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Sample Vessel

DESIGN CALCULATION

In Accordance with ASME Section VIII Division 1

ASME Code Version : 2007

Analysis Performed by : KEDKEP CONSULTING, INC.

Job File : E:\ASME CALCULATIONS REV 2.PVI

Date of Analysis : Jul 20,2008

PV Elite 2008, May 2008

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Warnings and Errors Step: 0 10:01a Jul 20,2008

Class From To : Basic Element Checks.

=====

Class From To: Check of Additional Element Data

=====

There were no geometry errors or warnings.

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Sample Vessel

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FileName : ASME Calculations Rev 2

Input Echo

Step: 1 10:01a Jul 20,2008

PV Elite Vessel Analysis Program: Input Data

Sample Vessel

Design Internal Pressure (for Hydrotest)	1060.0	kPa
Design Internal Temperature	200	C
Type of Hydrotest	UG99-b Note [34]	
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	-10	C
Type of Construction	Welded	
Special Service	Unfired Steam	
Degree of Radiography	RT 3	
Miscellaneous Weight Percent	20.	
Use Higher Longitudinal Stresses (Flag)	Y	
Select t for Internal Pressure (Flag)	N	
Select t for External Pressure (Flag)	N	
Select t for Axial Stress (Flag)	N	
Select Location for Stiff. Rings (Flag)	N	
Use Hydrotest Allowable Unmodified	Y	
Consider Vortex Shedding	N	
Perform a Corroded Hydrotest	N	
Is this a Heat Exchanger	No	
User Defined Hydro. Press. (Used if > 0)	0.0000	kPa
User defined MAWP	0.0000	kPa
User defined MAPnc	0.0000	kPa

Load Case 1	NP+EW+WI+FW+BW
Load Case 2	NP+EW+EE+FS+BS
Load Case 3	NP+OW+WI+FW+BW
Load Case 4	NP+OW+EQ+FS+BS
Load Case 5	NP+HW+HI
Load Case 6	NP+HW+HE
Load Case 7	IP+OW+WI+FW+BW
Load Case 8	IP+OW+EQ+FS+BS
Load Case 9	EP+OW+WI+FW+BW
Load Case 10	EP+OW+EQ+FS+BS
Load Case 11	HP+HW+HI
Load Case 12	HP+HW+HE
Load Case 13	IP+WE+EW
Load Case 14	IP+WF+CW
Load Case 15	IP+VO+OW
Load Case 16	IP+VE+OW
Load Case 17	IP+VF+CW
Load Case 18	FS+BS+IP+OW
Load Case 19	FS+BS+EP+OW

Wind Design Code	No Wind Loads	
Design Wind Speed	112.65	Km/hr
Exposure Constant	C	
Importance Factor		
Roughness Factor		
Base Elevation	0.0000	mm
Percent Wind for Hydrotest	33.	
Use Wind Profile (Y/N)	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	

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Input Echo Step: 1 10:01a Jul 20,2008

Seismic Design Code	No Seismic
Design Nozzle for Des. Press. + St. Head	Y
Consider MAP New and Cold in Noz. Design	N
Consider External Loads for Nozzle Des.	Y
Consider Code Case 2168 for Nozzle Des.	N
Material Database Year	Current w/Addenda or Code Year

Complete Listing of Vessel Elements and Details:

Element From Node	10	
Element To Node	20	
Element Type	Elliptical	
Description	LEFT HEAD	
Distance "FROM" to "TO"	60.000	mm
Inside Diameter	2250.0	mm
Element Thickness	18.000	mm
Internal Corrosion Allowance	3.0000	mm
Nominal Thickness	20.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1060.0	kPa
Design Temperature Internal Pressure	200	C
Design External Pressure	0.0000	kPa
Design Temperature External Pressure	70	C
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	
Allowable Stress, Ambient	137.90	N/mm ²
Allowable Stress, Operating	137.90	N/mm ²
Allowable Stress, Hydrotest	235.81	N/mm ²
Material Density	0.007833	kg/cm ³
P Number Thickness	31.750	mm
Yield Stress, Operating	224.70	N/mm ²
UCS-66 Chart Curve Designation	B	
External Pressure Chart Name	CS-2	
UNS Number	K02700	
Product Form	Plate	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	0.85	
Elliptical Head Factor	2.	
Element From Node	10	
Detail Type	Liquid	
Detail ID	STEAM	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Height/Length of Liquid	2250.0	mm
Density of Liquid	0.0010000	kg/cm ³
Element From Node	10	
Detail Type	Nozzle	
Detail ID	Central Support	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Nozzle Diameter	250.	mm
Nozzle Schedule	DIN4.0	
Nozzle Class	0	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	kgf
Grade of Attached Flange	None	
Nozzle Matl	SA-106 B	

Sample Vessel

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FileName : ASME Calculations Rev 2

Input Echo

 Step: 1 10:01a Jul 20,2008

Element From Node	10	
Detail Type	Nozzle	
Detail ID	Manway	
Dist. from "FROM" Node / Offset dist	630.00	mm
Nozzle Diameter	400.	mm
Nozzle Schedule	DIN4.0	
Nozzle Class	0	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	kgf
Grade of Attached Flange	None	
Nozzle Matl	SA-36	

Element From Node	10	
Detail Type	Nozzle	
Detail ID	DRAIN	
Dist. from "FROM" Node / Offset dist	1100.0	mm
Nozzle Diameter	52.	mm
Nozzle Schedule	DIN4.0	
Nozzle Class	0	
Layout Angle	207.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	kgf
Grade of Attached Flange	None	
Nozzle Matl	SA-36	

Element From Node	20	
Element To Node	30	
Element Type	Cylinder	
Description	Cylinder	
Distance "FROM" to "TO"	1000.0	mm
Inside Diameter	2250.0	mm
Element Thickness	20.000	mm
Internal Corrosion Allowance	3.0000	mm
Nominal Thickness	20.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1060.0	kPa
Design Temperature Internal Pressure	200	C
Design External Pressure	0.0000	kPa
Design Temperature External Pressure	70	C
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	
Efficiency, Longitudinal Seam	0.85	
Efficiency, Circumferential Seam	0.85	

Element From Node	20	
Detail Type	Liquid	
Detail ID	WATER	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Height/Length of Liquid	2250.0	mm
Density of Liquid	0.0010000	kg/cm^3

Element From Node	30	
Element To Node	50	
Element Type	Flat	
Description	TUBESHEET	
Distance "FROM" to "TO"	125.00	mm
Inside Diameter	2200.0	mm
Element Thickness	125.00	mm
Internal Corrosion Allowance	3.0000	mm
Nominal Thickness	125.00	mm

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Input Echo Step: 1 10:01a Jul 20,2008

External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1060.0	kPa
Design Temperature Internal Pressure	200	C
Design External Pressure	0.0000	kPa
Design Temperature External Pressure	70	C
Effective Diameter Multiplier	1.2	
Material Name [Normalized]	SA-516 70	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	1.	
Flat Head Attachment Factor	0.33000001	
Small diameter if Non-Circular	0.0000	mm

Element From Node	30	
Detail Type	Nozzle	
Detail ID	CENTRAL SUPPORT	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Nozzle Diameter	250.	mm
Nozzle Schedule	DIN4.0	
Nozzle Class	0	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	kgf
Grade of Attached Flange	None	
Nozzle Matl	SA-106 B	

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Internal Pressure Calculations Step: 3 10:01a Jul 20,2008

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd kPa	Nominal Thickness mm	Total Corr Allowance mm	Element Diameter mm	Allowable Stress(SE) N/mm ²
LEFT HEAD		1082.09	20.0000	3.00000	2250.00	137.900
Cylinder		1082.09	20.0000	3.00000	2250.00	117.215
TUBESHEET		1082.09	125.000	3.00000	2200.00	137.900

Element Required Thickness and MAWP :

From	To	Design Pressure kPa	M.A.W.P. Corroded kPa	M.A.P. New & Cold kPa	Actual Thickness mm	Required Thickness mm
LEFT HEAD		1060.00	1809.14	2202.75	18.0000	11.8588
Cylinder		1060.00	1728.51	2061.71	20.0000	13.4720
TUBESHEET		1060.00	1255.92	1348.96	125.000	115.260
	Minimum		1255.917	1348.962		

MAWP: 1255.917 kPa, limited by: TUBESHEET.

Internal Pressure Calculation Results :

ASME Code, Section VIII, Division 1, 2007

Elliptical Head From 10 To 20 SA-516 70 , UCS-66 Crv. B at 200 C

LEFT HEAD

Thickness Due to Internal Pressure [Tr]:

$$= (P \cdot D \cdot K) / (2 \cdot S \cdot E - 0.2 \cdot P) \text{ Appendix 1-4 (c)}$$

$$= (1082.092 \cdot 2256.0000 \cdot 3.00) / (2 \cdot 137.90 \cdot 1.00 - 0.2 \cdot 1082.092)$$

$$= 8.8588 + 3.0000 = 11.8588 \text{ mm}$$

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

Less Operating Hydrostatic Head Pressure of 22.092 kPa

$$= (2 \cdot S \cdot E \cdot t) / (K \cdot D + 0.2 \cdot t) \text{ per Appendix 1-4 (c)}$$

$$= (2 \cdot 137.90 \cdot 1.00 \cdot 15.0000) / (1.00 \cdot 2256.0000 + 0.2 \cdot 15.0000)$$

$$= 1831.235 - 22.092 = 1809.143 \text{ kPa}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$= (2 \cdot S \cdot E \cdot t) / (K \cdot D + 0.2 \cdot t) \text{ per Appendix 1-4 (c)}$$

$$= (2 \cdot 137.90 \cdot 1.00 \cdot 18.0000) / (1.00 \cdot 2250.0000 + 0.2 \cdot 18.0000)$$

$$= 2202.748 \text{ kPa}$$

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

$$= (P \cdot (K \cdot D + 0.2 \cdot t)) / (2 \cdot E \cdot t)$$

$$= (1082.092 \cdot (1.00 \cdot 2256.0000 + 0.2 \cdot 15.0000)) / (2 \cdot 1.00 \cdot 15.0000)$$

$$= 81.486 \text{ N/mm}^2$$

Required Thickness of Straight Flange = 11.894 mm

Percent Elongation per UCS-79 $(75 \cdot t_{nom} / R_f) \cdot (1 - R_f / R_o)$ 3.887 %

Min Metal Temp. w/o impact per UCS-66 -11 C
 Min Metal Temp. at Rqd thickness (UCS 66.1)[rat 0.59] -34 C
 Min Metal Temp. w/o impact per UG-20(f) -29 C

Cylindrical Shell From 20 To 30 SA-516 70 , UCS-66 Crv. B at 200 C

Sample Vessel

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Internal Pressure Calculations Step: 3 10:01a Jul 20,2008

Cylinder

Thickness Due to Internal Pressure [Tr]:

$$\begin{aligned}
&= (P \cdot R) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c)(1)} \\
&= (1082.092 \cdot 1128.0000) / (137.90 \cdot 0.85 - 0.6 \cdot 1082.092) \\
&= 10.4720 + 3.0000 = 13.4720 \text{ mm}
\end{aligned}$$

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

Less Operating Hydrostatic Head Pressure of 22.092 kPa

$$\begin{aligned}
&= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c)(1)} \\
&= (137.90 \cdot 0.85 \cdot 17.0000) / (1128.0000 + 0.6 \cdot 17.0000) \\
&= 1750.606 - 22.092 = 1728.514 \text{ kPa}
\end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
&= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c)(1)} \\
&= (137.90 \cdot 0.85 \cdot 20.0000) / (1125.0000 + 0.6 \cdot 20.0000) \\
&= 2061.710 \text{ kPa}
\end{aligned}$$

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

$$\begin{aligned}
&= (P \cdot (R + 0.6 \cdot t)) / (E \cdot t) \\
&= (1082.092 \cdot (1128.0000 + 0.6 \cdot 17.0000)) / (0.85 \cdot 17.0000) \\
&= 85.239 \text{ N/mm}^2
\end{aligned}$$

Percent Elongation per UCS-79 (50 * tnom / Rf) * (1 - Rf / Ro) 0.881 %

Min Metal Temp. w/o impact per UCS-66 -7 C

Min Metal Temp. at Rqd thickness (UCS 66.1)[rat 0.52] -38 C

Min Metal Temp. w/o impact per UG-20(f) -29 C

Welded Flat Head From 30 To 50 SA-516 70 , UCS-66 Crv. D at 200 C

TUBESHEET

Thickness Due to Internal Pressure [Tr]:

$$\begin{aligned}
&= d \cdot \text{sqrt}(Z \cdot C \cdot P / (S \cdot E)) \text{ per UG-34 (c)(3)} \\
&= 2206.0000 \cdot \text{sqrt}(1.00 \cdot 0.33 \cdot 1082.092 / (137.90 \cdot 1.00)) \\
&= 112.2600 + 3.0000 = 115.2600 \text{ mm}
\end{aligned}$$

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

Less Operating Hydrostatic Head Pressure of 22.092 kPa

$$\begin{aligned}
&= (t/d)^2 \cdot ((S \cdot E) / (C \cdot Z)) \text{ UG-34 (c)(3)} \\
&= (122.0000 / 2206.0000)^2 \cdot ((137.90 \cdot 1.00) / (0.33 \cdot 1.00)) \\
&= 1278.009 - 22.092 = 1255.917 \text{ kPa}
\end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
&= (t/d)^2 \cdot ((S \cdot E) / (C \cdot Z)) \text{ per UG-34 (c)(3)} \\
&= (125.0000 / 2200.0000)^2 \cdot ((137.90 \cdot 1.00) / (0.33 \cdot 1.00)) \\
&= 1348.962 \text{ kPa}
\end{aligned}$$

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

$$\begin{aligned}
&= (Z \cdot C \cdot P) / (((t/d)^2) \cdot E) \\
&= (1.00 \cdot 0.33 \cdot 1082.092) / (((122.0000 / 2206.0000)^2) \cdot 1.00) \\
&= 116.760 \text{ N/mm}^2
\end{aligned}$$

Min Metal Temp. w/o impact per UCS-66 -39 C

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

MINIMUM METAL DESIGN TEMPERATURE RESULTS :

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Internal Pressure Calculations Step: 3 10:01a Jul 20,2008

Minimum Metal Temp. w/o impact per UCS-66 -7. C
 Minimum Metal Temp. at Required thickness -34. C

Note: Heads and Shells Exempted to -20F (-29C) by paragraph UG-20F

Minimum Design Metal Temperature (Entered by User) -10. C

Hydrostatic Test Pressure Results:

Pressure per UG99b = 1.3 * M.A.W.P. * Sa/S 1632.692 kPa
 Pressure per UG99b[34] = 1.3 * Design Pres * Sa/S 1378.000 kPa
 Pressure per UG99c = 1.3 * M.A.P. - Head(Hyd) 1731.597 kPa
 Pressure per UG100 = 1.1 * M.A.W.P. * Sa/S 1381.509 kPa

UG-99(b) Note 34, Test Pressure Calculation:

= Test Factor * Design Pressure * Stress Ratio
 = 1.3 * 1060.000 * 1.000
 = 1378.000 kPa

Horizontal Hydrotest performed in accordance with: UG-99b (Note 34)

Stresses on Elements due to Hydrostatic Test Pressure:

<u>From To</u>	<u>Stress</u>	<u>Allowable</u>	<u>Ratio</u>	<u>Pressure</u>
LEFT HEAD	87.6	235.8	0.372	1400.05
Cylinder	93.6	235.8	0.397	1400.05
TUBESHEET	143.1	235.8	0.607	1399.56

Elements Suitable for Internal Pressure.

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Sample Vessel

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Nozzle Flange MAWP Step: 6 10:01a Jul 20,2008

Nozzle Flange MAWP Results :

There does not appear to be any valid flange data to process.

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Sample Vessel

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FileName : ASME Calculations Rev 2

Nozzle Calcs. Central Support Nozl: 1 10:01a Jul 20,2008

INPUT VALUES, Nozzle Description: Central Support From : 10

Pressure for Nozzle Reinforcement Calculations P		1071.031	kPa
Temperature for Internal Pressure	Temp	200	C
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	N/mm ²
Shell Allowable Stress At Ambient	Sa	137.90	N/mm ²
Inside Diameter of Elliptical Head	D	2250.0000	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Actual Thickness	T	18.0000	mm
Head Internal Corrosion Allowance	Cas	3.0000	mm
Head External Corrosion Allowance	Caext	0.0000	mm
Distance from Head Centerline	L1	0.0000	mm
User Entered Minimum Design Metal Temperature		-10.00	C
Nozzle Material		SA-106 B	
Nozzle Allowable Stress at Temperature	Sn	117.90	N/mm ²
Nozzle Allowable Stress At Ambient	Sna	117.90	N/mm ²
Nozzle Diameter Basis (for tr calc only)	Inbase	OD	
Layout Angle		0.00	deg
Nozzle Diameter	Dia	250.0000	mm.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	26.0000	mm
Nozzle Flange Material		C	
Nozzle Flange Type		None	
Hub Height of Integral Nozzle	h	4.0000	mm
Hub Thickness of Integral Nozzle (tn or x+tp)		1.0000	mm
Nozzle Corrosion Allowance	Can	3.0000	mm
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	65.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.5000	mm
Nozzle Inside Projection	H	65.0000	mm
Weld leg size, Inside Nozzle to Shell	Wi	15.0000	mm
ASME Code Weld Type per UW-16		F-4	

The Pressure Design option was Design Pressure + static head

NOZZLE CALCULATION, Description: Central Support

ASME Code, Section VIII, Division 1, 2007, UG-37 to UG-45

Actual Nozzle Outside Diameter Used in Calculation	250.000	mm.
Actual Nozzle Thickness Used in Calculation	26.000	mm

Nozzle input data check completed without errors.

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Nozzle Calcs. Central Support

Noz1: 1 10:01a Jul 20,2008

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

$$= (P \cdot K1 \cdot D) / (2 \cdot S \cdot E - 0.2 \cdot P) \text{ per UG-37(a)(3)}$$

$$= (1071.03 \cdot 0.90 \cdot 2256.0000) / (2 \cdot 137.90 \cdot 1.00 - 0.2 \cdot 1071.03)$$

$$= 7.8914 \text{ mm}$$

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

$$= (P \cdot Ro) / (S \cdot E + 0.4 \cdot P) \text{ per Appendix 1-1 (a)(1)}$$

$$= (1071.03 \cdot 125.0000) / (117 \cdot 1.00 + 0.4 \cdot 1071.03)$$

$$= 1.1314 \text{ mm}$$

UG-40, Thickness and Diameter Limit Results : [Int. Press]

Effective material diameter limit, D1 408.0000 mm
 Effective material thickness limit, no pad Tlnp 37.5000 mm

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5	Design	External	Mapnc
Area Required Ar	16.625	NA	NA cm ²
Area in Shell A1	14.027	NA	NA cm ²
Area in Nozzle Wall A2	14.023	NA	NA cm ²
Area in Inward Nozzle A3	12.825	NA	NA cm ²
Area in Welds A4	1.844	NA	NA cm ²
Area in Pad A5	0.000	NA	NA cm ²
Area in Hub A6	-0.855	NA	NA cm ²
TOTAL AREA AVAILABLE Atot	41.865	NA	NA cm ²

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Reinforcement Area Required for Nozzle [Ar]:

$$= (Dlr \cdot Tr + 2 \cdot Thk \cdot Tr \cdot (1 - fr1)) \text{ UG-37(c)}$$

$$= (204.0000 \cdot 7.8914 + 2 \cdot (26.0000 - 3.0000) \cdot 7.8914 \cdot (1 - 0.8550))$$

$$= 16.625 \text{ cm}^2$$

Areas per UG-37.1 but with DL = Diameter Limit, DLR = Corroded ID:

Area Available in Shell [A1]:

$$= (DL - Dlr) \cdot (ES \cdot (T - Cas) - Tr) - 2 \cdot (Thk - Can) \cdot (ES \cdot (T - Cas) - Tr) \cdot (1 - fr1)$$

$$= (408.000 - 204.000) \cdot (1.00 \cdot (18.0000 - 3.000) - 7.891) - 2 \cdot (26.000 - 3.000)$$

$$\cdot (1.00 \cdot (18.0000 - 3.0000) - 7.8914) \cdot (1 - 0.8550)$$

$$= 14.027 \text{ cm}^2$$

Area Available in Nozzle Wall, no Pad [A2np]:

$$= (2 \cdot \min(Tlnp, ho)) \cdot (Thk - Can - Trn) \cdot fr2$$

$$= (2 \cdot \min(37.50, 65.00)) \cdot (26.00 - 3.00 - 1.13) \cdot 0.8550$$

$$= 14.023 \text{ cm}^2$$

Area Available in Nozzle Penetration [A3]:

$$= 2 \cdot (Tn - Can - Can) \cdot (\min(H - Can, Tl, 2.5 \cdot Tn - Can - Can)) \cdot fr2$$

$$= 2 \cdot (20.0000) \cdot (37.5000) \cdot 0.8550$$

$$= 12.825 \text{ cm}^2$$

Area Available in Welds, no Pad [A4np]:

$$= Wo^2 \cdot fr2 + (Wi - Can / 0.707)^2 \cdot fr2$$

$$= 10.0000^2 \cdot 0.8550 + (10.7573)^2 \cdot 0.8550$$

$$= 1.844 \text{ cm}^2$$

Area Available in the Hub Section [A6]:

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Nozzle Calcs. Central Support

Noz1: 1 10:01a Jul 20,2008

$$= ((\text{Hubtk} - \text{Thk}) * h - \text{atrap}) * fr$$

$$= ((1.0000 - 26.0000) * 4.0000 - 0.0000) * 0.8550$$

$$= -0.855 \text{ cm}^2$$

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

Wall Thickness per UG45(a), tra = 4.1314 mm
 Wall Thickness per UG16(b), tr16b = 9.3500 mm
 Wall Thickness per UG45(b)(1), trb1 = 11.7682 mm
 Wall Thickness per UG45(b)(2), trb2 = 3.0000 mm
 Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 11.7682 mm
 Std. Wall Pipe per UG45(b)(4), trb4 = 11.1121 mm
 Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 11.1121 mm

Final Required Thickness, tr45 = Max(tra, trb) = 11.1121 mm
 Available Nozzle Neck Thickness = 26.0000 mm --> OK

M.A.W.P. Results for this Nozzle (Based on Areas and UG-45) at this Location

Approximate M.A.W.P. for given geometry 1809.143 kPa

Note: The MAWP of this junction was limited by the shell (minus static head).**Minimum Design Metal Temperature (Nozzle Neck), Curve: B**

Minimum Temp. w/o impact per UCS-66 0 C
 Minimum Temp. at required thickness -78 C

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,te), Curve: B

Minimum Temp. w/o impact per UCS-66 -11 C
 Minimum Temp. at required thickness -88 C
 Minimum Temp. w/o impact per UG-20(f) -29 C

Weld Size Calculations, Description: Central Support

Intermediate Calc. for nozzle/shell Welds Tmin 17.0000 mm
 Intermediate Calc. for Inward Weld TminIns 17.0000 mm

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * Wo mm
Inward Weld	6.0000 = Min per Code	7.6050 = 0.7 * Wi-Can mm

The Drop for this Nozzle is : 3.8345 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 148.0001 mm

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Sample Vessel

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FileName : ASME Calculations Rev 2

Nozzle Calcs. Manway

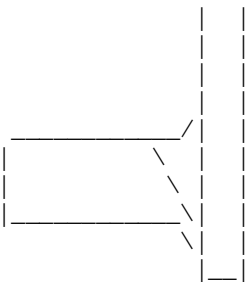
 Nozl: 2 10:01a Jul 20,2008

INPUT VALUES, Nozzle Description: Manway From : 10

Pressure for Nozzle Reinforcement Calculations P		1077.209	kPa
Temperature for Internal Pressure	Temp	200	C
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	N/mm ²
Shell Allowable Stress At Ambient	Sa	137.90	N/mm ²
Inside Diameter of Elliptical Head	D	2250.0000	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Actual Thickness	T	18.0000	mm
Head Internal Corrosion Allowance	Cas	3.0000	mm
Head External Corrosion Allowance	Caext	0.0000	mm
Distance from Head Centerline	L1	630.0000	mm
User Entered Minimum Design Metal Temperature		-10.00	C
Nozzle Material		SA-36	
Nozzle Allowable Stress at Temperature	Sn	114.46	N/mm ²
Nozzle Allowable Stress At Ambient	Sna	114.46	N/mm ²
Nozzle Diameter Basis (for tr calc only)	Inbase	ID	
Layout Angle		180.00	deg
Nozzle Diameter	Dia	400.0000	mm.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	20.0000	mm
Nozzle Flange Material		C	
Nozzle Flange Type		None	
Nozzle Corrosion Allowance	Can	3.0000	mm
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	0.70	
Nozzle Outside Projection	Ho	23.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm
Nozzle Inside Projection	H	50.0000	mm
Weld leg size, Inside Nozzle to Shell	Wi	0.0000	mm
ASME Code Weld Type per UW-16		C	

The Pressure Design option was Design Pressure + static head

Nozzle Sketch



Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Nozzle Calcs. Manway Nozl: 2 10:01a Jul 20,2008

Insert Nozzle No Pad, with Inside projection

NOZZLE CALCULATION, Description: Manway

ASME Code, Section VIII, Division 1, 2007, UG-37 to UG-45

Actual Nozzle Inside Diameter Used in Calculation 400.000 mm.
 Actual Nozzle Thickness Used in Calculation 20.000 mm

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Elliptical Head, Tr [Int. Press]
 = (P*D*K)/(2*S*E-0.2*P) Appendix 1-4(c)
 = (1077.21*2256.0000*1.00)/(2*137.90*1.00-0.2*1077.21)
 = 8.8188 mm

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
 = (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
 = (1077.21*203.00)/(114*1.00-0.6*1077.21)
 = 1.9215 mm

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
 = (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
 = (1077.21*203.00)/(114*0.70-0.6*1077.21)
 = 2.7517 mm

UG-40, Thickness and Diameter Limit Results : [Int. Press]

Effective material diameter limit, Dl 812.0000 mm
 Effective material thickness limit, no pad Tlnp 37.5000 mm

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5	Design	External	Mapnc
Area Required Ar	36.314	NA	NA cm^2
Area in Shell A1	24.738	NA	NA cm^2
Area in Nozzle Wall A2	5.757	NA	NA cm^2
Area in Inward Nozzle A3	8.134	NA	NA cm^2
Area in Welds A4	0.830	NA	NA cm^2
Area in Pad A5	0.000	NA	NA cm^2
TOTAL AREA AVAILABLE Atot	39.459	NA	NA cm^2

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Reinforcement Area Required for Nozzle [Ar]:
 = (Dlr*Tr+2*Thk*Tr*(1-fr1)) UG-37(c)
 = (406.0000*8.8188+2*(20.0000-3.0000)*8.8188*(1-0.8300))
 = 36.314 cm^2

Areas per UG-37.1 but with DL = Diameter Limit, DLR = Corroded ID:

Area Available in Shell [A1]:
 = (DL-Dlr)*(ES*(T-Cas)-Tr)-2*(Thk-Can)*(ES*(T-Cas)-Tr)*(1-fr1)
 = (812.000-406.000)*(1.00*(18.0000-3.000)-8.819)-2*(20.000-3.000)
 (1.00(18.0000-3.0000)-8.8188)*(1-0.8300)
 = 24.738 cm^2

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Nozzle Calcs. Manway Nozl: 2 10:01a Jul 20,2008

Area Available in Nozzle Wall, no Pad [A2np]:

$$= (2 * \min(Tl_{np}, h_o)) * (Thk - Can - Trn) * fr_2$$

$$= (2 * \min(37.50, 23.00)) * (20.00 - 3.00 - 1.92) * 0.8300$$

$$= 5.757 \text{ cm}^2$$

Area Available in Nozzle Penetration [A3]:

$$= 2 * (Tn - Can - Can) * (\min(H - Can, Tl, 2.5 * Tn - Can - Can)) * fr_2$$

$$= 2 * (14.0000) * (35.0000) * 0.8300$$

$$= 8.134 \text{ cm}^2$$

Area Available in Welds, no Pad [A4np]:

$$= W_o^2 * fr_2 + (W_i - Can / 0.707)^2 * fr_2$$

$$= 10.0000^2 * 0.8300 + (0.0000)^2 * 0.8300$$

$$= 0.830 \text{ cm}^2$$

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

Wall Thickness per UG45(a), tra = 5.7517 mm
 Wall Thickness per UG16(b), tr16b = 9.3500 mm
 Wall Thickness per UG45(b)(1), trb1 = 11.8188 mm
 Wall Thickness per UG45(b)(2), trb2 = 3.0000 mm
 Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 11.8188 mm
 Std. Wall Pipe per UG45(b)(4), trb4 = 11.3344 mm
 Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 11.3344 mm

Final Required Thickness, tr45 = Max(tra, trb) = 11.3344 mm
 Available Nozzle Neck Thickness = 20.0000 mm --> OK

M.A.W.P. Results for this Nozzle (Based on Areas and UG-45) at this Location

Approximate M.A.W.P. for given geometry 1124.044 kPa

Note: The MAWP of this junction was limited by the Areas.

Minimum Design Metal Temperature (Nozzle Neck), Curve: A

Minimum Temp. w/o impact per UCS-66 12 C
 Minimum Temp. at required thickness -65 C

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,te), Curve: A

Minimum Temp. w/o impact per UCS-66 9 C
 Minimum Temp. at required thickness -69 C

Weld Size Calculations, Description: Manway

Intermediate Calc. for nozzle/shell Welds Tmin 17.0000 mm

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * Wo mm

The Drop for this Nozzle is : 11.9010 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 91.0001 mm

Sample Vessel

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FileName : ASME Calculations Rev 2

Nozzle Calcs. DRAIN

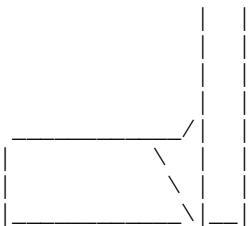
Noz1: 3 10:01a Jul 20,2008

INPUT VALUES, Nozzle Description: DRAIN From : 10

Pressure for Nozzle Reinforcement Calculations P		1080.642	kPa
Temperature for Internal Pressure	Temp	200	C
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	N/mm ²
Shell Allowable Stress At Ambient	Sa	137.90	N/mm ²
Inside Diameter of Elliptical Head	D	2250.0000	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Actual Thickness	T	18.0000	mm
Head Internal Corrosion Allowance	Cas	3.0000	mm
Head External Corrosion Allowance	Caext	0.0000	mm
Distance from Head Centerline	L1	1100.0000	mm
User Entered Minimum Design Metal Temperature		-10.00	C
Nozzle Material		SA-36	
Nozzle Allowable Stress at Temperature	Sn	114.46	N/mm ²
Nozzle Allowable Stress At Ambient	Sna	114.46	N/mm ²
Nozzle Diameter Basis (for tr calc only)	Inbase	ID	
Layout Angle		207.00	deg
Nozzle Diameter	Dia	52.0000	mm.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	59.0000	mm
Nozzle Flange Material		C	
Nozzle Flange Type		None	
Nozzle Corrosion Allowance	Can	3.0000	mm
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	0.70	
Nozzle Outside Projection	Ho	10.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	14.5000	mm
Nozzle Inside Projection	H	0.0000	mm
Weld leg size, Inside Nozzle to Shell	Wi	0.0000	mm
ASME Code Weld Type per UW-16		C	

The Pressure Design option was Design Pressure + static head

Nozzle Sketch



Insert Nozzle No Pad, no Inside projection

Sample Vessel

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FileName : ASME Calculations Rev 2

Nozzle Calcs. DRAIN

Nozl: 3 10:01a Jul 20,2008

NOZZLE CALCULATION, Description: DRAIN

ASME Code, Section VIII, Division 1, 2007, UG-37 to UG-45

Actual Nozzle Inside Diameter Used in Calculation 52.000 mm.
 Actual Nozzle Thickness Used in Calculation 59.000 mm

Nozzle input data check completed without errors.

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

$$= (P \cdot D \cdot K) / (2 \cdot S \cdot E - 0.2 \cdot P) \text{ Appendix 1-4(c)}$$

$$= (1080.64 \cdot 2256.0000 \cdot 1.00) / (2 \cdot 137.90 \cdot 1.00 - 0.2 \cdot 1080.64)$$

$$= 8.8469 \text{ mm}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$= R_o \cdot (Z^{1.5} - 1) \text{ per Appendix 1-2 (a)(1)}$$

$$= 29.000 \cdot (1.0191^{1.5} - 1)$$

$$= 0.2751 \text{ mm}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$= R_o \cdot (Z^{1.5} - 1) \text{ per Appendix 1-2 (a)(1)}$$

$$= 29.000 \cdot (1.0273^{1.5} - 1)$$

$$= 0.3938 \text{ mm}$$

UG-40, Thickness and Diameter Limit Results : [Int. Press]

Effective material diameter limit, D1 200.0000 mm
 Effective material thickness limit, no pad Tlnp 37.5000 mm

Note: Taking a UG-36(c)(3)(a) exemption for DRAIN

This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. It may be necessary to force the program to print the areas per UG-37.

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

Wall Thickness per UG45(a), tra = 3.3938 mm
 Wall Thickness per UG16(b), tr16b = 9.3500 mm
 Wall Thickness per UG45(b)(1), trb1 = 11.8469 mm
 Wall Thickness per UG45(b)(2), trb2 = 3.0000 mm
 Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 11.8469 mm
 Std. Wall Pipe per UG45(b)(4), trb4 = 10.1564 mm
 Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 10.1564 mm

Final Required Thickness, tr45 = Max(tra, trb) = 10.1564 mm
 Available Nozzle Neck Thickness = 59.0000 mm --> OK

Minimum Design Metal Temperature (Nozzle Neck), Curve: A

Minimum Temp. w/o impact per UCS-66 40 C
 Minimum Temp. at required thickness -38 C

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,te), Curve: A

Minimum Temp. w/o impact per UCS-66 9 C
 Minimum Temp. at required thickness -69 C

Weld Size Calculations, Description: DRAIN

Intermediate Calc. for nozzle/shell Welds Tmin 17.0000 mm

Results Per UW-16.1:

Sample Vessel

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Nozzle Calcs. DRAIN Noz1: 3 10:01a Jul 20,2008

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * Wo mm

The Drop for this Nozzle is : 1.7722 mm

The Cut Length for this Nozzle is, Drop + Ho + H + T : 29.7722 mm

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Sample Vessel

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FileName : ASME Calculations Rev 2

Nozzle Calcs. CENTRAL SUPPORT

Noz1: 4 10:01a Jul 20,2008

INPUT VALUES, Nozzle Description: CENTRAL SUPPORT From : 30

Pressure for Nozzle Reinforcement Calculations P		1060.000	kPa
Temperature for Internal Pressure	Temp	200	C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	N/mm ²
Shell Allowable Stress At Ambient	Sa	137.90	N/mm ²
Outside Diameter of Flat Head	D	2200.0000	mm
Large Diameter of Flat Head	Dl	2200.0000	mm
Flat Head Attachment Factor	F	0.33	
Head Actual Thickness	T	125.0000	mm
Head Internal Corrosion Allowance	Cas	3.0000	mm
Head External Corrosion Allowance	Caext	0.0000	mm
Required Thickness of Shell or Head (User)	Tsuser	78.5000	mm
Distance from Head Centerline	Ll	0.0000	mm
User Entered Minimum Design Metal Temperature		-10.00	C
Nozzle Material		SA-106 B	
Nozzle Allowable Stress at Temperature	Sn	117.90	N/mm ²
Nozzle Allowable Stress At Ambient	Sna	117.90	N/mm ²
Nozzle Diameter Basis (for tr calc only)	Inbase	OD	
Layout Angle		0.00	deg
Nozzle Diameter	Dia	250.0000	mm.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	26.0000	mm
Nozzle Flange Material		C	
Nozzle Flange Type		None	
Nozzle Corrosion Allowance	Can	3.0000	mm
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	200.0000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	20.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm
Nozzle Inside Projection	H	200.0000	mm
Weld leg size, Inside Nozzle to Shell	Wi	15.0000	mm
Pad Material [Normalized]		SA-516 70	
Pad Allowable Stress at Temperature	Sp	137.90	N/mm ²
Pad Allowable Stress At Ambient	Spa	137.90	N/mm ²
Diameter of Pad along vessel surface	Dp	500.0000	mm
Thickness of Pad	Tp	38.0000	mm
Weld leg size between Pad and Shell	Wp	20.0000	mm
Groove weld depth between Pad and Nozzle	Wgpn	20.0000	mm
Reinforcing Pad Width		125.0000	mm
ASME Code Weld Type per UW-16		None	

The Pressure Design option was Design Pressure + static head

Nozzle Sketch

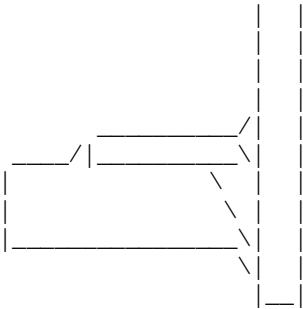
Sample Vessel

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FileName : ASME Calculations Rev 2

Nozzle Calcs. CENTRAL SUPPORT

Noz1: 4 10:01a Jul 20,2008



Insert Nozzle With Pad, with Inside projection

NOZZLE CALCULATION, Description: CENTRAL SUPPORT

ASME Code, Section VIII, Division 1, 2007, UG-37 to UG-45

Actual Nozzle Outside Diameter Used in Calculation 250.000 mm.
 Actual Nozzle Thickness Used in Calculation 26.000 mm

Note: Post Weld Heat Treating is required for this Nozzle Geometry!

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
 = $(P \cdot Ro) / (S \cdot E + 0.4 \cdot P)$ per Appendix 1-1 (a)(1)
 = $(1060.00 \cdot 125.0000) / (117 \cdot 1.00 + 0.4 \cdot 1060.00)$
 = 1.1198 mm

UG-40, Thickness and Diameter Limit Results : [Int. Press]

Effective material diameter limit, D1 494.0000 mm
 Effective material thickness limit, no pad Tlnp 57.5000 mm
 Effective material thickness limit, pad side Tlwp 95.5000 mm

Note : The Pad diameter is greater than the Diameter Limit, the excess will not be considered .

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5	Design	External	Mapnc
Area Required Ar	82.688	NA	NA cm ²
Area in Shell A1	123.249	NA	NA cm ²
Area in Nozzle Wall A2	35.731	NA	NA cm ²
Area in Inward Nozzle A3	17.100	NA	NA cm ²
Area in Welds A4	4.409	NA	NA cm ²
Area in Pad A5	92.720	NA	NA cm ²
TOTAL AREA AVAILABLE Atot	273.209	NA	NA cm ²

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.
 The area available with the given pad is Sufficient.

Reinforcement Area Required for Nozzle [Ar]:
 = $0.5 \cdot (DLR \cdot Tr + 2 \cdot Thk \cdot Tr \cdot (1 - fr1))$ per UG-37(d) or UG-39
 = $0.5 \cdot (204.0000 \cdot 78.5000 + 2 \cdot (26.0000 - 3.0000) \cdot 78.5000 \cdot (1 - 0.8550))$
 = 82.688 cm²

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Nozzle Calcs. CENTRAL SUPPORT Nozl: 4 10:01a Jul 20,2008

Areas per UG-37.1 but with DL = Diameter Limit, DLR = Corroded ID:

Area Available in Shell [A1]:

$$\begin{aligned}
 &= (DL-Dlr) * (ES * (T-Cas) - Tr) - 2 * (Thk-Can) * (ES * (T-Cas) - Tr) * (1-fr1) \\
 &= (494.000 - 204.000) * (1.00 * (125.0000 - 3.000) - 78.500) - 2 * (26.000 - 3.000) \\
 &\quad * (1.00 * (125.0000 - 3.0000) - 78.5000) * (1 - 0.8550) \\
 &= 123.249 \text{ cm}^2
 \end{aligned}$$

Area Available in Nozzle Wall, no Pad [A2np]:

$$\begin{aligned}
 &= (2 * \min(Tlnp, ho)) * (Thk - Can - Trn) * fr2 \\
 &= (2 * \min(57.50, 200.00)) * (26.00 - 3.00 - 1.12) * 0.8550 \\
 &= 21.514 \text{ cm}^2
 \end{aligned}$$

Area Available in Nozzle Wall, with Pad [A2wp]:

$$\begin{aligned}
 &= (2 * \min(Tlwp, ho)) * (Thk - Can - Trn) * fr2 \\
 &= (2 * \min(95.50, 200.00)) * (26.00 - 3.00 - 1.12) * 0.8550 \\
 &= 35.731 \text{ cm}^2
 \end{aligned}$$

Area Available in Nozzle Penetration [A3]:

$$\begin{aligned}
 &= 2 * (Tn-Can-Can) * (\min(H-Can, Tl, 2.5 * Tn-Can-Can)) * fr2 \\
 &= 2 * (20.0000) * (50.0000) * 0.8550 \\
 &= 17.100 \text{ cm}^2
 \end{aligned}$$

Area Available in Welds, no Pad [A4np]:

$$\begin{aligned}
 &= Wo^2 * fr2 + (Wi-Can/0.707)^2 * fr2 \\
 &= 20.0000^2 * 0.8550 + (10.7573)^2 * 0.8550 \\
 &= 4.409 \text{ cm}^2
 \end{aligned}$$

Area Available in Welds, with Pad [A4wp]:

$$\begin{aligned}
 &= Wo^2 * fr3 + (Wi-Can/0.707)^2 * Fr2 + Wp^2 * Fr4 \\
 &= 20.0000^2 * 0.86 + (10.7573)^2 * 0.86 + 0.0000^2 * 1.00 \\
 &= 4.409 \text{ cm}^2
 \end{aligned}$$

Area Available in Pad [A5]:

$$\begin{aligned}
 &= (\min(Dp, DL) - (\text{Nozzle OD})) * (\min(Tp, Tlwp, Te)) * fr4 \\
 &= (494.0000 - 250.0000) * 38.0000 * 1.0000 \\
 &= 92.720 \text{ cm}^2
 \end{aligned}$$

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

Wall Thickness per UG45(a), tra = 4.1198 mm
 Wall Thickness per UG16(b), tr16b = 9.3500 mm
 Wall Thickness per UG45(b)(1), trb1 = 81.5000 mm
 Wall Thickness per UG45(b)(2), trb2 = 3.0000 mm
 Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 81.5000 mm
 Std. Wall Pipe per UG45(b)(4), trb4 = 11.1121 mm
 Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 11.1121 mm

Final Required Thickness, tr45 = Max(tra, trb) = 11.1121 mm
 Available Nozzle Neck Thickness = 26.0000 mm --> OK

M.A.W.P. Results for this Nozzle (Based on Areas and UG-45) at this Location

Approximate M.A.W.P. for given geometry 1255.917 kPa

Note: The MAWP of this junction was limited by the shell (minus static head).

Minimum Design Metal Temperature Results:	Nozzle	Pad
Minimum Temp. w/o impact per UCS-66	0	-26 C
Minimum Temp. at required thickness	-78	-31 C
Minimum Temp. w/o impact per UG-20(f)	NA	NA C

Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Nozzle Calcs. CENTRAL SUPPORT

Nozl: 4 10:01a Jul 20,2008

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,e), Curve: B

Minimum Temp. w/o impact per UCS-66 0 C

Minimum Temp. at required thickness -78 C

Weld Size Calculations. Description: CENTRAL SUPPORT

Intermediate Calc. for nozzle/shell Welds Tmin 19.0000 mm

Intermediate Calc. for pad/shell Welds TminPad 19.0000 mm

Intermediate Calc. for Inward Weld TminIns 19.0000 mm

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	13.3000 = 0.7 * TMIN	14.1400 = 0.7 * Wo mm
Pad Weld	9.5000 = 0.5*TminPad	14.1400 = 0.7 * Wp mm
Inward Weld	6.0000 = Min per Code	7.6050 = 0.7 * Wi-Can mm

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:

$$= (Ar - A1 + 2 * (Thk - can) * Ffr1 * (E1(T - Cas) - Tr)) * S$$

$$= (82.6880 - 123.2486 + 2 * (26.0000 - 3.0000) * 0.8550 * (1.00 * (125.0000 - 3.0000) - 78.5000)) * 137$$

$$= 0.00 \text{ kgf}$$

Weld Load [W1]:

$$= (A2 + A5 + A4 - (Wi - Can / .707)^2 * Ffr2) * S$$

$$= (35.7314 + 92.7200 + 4.4094 - 4.5559 * 0.86) * 137$$

$$= 185432.67 \text{ kgf}$$

Weld Load [W2]:

$$= ((A2 + A6) + A3 + A4 + (2 * (Thk - Can) * (T - Ca) * Fr1)) * S$$

$$= (35.7314 + 17.1000 + 4.4094 + 47.9826) * 137$$

$$= 147961.25 \text{ kgf}$$

Weld Load [W3]:

$$= ((A2 + A6) + A3 + A4 + A5 + (2 * (Thk - Can) * (T - Ca) * Fr1)) * S$$

$$= (35.7314 + 17.1000 + 4.4094 + 92.7200 + 47.9826) * 137$$

$$= 278340.66 \text{ kgf}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (\pi / 2) * Dlo * Wo * 0.49 * Snw$$

$$= (3.1416 / 2.0) * 250.0000 * 20.0000 * 0.49 * 117$$

$$= 46269. \text{ kgf}$$

Shear, Inward Nozzle Weld [Sinw]:

$$= (\pi / 2) * Dlo * Wo * 0.49 * Snw$$

$$= (3.1416 / 2.0) * 250.0000 * 10.7573 * 0.49 * 117$$

$$= 24886. \text{ kgf}$$

Shear, Pad Element Weld [Spew]:

$$= (\pi / 2) * DP * WP * 0.49 * SEW$$

$$= (3.1416 / 2.0) * 500.0000 * 20.0000 * 0.49 * 137$$

$$= 108231. \text{ kgf}$$

Shear, Nozzle Wall [Snw]:

$$= (\pi * (Dlr + Dlo) / 4) * (Thk - Can) * 0.7 * Sn$$

$$= (3.1416 * 113.5000) * (26.0000 - 3.0000) * 0.7 * 117$$

$$= 69020. \text{ kgf}$$

Sample Vessel

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Nozzle Calcs. CENTRAL SUPPORT

Nozl: 4 10:01a Jul 20,2008**Tension, Pad Groove Weld [Tpgw]:**

$$\begin{aligned}
 &= (\pi/2) * D_{lo} * W_{gpn} * 0.74 * S_{eg} \\
 &= (3.1416 / 2) * 250.0000 * 20.0000 * 0.74 * 117 \\
 &= 69875. \text{ kgf}
 \end{aligned}$$

Tension, Nozzle Groove Weld [Tngw]:

$$\begin{aligned}
 &= (\pi/2) * D_{lo} * (W_{gnvi} - C_{as}) * 0.74 * S_{ng} \\
 &= (3.1416 / 2.0) * 250.0000 * (20.0000 - 3.0000) * 0.74 * 117 \\
 &= 59394. \text{ kgf}
 \end{aligned}$$

Strength of Failure Paths:

$$\begin{aligned}
 \text{PATH11} &= (\text{SPEW} + \text{SNW}) = (108230 + 69019) = 177250 \text{ kgf} \\
 \text{PATH22} &= (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw}) \\
 &= (46268 + 69875 + 59393 + 24886) = 200424 \text{ kgf} \\
 \text{PATH33} &= (\text{Spew} + \text{Tngw} + \text{Sinw}) \\
 &= (108230 + 59393 + 24886) = 192511 \text{ kgf}
 \end{aligned}$$

Summary of Failure Path Calculations:

Path 1-1 = 177250 kgf, must exceed W = 0 kgf or W1 = 185432 kgf
 Path 2-2 = 200424 kgf, must exceed W = 0 kgf or W2 = 147961 kgf
 Path 3-3 = 192511 kgf, must exceed W = 0 kgf or W3 = 278340 kgf

The Cut Length for this Nozzle is, Drop + Ho + H + T : 525.0000 mm

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Nozzle Schedule

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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	
DRAIN	52	-	None	170.000	59.000	-	-	29
Central Support	250	-	None	250.000	26.000	-	-	148
CENTRAL SUPPORT	250	-	None	250.000	26.000	500.00	38.00	525
Manway	400	-	None	440.000	20.000	-	-	91

Note on the Cut Length Calculation:

The Cut Length is the Outside Projection + Inside Projection + Drop + In Plane Shell Thickness. This value does not include weld gaps, nor does it account for shrinkage.

Please Note: In the case of Oblique Nozzles, the Outside Diameter must be increased. The Re-Pad WIDTH around the nozzle is calculated as follows:

Width of Pad = (Pad Outside Dia. (per above) - Nozzle Outside Dia.)/2

Nozzle Material and Weld Fillet Leg Size Details:

Nozzle	Material	Shl Grve Weld mm	Noz Shl/Pad Weld mm	Pad OD Weld mm	Pad Grve Weld mm	Inside Weld mm
DRAIN	SA-36	14.500	10.000	-	-	-
Central	SA-106 B	14.500	10.000	-	-	15.000
CENTRAL	SA-106 B	20.000	20.000	20.000	20.000	15.000
Manway	SA-36	18.000	10.000	-	-	-

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

Nozzle Miscellaneous Data:

Nozzle	Elevation/Distance From Datum mm	Layout Angle deg.	Projection Outside mm	Projection Inside mm	Installed In Component
DRAIN		207.00	10.00	0.00	LEFT HEAD
Central Support		0.00	65.00	65.00	LEFT HEAD
CENTRAL SUPPORT		0.00	200.00	200.00	TUBESHEET
Manway		180.00	23.00	50.00	LEFT HEAD

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Nozzle Summary

Step: 12 10:01a Jul 20,2008

Nozzle Calculation Summary

Description	Internal kPa	Ext	MAPNC kPa	UG45 [tr]	Weld Path	Areas
Central Support	1809.14	...	...	OK 11.11	OK	Passed
Manway	1106.84	...	...	OK 11.33	OK	Passed
DRAIN	1080.64	...	...	OK 10.16	OK	Passed
CENTRAL SUPPORT	1255.92	...	...	OK 11.11	OK	Passed

Min. - Nozzles 1080.64 DRAIN
 Min. Shell&Flgs 1255.92 30 50 1348.96

Computed Vessel M.A.W.P. 1080.64 kPa

Note: MAWPs (Internal Case) shown above are at the High Point.

Warning: A Nozzle Reinforcement is governing the MAWP of this Vessel.

Check the Spatial Relationship between the Nozzles

From Node	Nozzle Description	X Coordinate,	Layout Angle,	Dia. Limit
10	Central Support	0.000	0.000	408.000
10	Manway	0.000	180.000	812.000
10	DRAIN	0.000	207.000	200.000
30	CENTRAL SUPPORT	0.000	0.000	494.000

The nozzle spacing is computed by the following:

= Sqrt(l² + lc²) where
 ll - Arc length along the inside vessel surface in the long. direction.
 lc - Arc length along the inside vessel surface in the circ. direction

If any interferences/violations are found, they will be noted below.
 No interference violations have been detected !

Checking Multiple Nozzles on Flat Head per ASME Sec. VIII Div. 1 UG-39

Comparing Nozzles on Element: TUBESHEET

Note: No Nozzle pairs found on this element.

UG-39 Nozzle Diameter and Distance to Edge Checks :

Nozzle Description	Nozzle dia. mm	Head Dia. /2 mm	Distance from Edge mm	Nozzle dia./4 mm
CENTRAL SUPPORT	204.00	1100.0	975.00	51.000

No Multiple Nozzle spacing violations have been detected !

Sample Vessel

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FileName : ASME Calculations Rev 2

Vessel Design Summary

Step: 13 10:01a Jul 20,2008**Design Code: ASME Code Section VIII Division 1, 2007**

Diameter Spec : 2250.000 mm ID
Vessel Design Length, Tangent to Tangent 1185.00 mm

Specified Datum Line Distance 0.00 mm

Shell/Head Matl SA-516 70
Nozzle Material SA-106 B
Nozzle Material SA-36
Re-Pad Material SA-516 70

Internal Design Temperature 200 C
Internal Design Pressure 1060.00 kPa

External Design Temperature 70 C

Maximum Allowable Working Pressure 1080.64 kPa
External Max. Allowable Working Pressure 600.68 kPa
Hydrostatic Test Pressure 1378.00 kPa

Required Minimum Design Metal Temperature -10 C
Warmest Computed Minimum Design Metal Temperature -31 C

Wind Design Code No Wind Loads
Earthquake Design Code No Seismic

Element Pressures and MAWP: kPa

<u>Element Desc</u>	<u>Internal</u>	<u>External</u>	<u>M. A. W. P</u>	<u>Corr. All.</u>
LEFT HEAD	1082.092	0.000	1809.143	3.0000
Cylinder	1082.092	0.000	1728.514	3.0000
TUBESHEET	1082.092	0.000	1255.917	3.0000

Liquid Level: 2250.00 mm Dens.: 0.001 kg/cm³ Sp. Gr.: 1.000

<u>Element Type</u>	<u>"To" Elev mm</u>	<u>Length mm</u>	<u>Element Thk mm</u>	<u>R e q d T h k</u>		<u>Joint Eff</u>	
				<u>Int.</u>	<u>Ext.</u>	<u>Long</u>	<u>Circ</u>
Ellipse	60.0	60.0	20.0	11.9	No Calc	1.00	0.85
Cylinder	1060.0	1000.0	20.0	13.5	No Calc	0.85	0.85
Wld Flat	1185.0	125.0	125.0	115.3	No Calc	1.00	1.00

Element thicknesses are shown as Nominal if specified, otherwise are Minimum

Weights:

Fabricated - Bare W/O Removable Internals	7153.2	kgm
Shop Test - Fabricated + Water (Full)	12856.4	kgm
Shipping - Fab. + Rem. Intls.+ Shipping App.	7153.2	kgm
Erected - Fab. + Rem. Intls.+ Insul. (etc)	7153.2	kgm
Empty - Fab. + Intls. + Details + Wghts.	7153.2	kgm
Operating - Empty + Operating Liquid (No CA)	12858.4	kgm
Field Test - Empty Weight + Water (Full)	12856.4	kgm

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Sample Vessel

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FileName : ASME Calculations Rev 2 -----

Problems/Failures Summary Step: 14 10:01a Jul 20,2008

Listed below are the known problem areas for the current design. If one or more of the design flags are turned on, please re-run the analysis. Some of these issues may be resolved when using updated input values.

**** Warning: PWHT was required for at least 1 Nozzle/Pad in this vessel !**

Please review all reports carefully!

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