.

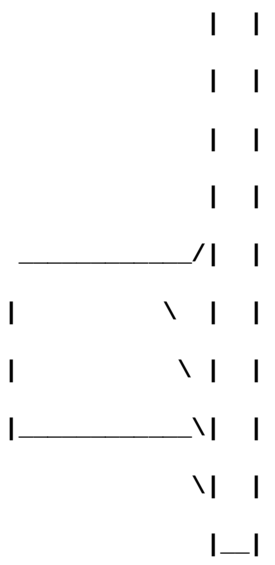
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		33.7000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	350.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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, with Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R3-Iesire metan

Actual Outside Diameter Used in Calculation	33.700	mm.
Actual Thickness Used in Calculation	4.500	mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 24.700 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.045 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((33.700 -2*0.000 -4.500)*4.500),100.000)

= 11.4630 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(350.000 , 05*11.463)

= 5.7315 mm.

Compute cone pressure area per Equation 9.5.36 [Aps]:

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

= 0.5*(59.372 +12.350)*(2*350.000 +(59.372 +12.350)*tan(0.00))

= 251.0260 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 24.700² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 33.700 /2)*350.000 + 1.327 /2*(5.000 +0.000)

= 267.6185 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.463 * 24.700 / 2

= 1.4157 cm^2

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 -33.700 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.463 *4.500 +5.731 *(4.500 -0.000 +0.000

= 0.7738 cm^2

Afp = Ip * eap = 0.896 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.774 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 7.0472 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 267.618 + 1.416 + 0.5*0.000 )

= 1.6461 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4058 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 455.4058 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R4-iesire metan From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1130.0000	mm.

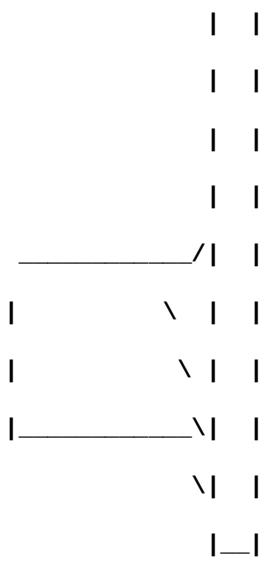
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		33.7000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	350.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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, with Inside projection

Isolated Nozzle Calculation per EN 13445, Description: R4-iesire metan

Actual Outside Diameter Used in Calculation	33.700	mm.
Actual Thickness Used in Calculation	4.500	mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 24.700 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.045 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((33.700 -2*0.000 -4.500)*4.500),100.000)

= 11.4630 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(350.000 , 05*11.463)

= 5.7315 mm.

Compute cone pressure area per Equation 9.5.36 [Aps]:

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

= 0.5*(59.372 +12.350)*(2*350.000 +(59.372 +12.350)*tan(0.00))

= 251.0260 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 24.700² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 33.700 /2)*350.000 + 1.327 /2*(5.000 +0.000)

= 267.6185 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.463 * 24.700 / 2

= 1.4157 cm^2

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 -33.700 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.463 *4.500 +5.731 *(4.500 -0.000 +0.000

= 0.7738 cm^2

Afp = Ip * eap = 0.896 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.774 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 7.0472 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 267.618 + 1.416 + 0.5*0.000 )

= 1.6461 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4058 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 455.4058 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R7 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1130.0000	mm.

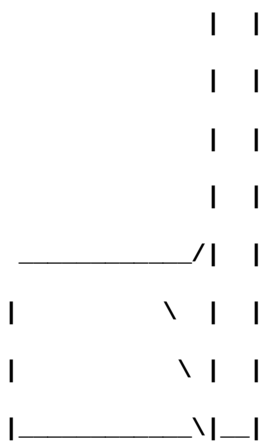
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		270.00	deg
Diameter		33.7000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R7

Actual Outside Diameter Used in Calculation 33.700 mm.

Actual Thickness Used in Calculation 4.500 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 24.700 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.045 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((33.700 -2*0.000 -4.500)*4.500),100.000)

= 11.4630 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*11.463)

= 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*(59.372 +12.350)*(2*350.000 +(59.372 +12.350)*tan(0.00))

= 251.0260 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 24.700² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 33.700 /2)*350.000 + 1.327 /2*(5.000 +0.000)

= 267.6185 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.463 * 24.700 / 2

= 1.4157 cm^2

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 -33.700 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.463 *4.500 +0.000 *(4.500 -0.000 +0.000

= 0.5158 cm^2

Afp = Ip * eap = 0.896 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.516 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.6140 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 267.618 + 1.416 + 0.5*0.000 )

= 1.6461 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4058 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 105.4058 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R5-evacuare gaz From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		550.0000	mm.

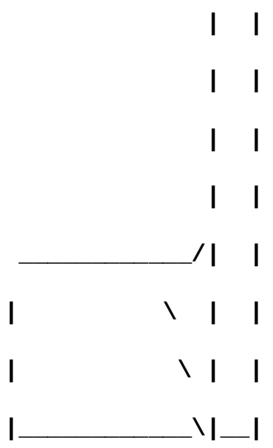
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		33.7000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R5-evacuare gaz

Actual Outside Diameter Used in Calculation 33.700 mm.

Actual Thickness Used in Calculation 4.500 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 24.700 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.045 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((33.700 -2*0.000 -4.500)*4.500),100.000)

= 11.4630 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*11.463)

= 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*(59.372 +12.350)*(2*350.000 +(59.372 +12.350)*tan(0.00))

= 251.0260 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 24.700² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 33.700 /2)*350.000 + 1.327 /2*(5.000 +0.000)

= 267.6185 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.463 * 24.700 / 2

= 1.4157 cm^2

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 -33.700 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.463 *4.500 +0.000 *(4.500 -0.000 +0.000

= 0.5158 cm^2

Afp = Ip * eap = 0.896 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.516 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.6140 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 267.618 + 1.416 + 0.5*0.000 )

= 1.6461 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4058 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 105.4058 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R8-aerisire From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		750.0000	mm.

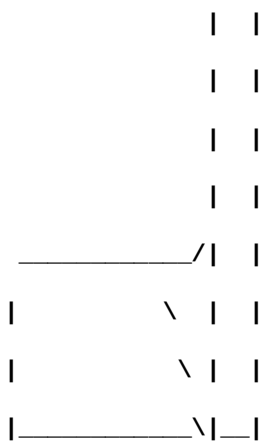
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		35.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	6.0000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	40.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R8-aerisire

Actual Outside Diameter Used in Calculation 35.000 mm.

Actual Thickness Used in Calculation 6.000 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 23.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.042 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((35.000 -2*0.000 -6.000)*6.000),40.000)

= 13.1909 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*13.191)

= 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*(59.372 +11.500)*(2*350.000 +(59.372 +11.500)*tan(0.00))

= 248.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 23.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 35.000 /2)*350.000 + 1.378 /2*(5.000 +0.000)

= 269.9260 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 13.191 * 23.000 / 2

= 1.5170 cm^2

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 -35.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 6.000)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=13.191 *6.000 +0.000 *(6.000 -0.000 +0.000

= 0.7915 cm^2

Afp = Ip * eap = 0.835 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.791 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 7.0770 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 269.926 + 1.517 + 0.5*0.000 )

= 1.6608 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4378 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 45.4378 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R9-intrare azot From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1250.0001	mm.

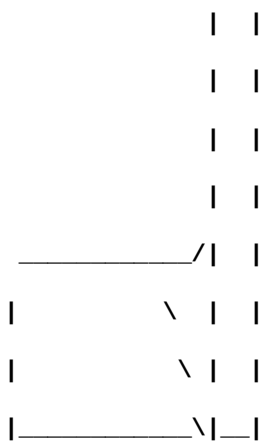
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		35.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	6.0000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	40.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R9-intrare azot

Actual Outside Diameter Used in Calculation 35.000 mm.

Actual Thickness Used in Calculation 6.000 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 23.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.042 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((35.000 -2*0.000 -6.000)*6.000),40.000)

= 13.1909 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*13.191)

= 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*(59.372 +11.500)*(2*350.000 +(59.372 +11.500)*tan(0.00))

= 248.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 23.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 35.000 /2)*350.000 + 1.378 /2*(5.000 +0.000)

= 269.9260 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 13.191 * 23.000 / 2

= 1.5170 cm^2

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 -35.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 6.000)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=13.191 *6.000 +0.000 *(6.000 -0.000 +0.000

= 0.7915 cm^2

Afp = Ip * eap = 0.835 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.791 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 7.0770 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 269.926 + 1.517 + 0.5*0.000 )

= 1.6608 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4378 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 45.4378 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: r10 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		930.0000	mm.

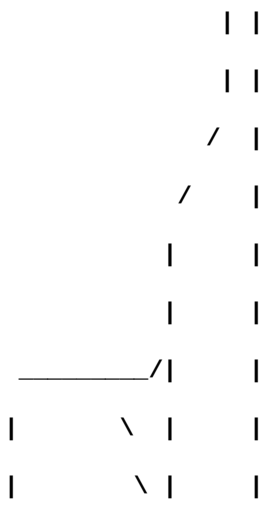
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		90.00	deg
Diameter		20.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	2.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	101.0000	mm.
Height of Beveled Transition	L`	25.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		38.0000	mm.
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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)



|_____\|_____|

Hub Nozzle

Isolated Nozzle Calculation per EN 13445, Description: r10

Actual Outside Diameter Used in Calculation	20.000	mm.
Actual Thickness Used in Calculation	2.500	mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 15.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.027 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [lbo]:

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

= min(sqrt((91.000 -2*0.000 -38.000)*38.000),100.000)

= 44.8776 mm.

Credit Distance Along the Nozzle per 9.5.77 [lbi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*44.878)

= 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*(59.372 +7.500)*(2*350.000 +(59.372 +7.500)*tan(0.00))

= 234.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 15.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 91.000 /2)*350.000 + 3.583 /2*(5.000 +0.000)

= 369.3260 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 44.878 * 15.000 / 2

= 3.3658 cm^2

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 -91.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 * eas = 59.372 * 5.000 = 2.9686 cm^2

Afb = (Ibo+eas)*eab+Ibi*(eab-ci+co) = (44.878 +5.000)*38.000 +0.000 *(

= 18.9535 cm^2

Afp = Ip * eap = 0.544 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(165.008 , 165.008) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000) = 0.000 N./mm^2

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)

= (2.969 + 0.454) * (165.008 - 0.5 * 6.000) +

(0.000 * (Min(165.008 , 0.000) - 0.50 * 6.000) +

(18.953 * (Min(165.008 , 165.008) - 0.50 * 6.000)

= 37.5805 x 10^3 Kgf

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * (369.326 + 3.366 + 0.5*0.000)

= 2.2803 x 10^3 Kgf

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.1429 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 105.1429 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R11 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		930.0000	mm.

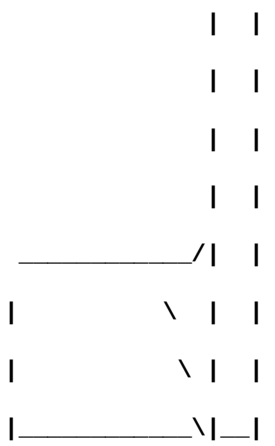
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		270.00	deg
Diameter		20.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	2.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	100.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R11

Actual Outside Diameter Used in Calculation 20.000 mm.

Actual Thickness Used in Calculation 2.500 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 15.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.027 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((20.000 -2*0.000 -2.500)*2.500),100.000)

= 6.6144 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*6.614)

= 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*(59.372 +7.500)*(2*350.000 +(59.372 +7.500)*tan(0.00))

= 234.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 15.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 20.000 /2)*350.000 + 0.787 /2*(5.000 +0.000)

= 243.3010 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 6.614 * 15.000 / 2

= 0.4961 cm^2

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 -20.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 2.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=6.614 *2.500 +0.000 *(2.500 -0.000 +0.000)

= 0.1654 cm^2

Afp = Ip * eap = 0.544 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.165 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.0254 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 243.301 + 0.496 + 0.5*0.000 )

= 1.4917 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.1429 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 105.1429 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R13 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		990.0000	mm.

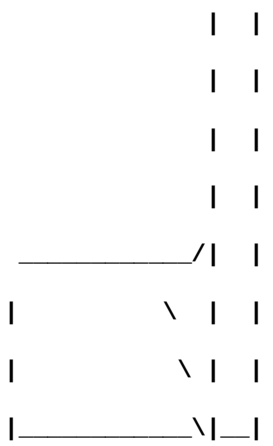
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		50.00	deg
Diameter		20.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	2.5000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	30.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R13

Actual Outside Diameter Used in Calculation 20.000 mm.

Actual Thickness Used in Calculation 2.500 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 15.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.027 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((20.000 -2*0.000 -2.500)*2.500),30.000)

= 6.6144 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*6.614)

= 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*(59.372 +7.500)*(2*350.000 +(59.372 +7.500)*tan(0.00))

= 234.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 15.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 20.000 /2)*350.000 + 0.787 /2*(5.000 +0.000)

= 243.3010 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 6.614 * 15.000 / 2

= 0.4961 cm^2

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 -20.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 2.500)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=6.614 *2.500 +0.000 *(2.500 -0.000 +0.000)

= 0.1654 cm^2

Afp = Ip * eap = 0.544 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.165 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.0254 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 243.301 + 0.496 + 0.5*0.000 )

= 1.4917 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.1429 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 35.1429 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R12 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		350.0000	mm.

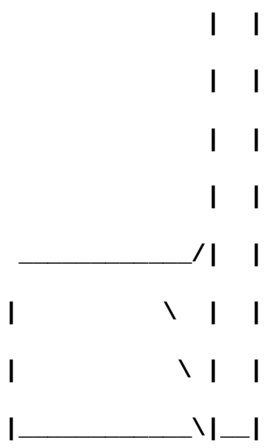
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		50.00	deg
Diameter		35.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.0000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	30.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R12

Actual Outside Diameter Used in Calculation 35.000 mm.

Actual Thickness Used in Calculation 4.000 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 27.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.049 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((35.000 -2*0.000 -4.000)*4.000),30.000)

= 11.1355 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*11.136)

= 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*(59.372 +13.500)*(2*350.000 +(59.372 +13.500)*tan(0.00))

= 255.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 27.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 35.000 /2)*350.000 + 1.378 /2*(5.000 +0.000)

= 269.9260 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.136 * 27.000 / 2

= 1.5033 cm^2

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 -35.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.000)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.136 *4.000 +0.000 *(4.000 -0.000 +0.000

= 0.4454 cm^2

Afp = Ip * eap = 0.980 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.445 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.4958 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 269.926 + 1.503 + 0.5*0.000 )

= 1.6608 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4378 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 35.4378 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R14 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		990.0000	mm.

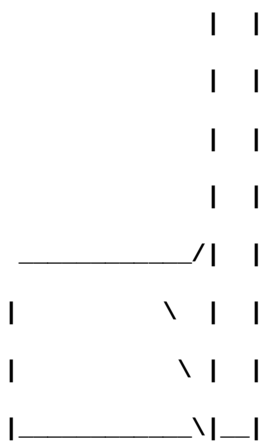
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		330.00	deg
Diameter		35.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.0000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	40.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R14

Actual Outside Diameter Used in Calculation 35.000 mm.

Actual Thickness Used in Calculation 4.000 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 27.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.049 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((35.000 -2*0.000 -4.000)*4.000),40.000)

= 11.1355 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*11.136)

= 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*(59.372 +13.500)*(2*350.000 +(59.372 +13.500)*tan(0.00))

= 255.0510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 27.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 35.000 /2)*350.000 + 1.378 /2*(5.000 +0.000)

= 269.9260 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 11.136 * 27.000 / 2

= 1.5033 cm^2

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 -35.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.000)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=11.136 *4.000 +0.000 *(4.000 -0.000 +0.000

= 0.4454 cm^2

Afp = Ip * eap = 0.980 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.445 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.4958 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 269.926 + 1.503 + 0.5*0.000 )

= 1.6608 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.4378 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 45.4378 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R15 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		550.0000	mm.

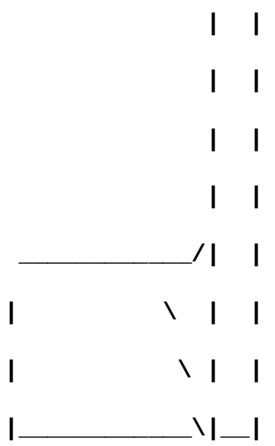
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		25.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.0000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	40.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R15

Actual Outside Diameter Used in Calculation 25.000 mm.

Actual Thickness Used in Calculation 4.000 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 17.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.031 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((25.000 -2*0.000 -4.000)*4.000),40.000)

= 9.1652 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*9.165)

= 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*(59.372 +8.500)*(2*350.000 +(59.372 +8.500)*tan(0.00))

= 237.5510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 17.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 25.000 /2)*350.000 + 0.984 /2*(5.000 +0.000)

= 252.1760 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 9.165 * 17.000 / 2

= 0.7790 cm^2

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 -25.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.000)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=9.165 *4.000 +0.000 *(4.000 -0.000 +0.000)

= 0.3666 cm^2

Afp = Ip * eap = 0.617 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.367 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.3634 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 252.176 + 0.779 + 0.5*0.000 )

= 1.5477 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.2233 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 45.2233 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R16 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		850.0000	mm.

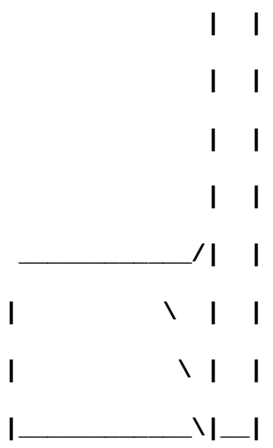
Type of Element Connected to the Shell : Nozzle

Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		0.00	deg
Diameter		25.0000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.0000	mm.

Flange Material		X5CRNI18-10	
Flange Type		None	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	40.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Class of attached Flange		150	
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: R16

Actual Outside Diameter Used in Calculation 25.000 mm.

Actual Thickness Used in Calculation 4.000 mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 17.000 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.031 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((25.000 -2*0.000 -4.000)*4.000),40.000)

= 9.1652 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*9.165)

= 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*(59.372 +8.500)*(2*350.000 +(59.372 +8.500)*tan(0.00))

= 237.5510 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 0.000 * 0.000

= 0.0000 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 17.000² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 25.000 /2)*350.000 + 0.984 /2*(5.000 +0.000)

= 252.1760 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 9.165 * 17.000 / 2

= 0.7790 cm^2

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 -25.000 /Cos(0.000), 0.0)/2.0, 59.372)

= 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 = (59.372 + 4.000)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=9.165 *4.000 +0.000 *(4.000 -0.000 +0.000)

= 0.3666 cm^2

Afp = Ip * eap = 0.617 * 0.000 = 0.0000 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 0.0000² + 0.0000²) / 2 = 0.4536 cm^2

Note: There is No Reinforcement Pad

Calculation per paragraph 9.5.2.1.1 [fob, fop]

```
fob = Min(fs, fb) = Min(165.008 , 165.008 ) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 0.000 ) = 0.000 N./mm^2
```

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)

= (2.969 + 0.454 ) * (165.008 - 0.5 * 6.000 ) +

  (0.000 * (Min(165.008 , 0.000 ) - 0.50 * 6.000 ) +

  (0.367 * (Min(165.008 , 165.008 ) - 0.50 * 6.000 )

= 6.3634 x 10^3 Kgf
```

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * ( 252.176 + 0.779 + 0.5*0.000 )

= 1.5477 x 10^3 Kgf
```

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 0.2233 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 45.2233 mm.

For possible nozzle interference - See Nozzle Summary

INPUT VALUES, Nozzle Description: R17 From : 20

Pressure for Reinforcement Calculations	P	6.000	bars
Temperature for Internal Pressure	Temp	60	C
Shell Material		X5CrNi18-10	
Shell Allowable Stress at Temperature	S	165.01	N./mm^2
Shell Allowable Stress At Ambient	Sa	180.01	N./mm^2
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Shell Finished (Minimum) Thickness	t	5.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		850.0000	mm.

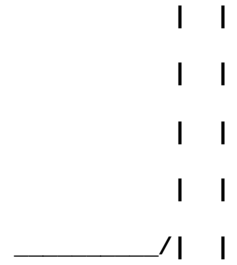
Type of Element Connected to the Shell : Nozzle

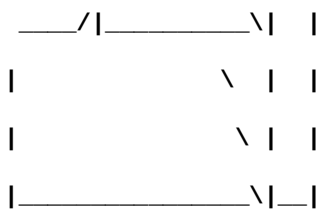
Nozzle Material		X5CrNi18-10	
Allowable Stress at Temperature	Sn	165.01	N./mm^2
Allowable Stress At Ambient	Sna	180.01	N./mm^2
Diameter Basis (for tr calc only)		OD	
Layout Angle		180.00	deg
Diameter		323.9000	mm.
Size and Thickness Basis		Actual	
Actual Thickness	tn	4.5100	mm.

Flange Material		X5CRNI18-10	
Flange Type		Slip on	
Corrosion Allowance	can	0.0000	mm.
Outside Projection	ho	40.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	9.5250	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	5.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Pad Material		X5CrNi18-10	
Pad Allowable Stress at Temperature	Sp	135.21	N./mm^2
Pad Allowable Stress At Ambient	Spa	150.01	N./mm^2
Diameter of Pad along vessel surface	Dp	500.0000	mm.
Thickness of Pad	te	5.0000	mm.
Weld leg size between Pad and Shell	Wp	2.0000	mm.
Groove weld depth between Pad and Nozzle	Wgpn	5.0000	mm.
Reinforcing Pad Width		88.0500	mm.
Class of attached Flange		150	
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: R17

Actual Outside Diameter Used in Calculation	323.900	mm.
Actual Thickness Used in Calculation	4.510	mm.

Required Thickness of Nozzle Neck due to Internal Pressure:

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

= 6.000 * 314.880 / (2 * 165.008 * 1.000 - 0.600) + 0.000

= 0.574 mm.

EN13445 Section 9 - Pressure Area Design Method:

Inside Radius per paragraph 9.5.3 [ris]:

= (Di + 2 * cs) / 2 = (700.000 + 2 * 0.000) / 2

= 350.0000 mm.

Credit Distance Along the Nozzle per 9.5.76 [Ibo]:

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

= min(sqrt((323.900 -2*0.000 -4.510)*4.510),40.000)

= 37.9532 mm.

Credit Distance Along the Nozzle per 9.5.77 [Ibi]:

= Min(hi, 0.5*Ibo) = Min(0.000 , 05*37.953)

= 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*(59.372 +157.440)*(2*350.000 +(59.372 +157.440)*tan(0.00))

= 758.8410 cm^2

Compute area in the re-pad [Afp]:

= Ip * ep = 59.372 * 5.000

= 2.9686 cm^2

Compute triangular area [Ap.psi]:

= dib² * tan(Psi) / 2 = 314.880² * tan(0.000)

= 0.0000 cm^2

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 * (59.372 + 323.900 /2)*350.000 + 12.752 /2*(5.000 +5.000)

= 790.8210 cm^2

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

(This is an inserted nozzle)

= Ibo * dib / 2 = 37.953 * 314.880 / 2

= 59.7536 cm^2

Compute the effective re-pad width [Ip]:

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

= Min(Max (500.000 -2.0*0.000 -323.900 /Cos(0.000), 0.0)/2.0, 59.372)

= 59.3717 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 = (59.372 + 4.510)*5.000 = 2.9686 cm^2

Afb = Ibo*eb+Ibi*(eb-ci+co)=37.953 *4.510 +0.000 *(4.510 -0.000 +0.000

= 1.7117 cm^2

Afp = Ip * eap = 11.426 * 5.000 = 2.9686 cm^2

Afw = (wshell² + wpad² + winside²) / 2

= (9.5250² + 2.0000² + 0.0000²) / 2 = 0.4736 cm^2

Calculation per paragraph 9.5.2.1.1 [fob, fop]

fob = Min(fs, fb) = Min(165.008 , 165.008) = 165.008 N./mm^2

fop = Min(fs, fp) = Min(165.008 , 135.206) = 135.206 N./mm^2

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)

= (2.969 + 0.474) * (165.008 - 0.5 * 6.000) +

(2.969 * (Min(165.008 , 135.206) - 0.50 * 6.000) +

(1.712 * (Min(165.008 , 165.008) - 0.50 * 6.000)

= 12.7398 x 10^3 Kgf

Force Term per 9.5.2.1.1 [Pa]:

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

= 6.000 * (790.821 + 59.754 + 0.5*0.000)

= 5.2043 x 10^3 Kgf

Since Fa >= Pa, Code Requirements are satisfied.

The Drop for this Nozzle is : 39.7224 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 84.7224 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.
r10	22	150	WNF	20.000	2.500	-	-	105
R11	20	150	WNF	20.000	2.500	-	-	105
R13	20	150	None	20.000	2.500	-	-	35
R15	25	150	None	25.000	4.000	-	-	45
R16	25	150	None	25.000	4.000	-	-	45
R6-SS	33	150	WNF	33.700	4.500	-	-	105
R3-Iesire metan	33	150	WNF	33.700	4.500	-	-	455
R4-iesire metan	33	150	WNF	33.700	4.500	-	-	455
R7	33	150	WNF	33.700	4.500	-	-	105
R5-evacuare gaz	33	150	WNF	33.700	4.500	-	-	105
R8-aerisire	35	150	None	35.000	6.000	-	-	45
R9-intrare azot	35	150	None	35.000	6.000	-	-	45
R12	35	150	None	35.000	4.000	-	-	35
R14	35	150	None	35.000	4.000	-	-	45
R2-retur supape	60	150	WNF	60.000	3.200	-	-	677
R1-intrare meta	60	150	WNF	60.300	5.600	-	-	677
R17	323	150	SlipOn	323.900	4.510	500.00	5.00	84

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 mm.
r10	X5CrNi18-10	5.000	9.525	-	-	-
R11	X5CrNi18-10	5.000	9.525	-	-	-
R13	X5CrNi18-10	5.000	9.525	-	-	-
R15	X5CrNi18-10	5.000	9.525	-	-	-
R16	X5CrNi18-10	5.000	9.525	-	-	-
R6-SS	X5CrNi18-10	5.000	9.525	-	-	-
R3-Iesi	X5CrNi18-10	5.000	9.525	-	-	-
R4-iesi	X5CrNi18-10	5.000	9.525	-	-	-
R7	X5CrNi18-10	5.000	9.525	-	-	-
R5-evac	X5CrNi18-10	5.000	9.525	-	-	-
R8-aeri	X5CrNi18-10	5.000	9.525	-	-	-
R9-intr	X5CrNi18-10	5.000	9.525	-	-	-
R12	X5CrNi18-10	5.000	9.525	-	-	-
R14	X5CrNi18-10	5.000	9.525	-	-	-
R2-retu	X5CrNi18-10	5.000	9.525	-	-	-
R1-intr	X5CrNi18-10	5.000	9.525	-	-	-
R17	X5CrNi18-10	5.000	9.525	2.000	5.000	-

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

Nozzle Miscellaneous Data:

	Elevation/Distance	Layout	Projection	Installed In

Nozzle	From Datum mm.	Angle deg.	Outside mm.	Inside mm.	Component
r10	880.000	90.00	100.00	0.00	Node: 20
R11	880.000	270.00	100.00	0.00	Node: 20
R13	940.000	50.00	30.00	0.00	Node: 20
R15	500.000	0.00	40.00	0.00	Node: 20
R16	800.000	0.00	40.00	0.00	Node: 20
R6-SS	100.000	90.00	100.00	0.00	Node: 20
R3-Iesire metan	420.000	0.00	100.00	350.00	Node: 20
R4-iesire metan	1080.000	0.00	100.00	350.00	Node: 20
R7	1080.000	270.00	100.00	0.00	Node: 20
R5-evacuare gaz	500.000	90.00	100.00	0.00	Node: 20
R8-aerisire	700.000	90.00	40.00	0.00	Node: 20
R9-intrare azot	1200.000	90.00	40.00	0.00	Node: 20
R12	300.000	50.00	30.00	0.00	Node: 20
R14	940.000	330.00	40.00	0.00	Node: 20
R2-retur supape	1420.000	57.64	150.00	500.00	Node: 20
R1-intrare meta	1420.000	122.36	150.00	500.00	Node: 20
R17	800.000	180.00	40.00	0.00	Node: 20

Nozzle Calculation Summary:

Per EN 13445 Section 9:

Description	Pressure Area Result
R1-intrare	Pressure Area Passed
R2-retur su	Pressure Area Passed
R6-SS	Pressure Area Passed
R3-Iesire m	Pressure Area Passed
R4-iesire m	Pressure Area Passed
R7	Pressure Area Passed
R5-evacuare	Pressure Area Passed
R8-aerisire	Pressure Area Passed
R9-intrare	Pressure Area Passed
r10	Pressure Area Passed
R11	Pressure Area Passed
R13	Pressure Area Passed
R12	Pressure Area Passed
R14	Pressure Area Passed
R15	Pressure Area Passed
R16	Pressure Area Passed
R17	Pressure Area Passed

Check the Spatial Relationship between the Nozzles

From Node	Nozzle Description	X Coordinate,	Layout Angle,	Mean Radius
20	R1-intrare meta	1470.000	122.358	27.350
20	R2-retur supape	1470.000	57.642	28.400

20	R6-SS	150.000	90.000	14.600
20	R3-Iesire metan	470.000	0.000	14.600
20	R4-iesire metan	1130.000	0.000	14.600
20	R7	1130.000	270.000	14.600
20	R5-evacuare gaz	550.000	90.000	14.600
20	R8-aerisire	750.000	90.000	14.500
20	R9-intrare azot	1250.000	90.000	14.500
20	r10	930.000	90.000	-9.000
20	R11	930.000	270.000	8.750
20	R13	990.000	50.000	8.750
20	R12	350.000	50.000	15.500
20	R14	990.000	330.000	15.500
20	R15	550.000	0.000	10.500
20	R16	850.000	0.000	10.500
20	R17	850.000	180.000	159.695

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 R3-Iesire metan and R15 are a Group per EN 13445 para 9.6.4

The Nozzles are Installed In a Cylinder

ris = (ris1 + ris2)/2 = (350.000 + 350.000) / 2 = 350.0000 mm.

Lb = 80.0000 mm. (= Inside center to center distance)

a1 = deb1/2 = 16.8500 and a2 = deb2/2 = 12.5000 mm.

k = 2 - (Lb + a1 + a2)/(Iso1 + Iso2)

= 2 - (80.000 + 16.850 + 12.500)/(59.372 + 59.372) = 1.0791

as k > 1, set k to 1.00

Lb1 = Lb + a1 + a2 + k * (Iso1 + Iso2)

= 80.000 + 16.850 + 12.500 + 1.000 * (59.372 + 59.372)

= 228.0934 mm.

psi = atan(ris * abs(Angle2 - Angle1) / abs(y2 - y1)

= atan(350.000 * abs(0.000 - 0.000) / abs(420.000 - 500.000)

= 0.0000 Deg

Apls = 0.5*ris²*Lb * (1 + cos(psi))/(ris+0.5 * eas * sin(psi))

= 0.5*350.00²*80.00 *(1+cos(0.00))/(350.00 +0.5*5.00 * sin(0.00)

= 280.0000 cm^2

Metal area

Afb1 = 0.7738 , Afb2 = 0.3666 cm^2

Afls = eas * (Lb - a1 - a2)

= 5.000 * (80.000 - 16.850 - 12.500) = 2.5325 cm^2

Afw = Afw1 + Afw2 = 0.454 + 0.454 = 0.9073 cm^2

APsil = 0.0000 and APpsi2 = 0.0000 cm^2

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)

= (2.533 + 0.907) * (165.008 - 0.5 * 6.000)

+ 0.774 * (165.008 - 0.5 * 6.000)

+ 0.367 * (165.008 - 0.5 * 6.000)

+ 0.000 * (0.000 - 0.5 * 6.000)

+ 0.000 * (0.000 - 0.5 * 6.000)

= 7.6924 x 10^3 Kgf

```
  f2 = P * ( Apls + Apb1 + 0.5 * APpsi1 + Apb2 + 0.5 * APpsi2)

     = 6.000 *(280.000 +1.416 + .5*0.000 +0.779 +0.50* 0.000 )

     = 1.7266 x 10^3 Kgf
```

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 : 700.000 mm. ID

Vessel Design Length, Tangent to Tangent	1600.00	mm.
Specified Datum Line Distance	50.00	mm.
Shell Material Specification	X5CrNi18-10	
Re-Pad Material Specification	X5CrNi18-10	
Internal Design Temperature	60	C
Internal Design Pressure	6.000	bars
External Design Temperature	20	C
Maximum Allowable Working Pressure	18.960	bars
Hydrostatic Test Pressure	31.001	bars
Wind Design Code	ASCE-93	
Earthquake Design Code	UBC-94	

Element Pressures and MAWP: bars

Element Desc	Design Pres. + Stat. head	External Pressure	M.A.W.P	Corrosion Allowance
Ellipse	6.000	0.000	26.969	0.0000
Cylinder	6.000	0.000	23.404	0.0000
Ellipse	6.000	0.000	26.969	0.0000

Element	"To" Elev	Length	Element Thk	R e q d T h k	Joint Eff

Type	mm.	mm.	mm.	Int.	Ext.	Long	Circ
Ellipse	0.0	50.0	6.0	2.0	No Calc	1.00	1.00
Cylinder	1500.0	1500.0	5.0	1.3	No Calc	1.00	1.00
Ellipse	1550.0	50.0	6.0	2.0	No Calc	1.00	1.00

Element thicknesses are shown as Nominal if specified, otherwise are Minimum

Saddle Parameters:

Saddle Width	150.000	mm.
Saddle Bearing Angle	120.000	deg.
Centerline Dimension	700.000	mm.
Wear Pad Width	150.000	mm.
Wear Pad Thickness	5.000	mm.
Wear Pad Bearing Angle	132.000	deg.
Distance from Saddle to Tangent	225.800	mm.
Baseplate Length	700.000	mm.
Baseplate Thickness	10.000	mm.
Baseplate Width	150.000	mm.
Number of Ribs (including outside ribs)	2	
Rib Thickness	8.000	mm.
Web Thickness	8.000	mm.
Height of Center Web	304.800	mm.

Summary of Maximum Saddle Loads, Operating Case :

Maximum Vertical Saddle Load	326.70	Kgf
Maximum Transverse Saddle Shear Load	28.61	Kgf
Maximum Longitudinal Saddle Shear Load	23.30	Kgf

Summary of Maximum Saddle Loads, Hydrotest Case :

Maximum Vertical Saddle Load	613.38	Kgf
Maximum Transverse Saddle Shear Load	9.44	Kgf
Maximum Longitudinal Saddle Shear Load	7.69	Kgf

Weights:

Fabricated - Bare W/O Removable Internals	424.4	kg.
Shop Test - Fabricated + Water (Full)	1129.6	kg.
Shipping - Fab. + Rem. Intls.+ Shipping App.	424.4	kg.
Erected - Fab. + Rem. Intls.+ Insul. (etc)	424.4	kg.
Empty - Fab. + Intls. + Details + Wghts.	424.4	kg.
Operating - Empty + Operating Liquid (No CA)	424.4	kg.
Field Test - Empty Weight + Water (Full)	1129.6	kg.