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DESIGN CALCULATION

In Accordance with ASME Section VIII Division 1

ASME Code Version : 2007

Analysis Performed by : KEDKEP CONSULTING, INC.

Job File : E:\200828 AUDIT VESSEL\AUDIT VESSEL.PVI

Date of Analysis : Sep 15,2008

PV Elite 2008, May 2008

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)	100.00	psig
Design Internal Temperature	300	F
Type of Hydrotest	UG99-b Note [34]	
Hydrotest Position	Vertical	
Projection of Nozzle from Vessel Top	0.0000	in
Projection of Nozzle from Vessel Bottom	0.0000	in
Minimum Design Metal Temperature	-20	F
Type of Construction	Welded	
Special Service	None	
Degree of Radiography	RT-4	
Miscellaneous Weight Percent	0.	
Use Higher Longitudinal Stresses (Flag)	Y	
Select t for Internal Pressure (Flag)	N	
Select t for External Pressure (Flag)	N	
Select t for Axial Stress (Flag)	N	
Select Location for Stiff. Rings (Flag)	N	
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	psig
User defined MAWP	0.0000	psig
User defined MAPnc	0.0000	psig

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	No Wind Loads	
Design Wind Speed	70.000	mile/hr
Exposure Constant	C	
Importance Factor		
Roughness Factor		
Base Elevation	0.0000	in
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	

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	Bottom Head	
Distance "FROM" to "TO"	1.5000	in
Element Outside Diameter	16.000	in
Element Thickness	0.2250	in
Internal Corrosion Allowance	0.0000	in
Nominal Thickness	0.2500	in
External Corrosion Allowance	0.0000	in
Design Internal Pressure	100.00	psig
Design Temperature Internal Pressure	300	F
Design External Pressure	0.0000	psig
Design Temperature External Pressure	200	F
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	
Allowable Stress, Ambient	20000.	psi
Allowable Stress, Operating	20000.	psi
Allowable Stress, Hydrotest	34200.	psi
Material Density	0.2830	lbm/in^3
P Number Thickness	1.2500	in
Yield Stress, Operating	33600.	psi
UCS-66 Chart Curve Designation	B	
External Pressure Chart Name	CS-2	
UNS Number	K02700	
Product Form	Plate	
Efficiency, Longitudinal Seam	0.85	
Efficiency, Circumferential Seam	0.7	
Elliptical Head Factor	2.	

Element From Node	10	
Detail Type	Liquid	
Detail ID	WATER	
Dist. from "FROM" Node / Offset dist	-4.0000	in
Height/Length of Liquid	5.5000	in
Density of Liquid	62.400	lbm/ft^3

Element From Node	10	
Detail Type	Nozzle	
Detail ID	Noz N4	
Dist. from "FROM" Node / Offset dist	0.0000	in
Nozzle Diameter	2.5	in.
Nozzle Schedule	None	
Nozzle Class	0	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	lbf
Grade of Attached Flange	None	
Nozzle Matl	SA-105	

Element From Node	20	
Element To Node	30	
Element Type	Cylinder	
Description	Shell	
Distance "FROM" to "TO"	30.000	in

Element Outside Diameter	16.000	in
Element Thickness	0.2500	in
Internal Corrosion Allowance	0.0000	in
Nominal Thickness	0.2500	in
External Corrosion Allowance	0.0000	in
Design Internal Pressure	100.00	psig
Design Temperature Internal Pressure	300	F
Design External Pressure	0.0000	psig
Design Temperature External Pressure	200	F
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	
Efficiency, Longitudinal Seam	0.7	
Efficiency, Circumferential Seam	0.7	

Element From Node	20	
Detail Type	Liquid	
Detail ID	WATER	
Dist. from "FROM" Node / Offset dist	0.0000	in
Height/Length of Liquid	30.000	in
Density of Liquid	62.400	lbm/ft^3

Element From Node	20	
Detail Type	Nozzle	
Detail ID	Noz N3, N2	
Dist. from "FROM" Node / Offset dist	5.0000	in
Nozzle Diameter	3.	in.
Nozzle Schedule	None	
Nozzle Class	0	
Layout Angle	270.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	lbf
Grade of Attached Flange	None	
Nozzle Matl	SA-105	

Element From Node	20	
Detail Type	Nozzle	
Detail ID	Noz N5, N6	
Dist. from "FROM" Node / Offset dist	5.0000	in
Nozzle Diameter	2.	in.
Nozzle Schedule	80	
Nozzle Class	150	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	lbf
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-106 B	

Element From Node	20	
Detail Type	Leg	
Detail ID	LEGS	
Dist. from "FROM" Node / Offset dist	4.0000	in
Diameter at Leg Centerline	17.184	in
Leg Orientation	1	
Number of Legs	3	
Section Identifier	L2X2X0.2500	
Length of Legs	15.500	in

Element From Node	30	
Element To Node	40	
Element Type	Elliptical	
Description	Top Head	
Distance "FROM" to "TO"	1.5000	in
Element Outside Diameter	16.000	in

Element Thickness	0.2250	in
Internal Corrosion Allowance	0.0000	in
Nominal Thickness	0.2500	in
External Corrosion Allowance	0.0000	in
Design Internal Pressure	100.00	psig
Design Temperature Internal Pressure	300	F
Design External Pressure	0.0000	psig
Design Temperature External Pressure	200	F
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	
Efficiency, Longitudinal Seam	0.85	
Efficiency, Circumferential Seam	0.7	
Elliptical Head Factor	2.	
Element From Node	30	
Detail Type	Liquid	
Detail ID	WATER	
Dist. from "FROM" Node / Offset dist	0.0000	in
Height/Length of Liquid	5.5000	in
Density of Liquid	62.400	lbm/ft^3
Element From Node	30	
Detail Type	Nozzle	
Detail ID	Noz N1	
Dist. from "FROM" Node / Offset dist	0.0000	in
Nozzle Diameter	2.5	in.
Nozzle Schedule	None	
Nozzle Class	0	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	lbf
Grade of Attached Flange	None	
Nozzle Matl	SA-105	

XY Coordinate Calculations

From	To	X (Horiz.) in	Y (Vert.) in	DX (Horiz.) in	DY (Vert.) in
Bottom Hea	Shell	0.00000	1.50000	0.00000	1.50000
Shell	Top Head	0.00000	31.5000	0.00000	30.0000
Top Head		0.00000	33.0000	0.00000	1.50000

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd psig	Nominal Thickness in	Total Corr Allowance in	Element Diameter in	Allowable Stress(SE) psi
Bottom Hea		101.481	0.25000	0.00000	16.0000	17000.0
Shell		101.282	0.25000	0.00000	16.0000	14000.0
Top Head		100.199	0.25000	0.00000	16.0000	17000.0

Element Required Thickness and MAWP :

From	To	Design Pressure psig	M.A.W.P. Corroded psig	M.A.P. New & Cold psig	Actual Thickness in	Required Thickness in
Bottom Hea		100.000	489.061	490.542	0.22500	0.062500
Shell		100.000	441.756	443.038	0.25000	0.062500
Top Head		100.000	490.397	490.542	0.22500	0.062500
Minimum			228.899	285.000		

Note : The M.A.W.P is Governed by an ANSI Flange !

Flange MAWP including Static Pressure: 228.899 = 230.000 - 1.101 psig

Note : The M.A.P.(NC) is Governed by a Flange !

Internal Pressure Calculation Results :

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Elliptical Head From 10 To 20 SA-516 70 , UCS-66 Crv. B at 300 F

Bottom Head

Thickness Due to Internal Pressure [Tr]:
= (P*Do*K)/(2*S*E+2*P*(K-0.1)) per Appendix 1-4 (c)
= (101.481*16.0000*1.00)/(2*20000.00*0.85+2*101.481*(1.00-0.1))
= 0.0475 + 0.0000 = 0.0475 in

Note: The thickness required was less than the Code Minimum, therefore
the Code Minimum value of 0.0625 in will be used.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 1.481 psig
= (2*S*E*t)/(K*Do-2*t*(K-0.1)) per Appendix 1-4 (c)
= (2*20000.00*0.85*0.2250)/(1.00*16.0000-2*0.2250*(1.00-0.1))
= 490.542 - 1.481 = 489.061 psig

Maximum Allowable Pressure, New and Cold [MAPNC]:
= (2*S*E*t)/(K*Do-2*t*(K-0.1)) per Appendix 1-4 (c)
= (2*20000.00*0.85*0.2250)/(1.00*16.0000-2*0.2250*(1.00-0.1))
= 490.542 psig

Actual stress at given pressure and thickness, corroded [Sact]:
= (P*(K*Do-2*T*(K-0.1)))/(2*E*t)
= (101.481*(1.00*16.0000-2*0.2250*(1.00-0.1)))/(2*0.85*0.2250)
= 4137.488 psi

Required Thickness of Straight Flange = 0.048 in

Percent Elongation per UCS-79 (75*tnom/Rf)*(1-Rf/Ro) 7.003 %

Min Metal Temp. w/o impact per UCS-66 -20 F

Min Metal Temp. at Rqd thickness (UCS 66.1)[rat 0.24] -155 F

Cylindrical Shell From 20 To 30 SA-516 70 , UCS-66 Crv. B at 300 F

Shell

Thickness Due to Internal Pressure [Tr]:
= (P*Ro)/(S*E+0.4*P) per Appendix 1-1 (a)(1)
= (101.282*8.0000)/(20000.00*0.70+0.4*101.282)
= 0.0577 + 0.0000 = 0.0577 in

Note: The thickness required was less than the Code Minimum, therefore
the Code Minimum value of 0.0625 in will be used.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 1.282 psig
= (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
= (20000.00*0.70*0.2500)/(8.0000-0.4*0.2500)
= 443.038 - 1.282 = 441.756 psig

Maximum Allowable Pressure, New and Cold [MAPNC]:
= (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
= (20000.00*0.70*0.2500)/(8.0000-0.4*0.2500)
= 443.038 psig

Actual stress at given pressure and thickness, corroded [Sact]:
= (P*(Ro-0.4*t))/(E*t)
= (101.282*((8.0000-0.4*0.2500))/(0.70*0.2500)
= 4572.156 psi

Percent Elongation per UCS-79 (50*tnom/Rf)*(1-Rf/Ro) 1.587 %

Min Metal Temp. w/o impact per UCS-66 -20 F
Min Metal Temp. at Rqd thickness (UCS 66.1)[rat 0.20] -155 F

Elliptical Head From 30 To 40 SA-516 70 , UCS-66 Crv. B at 300 F

Top Head

Thickness Due to Internal Pressure [Tr]:
= (P*Do*K)/(2*S*E+2*P*(K-0.1)) per Appendix 1-4 (c)
= (100.144*16.0000*1.00)/(2*20000.00*0.85+2*100.144*(1.00-0.1))
= 0.0469 + 0.0000 = 0.0469 in

Note: The thickness required was less than the Code Minimum, therefore
the Code Minimum value of 0.0625 in will be used.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 0.144 psig
= (2*S*E*t)/(K*Do-2*t*(K-0.1)) per Appendix 1-4 (c)
= (2*20000.00*0.85*0.2250)/(1.00*16.0000-2*0.2250*(1.00-0.1))
= 490.542 - 0.144 = 490.397 psig

Maximum Allowable Pressure, New and Cold [MAPNC]:
= (2*S*E*t)/(K*Do-2*t*(K-0.1)) per Appendix 1-4 (c)
= (2*20000.00*0.85*0.2250)/(1.00*16.0000-2*0.2250*(1.00-0.1))
= 490.542 psig

Actual stress at given pressure and thickness, corroded [Sact]:
= (P*(K*Do-2*T*(K-0.1)))/(2*E*t)
= (100.144*(1.00*16.0000-2*0.2250*(1.00-0.1)))/(2*0.85*0.2250)
= 4083.013 psi

Required Thickness of Straight Flange = 0.047 in

Percent Elongation per UCS-79 (75*tnom/Rf)*(1-Rf/Ro) 7.003 %

Min Metal Temp. w/o impact per UCS-66 -20 F
Min Metal Temp. at Rqd thickness (UCS 66.1)[rat 0.24] -155 F

MINIMUM METAL DESIGN TEMPERATURE RESULTS :

Minimum Metal Temp. w/o impact per UCS-66 -20. F
Minimum Metal Temp. at Required thickness -155. F

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

Minimum Design Metal Temperature (Entered by User) -20. F

Hydrostatic Test Pressure Results:

Pressure per UG99b = 1.3 * M.A.W.P. * Sa/S 297.568 psig
Pressure per UG99b[34] = 1.3 * Design Pres * Sa/S 130.000 psig
Pressure per UG99c = 1.3 * M.A.P. - Head(Hyd) 370.500 psig
Pressure per UG100 = 1.1 * M.A.W.P. * Sa/S 251.788 psig

UG-99(b) Note 34, Test Pressure Calculation:
= Test Factor * Design Pressure * Stress Ratio
= 1.3 * 100.000 * 1.000
= 130.000 psig

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

Stresses on Elements due to Hydrostatic Test Pressure:

From To	Stress	Allowable	Ratio	Pressure
Bottom Head	5360.3	34200.0	0.157	131.47
Shell	5926.3	34200.0	0.173	131.28
Top Head	5308.2	34200.0	0.155	130.19

Elements Suitable for Internal Pressure.

External Pressure Calculation Results :

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Elliptical Head From 10 to 20 Ext. Chart: CS-2 at 200 F

Bottom Head

Elastic Modulus from Chart: CS-2 at 300 F : 0.29000E+08 psi

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	D/t	Factor A	B
0.225	16.00	71.11	0.0019531	14970.13

EMAP = B/(K0*D/t) = 14970.1309/(0.9000 *71.1111) = 233.9083 psig

Cylindrical Shell From 20 to 30 Ext. Chart: CS-2 at 200 F

Shell

Elastic Modulus from Chart: CS-2 at 300 F : 0.29000E+08 psi

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	SLEN	D/t	L/D	Factor A	B
0.250	16.00	35.59	64.00	2.2245	0.0011710	13053.81

EMAP = (4*B)/(3*(D/t)) = (4*13053.8066)/(3*64.0000) = 271.9543 psig

Results for Maximum Stiffened Length (Slen):

Tca	OD	SLEN	D/t	L/D	Factor A	B
0.250	16.00	0.90E+32	64.00	.5000E+02	0.0002686	3894.04

EMAP = (4*B)/(3*(D/t)) = (4*3894.0430)/(3*64.0000) = 81.1259 psig

Elliptical Head From 30 to 40 Ext. Chart: CS-2 at 200 F

Top Head

Elastic Modulus from Chart: CS-2 at 300 F : 0.29000E+08 psi

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	D/t	Factor A	B
0.225	16.00	71.11	0.0019531	14970.13

EMAP = B/(K0*D/t) = 14970.1309/(0.9000 *71.1111) = 233.9083 psig

External Pressure Calculations

From	To	Section Length in	Outside Diameter in	Corroded Thickness in	Factor A	Factor B psi
10	20	No Calc	16.0000	0.22500	0.0019531	14970.1
20	30	35.5917	16.0000	0.25000	0.0011710	13053.8
30	40	No Calc	16.0000	0.22500	0.0019531	14970.1

External Pressure Calculations

From	To	External Actual T. in	External Required T. in	External Des. Press. psig	External M.A.W.P. psig
10	20	0.22500	No Calc	0.00000	233.908
20	30	0.25000	No Calc	0.00000	271.954
30	40	0.22500	No Calc	0.00000	233.908
Minimum					233.908

External Pressure Calculations

From	To	Actual Len. Bet. Stiff. in	Allow. Len. Bet. Stiff. in	Ring Inertia Required in**4	Ring Inertia Available in**4
10	20	No Calc	No Calc	No Calc	No Calc
20	30	35.5917	90.24E+30	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. lbf	Element ID Volume gal	Corroded Metal Wgt. lbf	Corroded ID Volume gal	Extra due Misc % lbf
10	20	26.4066	3.36386	26.4066	3.36386	0.00000
20	30	105.021	24.5054	105.021	24.5054	0.00000
30	40	26.4066	3.36386	26.4066	3.36386	0.00000
Total		157	31	157	31	0

Weight of Details

From	Type	Weight of Detail lbf	X Offset, Dtl. Cent. in	Y Offset, Dtl. Cent. in	Description
10	Liqd	29.2713	0.00000	-2.00000	WATER
10	Nozl	0.14670	0.00000	0.32396	Noz N4
20	Liqd	204.416	0.00000	15.0000	WATER
20	Nozl	0.18667	9.25000	5.00000	Noz N3, N2
20	Nozl	7.91375	8.75000	5.00000	Noz N5, N6
20	Legs	12.3436	0.00000	-3.75000	LEGS
30	Liqd	28.0187	0.00000	2.00000	WATER
30	Nozl	0.14670	0.00000	0.32396	Noz N1

Total Weight of Each Detail Type

Total Weight of Liquid	261.7
Total Weight of Nozzles	8.4
Total Weight of Legs	12.3
Sum of the Detail Weights	282.4 lbf

Weight Summary

Fabricated Wt.	- Bare Weight W/O Removable Internals	178.6 lbf
Shop Test Wt.	- Fabricated Weight + Water (Full)	439.1 lbf
Shipping Wt.	- Fab. Wt + Rem. Intls.+ Shipping App.	178.6 lbf
Erected Wt.	- Fab. Wt + Rem. Intls.+ Insul. (etc)	178.6 lbf
Ope. Wt. no Liq	- Fab. Wt + Intls. + Details + Wghts.	178.6 lbf
Operating Wt.	- Empty Wt. + Operating Liquid (No CA)	440.3 lbf
Field Test Wt.	- Empty Weight + Water (Full)	439.1 lbf
Mass of the Upper 1/3 of the Vertical Vessel		152.6 lbf

Outside Surface Areas of Elements

From	To	Surface Area in^2
10	20	354.871
20	30	1507.96
30	40	354.871
Total		2217.707 in^2 [15.4 Square Feet]

Element and Detail Weights

From	To	Total Ele. Empty Wgt. lbm	Total. Ele. Oper. Wgt. lbm	Total. Ele. Hydro. Wgt. lbm	Total Dtl. Offset Mom. in-lb	Oper. Wgt. No Liquid lbm
10	20	26.5533	55.8246	54.6135	0.00000	26.5533
20	Legs	15.0829	42.3384	42.3384	9.46293	15.0829

Legs	30	98.0390	275.200	275.200	61.5090	98.0390
30	40	26.5533	54.5720	54.6135	0.00000	26.5533

Cumulative Vessel Weight

From	To	Cumulative Ope Wgt. No Liquid lbm	Cumulative Oper. Wgt. lbm	Cumulative Hydro. Wgt. lbm
10	20	-26.5533	-55.8246	-54.6135
20	Legs	-41.6362	-98.1630	-96.9520
Legs	30	124.592	329.772	329.813
30	40	26.5533	54.5720	54.6135

Note: The cumulative operating weights no liquid in the column above are the cumulative operating weights minus the operating liquid weight minus any weights absent in the empty condition.

Cumulative Vessel Moment

From	To	Cumulative Empty Mom. in-lb	Cumulative Oper. Mom. in-lb	Cumulative Hydro. Mom. in-lb
10	20	0.00000	0.00000	0.00000
20	Legs	9.46293	9.46293	9.46293
Legs	30	61.5090	61.5090	61.5090
30	40	0.00000	0.00000	0.00000

Nozzle Flange MAWP Results :

Flange Rating	Operating psig	Ambient psig	Temperature F	Class	Grade|Group
	230.000	285.000	300	150	GR 1.1
Minimum Rating	230.000	285.000	psig		

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

The Natural Frequencies for the vessel have been computed iteratively by solving a system of matrices. These matrices describe the mass and the stiffness of the vessel. This is the generalized eigenvalue/ eigenvector problem and is referenced in some mathematical texts.

The Natural Frequency for the Vessel (Empty.) is 123.297 Hz.

The Natural Frequency for the Vessel (Ope...) is 77.0974 Hz.

The Natural Frequency for the Vessel (Filled) is 77.2194 Hz.

The following table is for the Operating Case.

Wind/Earthquake Shear, Bending

From	To	Distance to Support in	Cummulative Wind Shear lbf	Earthquake Shear lbf	Wind Bending in-lb	Earthquake Bending in-lb
10	20	4.00000	0.00000	0.00000	0.00000	0.00000
20	Legs	2.00000	0.00000	0.00000	0.00000	0.00000
Legs	30	13.0000	0.00000	0.00000	0.00000	0.00000
30	40	26.0000	0.00000	0.00000	0.00000	0.00000

Longitudinal Stress Constants

From	To	Metal Area New & Cold in^2	Metal Area Corroded in^2	New & Cold Sect. Mod. in 3	Corroded Sect. Mod. in 3
10	20	11.1507	11.1507	43.3659	43.3659
20	30	12.3700	12.3700	47.9580	47.9580
30	40	11.1507	11.1507	43.3659	43.3659

Longitudinal Allowable Stresses

From	To	All. Str. Long. Ten. psi	All. Str. Hydr. Ten. psi	All. Str. Long. Com. psi	All. Str. Hyr. Comp. psi
10	20	16800.0	28728.0	-19938.3	-24922.9
20	Legs	16800.0	28728.0	-20216.6	-25270.8
Legs	30	16800.0	28728.0	-20216.6	-25270.8
30	40	16800.0	28728.0	-19938.3	-24922.9

Longitudinal Stress Report

Note: Longitudinal Operating and Empty Stresses are computed in the corroded condition. Stresses due to loads in the hydrostatic test cases have been computed in the new and cold condition.

Longitudinal Stresses Due to . . .

From	To	Long. Str. Int. Pres. psi	Long. Str. Ext. Pres. psi	Long. Str. Hyd. Pres. psi
10	20	1707.78	0.00000	2220.11
20	30	1530.00	0.00000	1989.00
30	40	1707.78	0.00000	2220.11

Longitudinal Stresses Due to . . .

From	To	Wght. Str. Empty psi	Wght. Str. Operating psi	Wght. Str. Hydrotest psi	Wght. Str. Emp. Mom. psi	Wght. Str. Opr. Mom. psi
10	20	2.38131	5.00638	4.89777	0.00000	0.00000
20	Legs	3.36590	7.93556	7.83765	0.19732	0.19732
Legs	30	-10.0721	-26.6589	-26.6623	1.28256	1.28256
30	40	-2.38131	-4.89405	-4.89777	0.00000	0.00000

Longitudinal Stresses Due to . . .

From	To	Wght. Str. Hyd. Mom. psi	Bend. Str. Oper. Wind psi	Bend. Str. Oper. Equ. psi	Bend. Str. Hyd. Wind psi	Bend. Str. Hyd. Equ. psi
10	20	0.00000	0.00000	0.00000	0.00000	0.00000
20	Legs	0.19732	0.00000	0.00000	0.00000	0.00000
Legs	30	1.28256	0.00000	0.00000	0.00000	0.00000
30	40	0.00000	0.00000	0.00000	0.00000	0.00000

Longitudinal Stresses Due to . . .

From	To	Long. Str. Vortex Ope. psi	Long. Str. Vortex Emp. psi	Long. Str. Vortex Tst. psi	EarthQuake Empty psi
10	20	0.00000	0.00000	0.00000	0.00000
20	Legs	0.00000	0.00000	0.00000	0.00000
Legs	30	0.00000	0.00000	0.00000	0.00000
30	40	0.00000	0.00000	0.00000	0.00000

Longitudinal Stresses Due to . . .

From	To	Long. Str. Y Forces W psi	Long. Str. Y ForceS S psi
10	20	0.00000	0.00000
20	Legs	0.00000	0.00000
Legs	30	0.00000	0.00000
30	40	0.00000	0.00000

Long. Stresses due to User Forces and Moments

From	To	Wind For/Mom Corroded psi	Eqk For/Mom Corroded psi	Wnd For/Mom No Corr. psi	Eqk For/Mom No Corr. psi
10	20	0.00000	0.00000	0.00000	0.00000
20	Legs	0.00000	0.00000	0.00000	0.00000

Legs	30	0.00000	0.00000	0.00000	0.00000
30	40	0.00000	0.00000	0.00000	0.00000

Stress Combination Load Cases for Vertical Vessels:

Load Case Definition Key

IP = Longitudinal Stress due to Internal Pressure
EP = Longitudinal Stress due to External Pressure
HP = Longitudinal Stress due to Hydrotest Pressure
NP = No Pressure
EW = Longitudinal Stress due to Weight (No Liquid)
OW = Longitudinal Stress due to Weight (Operating)
HW = Longitudinal Stress due to Weight (Hydrotest)
WI = Bending Stress due to Wind Moment (Operating)
EQ = Bending Stress due to Earthquake Moment (Operating)
EE = Bending Stress due to Earthquake Moment (Empty)
HI = Bending Stress due to Wind Moment (Hydrotest)
HE = Bending Stress due to Earthquake Moment (Hydrotest)
WE = Bending Stress due to Wind Moment (Empty) (no CA)
WF = Bending Stress due to Wind Moment (Filled) (no CA)
CW = Longitudinal Stress due to Weight (Empty) (no CA)
VO = Bending Stress due to Vortex Shedding Loads (Ope)
VE = Bending Stress due to Vortex Shedding Loads (Emp)
VF = Bending Stress due to Vortex Shedding Loads (Test No CA.)
FW = Axial Stress due to Vertical Forces for the Wind Case
FS = Axial Stress due to Vertical Forces for the Seismic Case
BW = Bending Stress due to Lat. Forces for the Wind Case, Corroded
BS = Bending Stress due to Lat. Forces for the Seismic Case, Corroded
BN = Bending Stress due to Lat. Forces for the Wind Case, UnCorroded
BU = Bending Stress due to Lat. Forces for the Seismic Case, UnCorroded

General Notes:

Case types HI and HE are in the Un-Corroded condition.

Case types WE, WF, and CW are in the Un-Corroded condition.

A blank stress and stress ratio indicates that the corresponding stress comprising those components that did not contribute to that type of stress.

An asterisk (*) in the final column denotes overstress.

Analysis of Load Case 1 : NP+EW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	2.38	16800.00		-19938.30	0.0001	
20	3.56	16800.00		-20216.65	0.0002	
20		16800.00	-11.35	-20216.65		0.0006
30		16800.00	-2.38	-19938.30		0.0001

Analysis of Load Case 2 : NP+EW+EE+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	2.38	16800.00		-19938.30	0.0001	
20	3.56	16800.00		-20216.65	0.0002	
20		16800.00	-11.35	-20216.65		0.0006
30		16800.00	-2.38	-19938.30		0.0001

Analysis of Load Case 3 : NP+OW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	5.01	16800.00		-19938.30	0.0003	

20	8.13	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 4 : NP+OW+EQ+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	5.01	16800.00		-19938.30	0.0003	
20	8.13	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 5 : NP+HW+HI

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	4.90	16800.00		-19938.30	0.0003	
20	8.03	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.90	-19938.30		0.0002

Analysis of Load Case 6 : NP+HW+HE

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	4.90	16800.00		-19938.30	0.0003	
20	8.03	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.90	-19938.30		0.0002

Analysis of Load Case 7 : IP+OW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1712.78	16800.00		-19938.30	0.1020	
20	1538.13	16800.00		-20216.65	0.0916	
20	1682.40	16800.00		-20216.65	0.1001	
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 8 : IP+OW+EQ+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1712.78	16800.00		-19938.30	0.1020	
20	1538.13	16800.00		-20216.65	0.0916	
20	1682.40	16800.00		-20216.65	0.1001	
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 9 : EP+OW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	5.01	16800.00		-19938.30	0.0003	
20	8.13	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 10 : EP+OW+EQ+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	5.01	16800.00		-19938.30	0.0003	
20	8.13	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 11 : HP+HW+HI

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio

10	2225.01	28728.00		-24922.88	0.0775	
20	1997.03	28728.00		-25270.81	0.0695	
20	2194.73	28728.00		-25270.81	0.0764	
30		28728.00	-4.90	-24922.88		0.0002

Analysis of Load Case 12 : HP+HW+HE

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	2225.01	28728.00		-24922.88	0.0775	
20	1997.03	28728.00		-25270.81	0.0695	
20	2194.73	28728.00		-25270.81	0.0764	
30		28728.00	-4.90	-24922.88		0.0002

Analysis of Load Case 13 : IP+WE+EW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1710.16	16800.00		-19938.30	0.1018	
20	1533.56	16800.00		-20216.65	0.0913	
20	1698.99	16800.00		-20216.65	0.1011	
30		16800.00	-2.38	-19938.30		0.0001

Analysis of Load Case 14 : IP+WF+CW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1712.78	16800.00		-19938.30	0.1020	
20	1537.94	16800.00		-20216.65	0.0915	
20	1681.12	16800.00		-20216.65	0.1001	
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 15 : IP+VO+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1712.78	16800.00		-19938.30	0.1020	
20	1538.13	16800.00		-20216.65	0.0916	
20	1682.40	16800.00		-20216.65	0.1001	
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 16 : IP+VE+EW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1710.16	16800.00		-19938.30	0.1018	
20	1533.56	16800.00		-20216.65	0.0913	
20	1698.99	16800.00		-20216.65	0.1011	
30		16800.00	-2.38	-19938.30		0.0001

Analysis of Load Case 17 : NP+VO+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	5.01	16800.00		-19938.30	0.0003	
20	8.13	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 18 : FS+BS+IP+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	1712.78	16800.00		-19938.30	0.1020	
20	1538.13	16800.00		-20216.65	0.0916	
20	1682.40	16800.00		-20216.65	0.1001	
30		16800.00	-4.89	-19938.30		0.0002

Analysis of Load Case 19 : FS+BS+EP+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio

Node	Stress	Stress	Stress	Stress	Ratio	Ratio
10	5.01	16800.00		-19938.30	0.0003	
20	8.13	16800.00		-20216.65	0.0005	
20		16800.00	-27.94	-20216.65		0.0014
30		16800.00	-4.89	-19938.30		0.0002

Absolute Maximum of the all of the Stress Ratio's 0.1020

Governing Element: Bottom Head
Governing Load Case 7 : IP+OW+WI+FW+BW

Shop/Field Installation Options :

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

Center of Gravity of Liquid	16.3 in
Center of Gravity of Nozzles	6.8 in
Center of Gravity of Legs	-2.2 in
Center of Gravity of Bare Shell New and Cold	16.8 in
Center of Gravity of Bare Shell Corroded	16.8 in
Vessel CG in the Operating Condition	15.7 in
Vessel CG in the Fabricated (Shop/Empty) Condition	15.0 in

RESULTS FOR LEGS : Operating Case Description: LEGS

Legs attached to: Shell

Section Properties : Single Angle L2X2X0.2500

USA AISC 1989 Steel Table

Overall Leg Length		15.500	in
Effective Leg Length	Leglen	15.500	in
Distance Leg Up Side of Vessel		4.000	in
Number of Legs	Nleg	3	
Cross Sectional Area for L2X2X0.2500	Aleg	0.938	in^2
Section Inertia (strong axis)		0.348	in**4
Section Inertia (weak axis)		0.348	in**4
Section Modulus (strong axis)		0.247	in ^(3)
Section Modulus (weak axis)		0.247	in ^(3)
Radius of Gyration (strong axis)		0.609	in
Radius of Gyration (weak axis)		0.609	in

Leg Orientation - Strong Axis

Overturning Moment at top of Legs		0.0	in-lb
Total Weight Load at top of Legs	W	427.9	lbf
Total Shear force at top of Legs		0.0	lbf
Additional force in Leg due to Bracing	Fadd	0.0	lbf
Occasional Load Factor	Occfac	1.000	
Effective Leg End Condition Factor	k	1.000	

Note: The Legs are Not Cross Braced
The Leg Shear Force includes Wind and Seismic Effects

Maximum Shear at top of one Leg [Vleg]:
= (Max(Wind, Seismic) + Fadd) * (Imax / Itot)
= (0.0 + 0.0) * (0.3 / 1.04)
= 0.00 lbf

Axial Compression, Leg futhest from N.A. [Sma]
= ((W/Nleg)+(Mleg/(Nlegm*Rn)))/Aleg)
= ((427 / 3) + (0 /(1 * 9.41)))/ 0.938)
= 152.07 psi

Axial Compression, Leg closest to N.A. [Sva]
= (W / Nleg) / Aleg
= (427 / 3) / 0.938
= 152.07 psi

Computing Principal Axis and Inertias for Angle.

Leg lengths and thickness:	2.0000	2.0000	0.25000
Distance to geometric centroid:	0.59200	0.59200	
Arm about YY:	0.46700	0.53300	
Arm about ZZ:	0.40800	0.46700	
Leg areas:	0.50000	0.43750	
Geometric inertia components YY:	0.11165	0.23594	
Geometric inertia components ZZ:	0.24990	0.97693E-01	
Geometric inertias Iy & Iz:	0.34759	0.34759	
Product of inertia:	0.20417		
Mohrs Radius:	0.20417		
Average Inertia:	0.34759		

QFACT = 1.0000 FBZ = 23.760
Principal Axis Inertias (Z&W) = 0.14342 0.55176

```
Angle to Principal Axis             =   45.000
Distances to extreme fibers CW & CZ =   1.4142     0.57700
FOB from Eq 5-5                     =   455.65
Bending allowables Fby & Fbz        =   23.760      23.760

Shear Center Coordinates Wo & Zo:  0.63728      0.0000
Values for Elastic Flexural-Torsional Buckling Stress:
E,    G,      J,   R0^(2):    29500.      11346.     0.19542E-01  1.1473
AREA, LENGTH, Kw,  Kz:    0.93800      15.500      1.0000      1.0000
H,    Few,    Fez, Fej:   0.64600      712.86      185.30      206.04
Fe computed from C4-1:     183.52

Initial (Kl/r)max, & (Kl/r)equiv    =   39.639      39.831
Final (Kl/r)max, & Cc               =   39.831      127.18
Fa based on Eq 4-1                  =   19.230

                              Actual   Allowable
Weak Axis Bending    :          0.00    23760.00   psi
Strong Axis Bending  :          0.00    23760.00   psi
Axial Compression    :        152.07    19229.93   psi

UNITY CHECKS ARE: H1-1     0.000
                  H1-2     0.000
                  H1-3     0.008

AISC Unity Check :   0.008 Should be <= to 1
```

RESULTS FOR LEGS : HydroTest Case Description: LEGS

Legs attached to: Shell

Section Properties : Single Angle L2X2X0.2500

USA AISC 1989 Steel Table

Overall Leg Length		15.500	in
Effective Leg Length	Leglen	15.500	in
Distance Leg Up Side of Vessel		4.000	in
Number of Legs	Nleg	3	
Cross Sectional Area for L2X2X0.2500	Aleg	0.938	in^2
Section Inertia (strong axis)		0.348	in**4
Section Inertia (weak axis)		0.348	in**4
Section Modulus (strong axis)		0.247	in ^(3)
Section Modulus (weak axis)		0.247	in ^(3)
Radius of Gyration (strong axis)		0.609	in
Radius of Gyration (weak axis)		0.609	in

Leg Orientation - Strong Axis

Overturning Moment at top of Legs		0.0	in-lb
Total Weight Load at top of Legs	W	426.8	lbf
Total Shear force at top of Legs		0.0	lbf
Additional force in Leg due to Bracing	Fadd	0.0	lbf
Occasional Load Factor	Occfac	1.000	
Effective Leg End Condition Factor	k	1.000	

Note: The Legs are Not Cross Braced
The Leg Shear Force includes Wind and Seismic Effects

Maximum Shear at top of one Leg [Vleg]:
= (Max(Wind, Seismic) + Fadd) * (Imax / Itot)
= (0.0 + 0.0) * (0.3 / 1.04)
= 0.00 lbf

Axial Compression, Leg futhest from N.A. [Sma]
= ((W/Nleg)+(Mleg/(Nlegm*Rn)))/Aleg)
= ((426 / 3) + (0 /(1 * 9.41)))/ 0.938)
= 151.66 psi

Axial Compression, Leg closest to N.A. [Sva]
= (W / Nleg) / Aleg
= (426 / 3) / 0.938
= 151.66 psi

Computing Principal Axis and Inertias for Angle.

Leg lengths and thickness:	2.0000	2.0000	0.25000
Distance to geometric centroid:	0.59200	0.59200	
Arm about YY:	0.46700	0.53300	
Arm about ZZ:	0.40800	0.46700	
Leg areas:	0.50000	0.43750	
Geometric inertia components YY:	0.11165	0.23594	
Geometric inertia components ZZ:	0.24990	0.97693E-01	
Geometric inertias Iy & Iz:	0.34759	0.34759	
Product of inertia:	0.20417		
Mohrs Radius:	0.20417		
Average Inertia:	0.34759		

QFACT = 1.0000 FBZ = 23.760
Principal Axis Inertias (Z&W) = 0.14342 0.55176

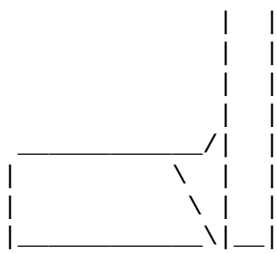
```
Angle to Principal Axis             =   45.000
Distances to extreme fibers CW & CZ =   1.4142     0.57700
FOB from Eq 5-5                     =   455.65
Bending allowables Fby & Fbz        =   23.760      23.760

Shear Center Coordinates Wo & Zo:  0.63728      0.0000
Values for Elastic Flexural-Torsional Buckling Stress:
E,    G,      J,   R0^(2):    29500.      11346.     0.19542E-01  1.1473
AREA, LENGTH, Kw,  Kz:    0.93800      15.500      1.0000      1.0000
H,    Few,    Fez, Fej:   0.64600      712.86      185.30      206.04
Fe computed from C4-1:     183.52

Initial (Kl/r)max, & (Kl/r)equiv    =   39.639      39.831
Final (Kl/r)max, & Cc               =   39.831      127.18
Fa based on Eq 4-1                  =   19.230

                              Actual   Allowable
Weak Axis Bending    :          0.00    23760.00   psi
Strong Axis Bending  :          0.00    23760.00   psi
Axial Compression    :        151.66    19229.93   psi

UNITY CHECKS ARE: H1-1     0.000
                  H1-2     0.000
                  H1-3     0.008

AISC Unity Check :   0.008 Should be <= to 1
```

INPUT VALUES, Nozzle Description: Noz N4 From : 10

Pressure for Nozzle Reinforcement Calculations	P	101.481	psig
Temperature for Internal Pressure	Temp	300	F
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	20000.00	psi
Shell Allowable Stress At Ambient	Sa	20000.00	psi
Inside Diameter of Elliptical Head	D	15.5500	in
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Actual Thickness	T	0.2250	in
Head Internal Corrosion Allowance	Cas	0.0000	in
Head External Corrosion Allowance	Caext	0.0000	in
Distance from Head Centerline	L1	0.0000	in
User Entered Minimum Design Metal Temperature		-20.00	F
Nozzle Material		SA-105	
Nozzle Allowable Stress at Temperature	Sn	20000.00	psi
Nozzle Allowable Stress At Ambient	Sna	20000.00	psi
Nozzle Diameter Basis (for tr calc only)	Inbase	OD	
Layout Angle		0.00	deg
Nozzle Diameter	Dia	2.5000	in.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	0.3000	in
Nozzle Corrosion Allowance	Can	0.0000	in
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	0.2500	in
Weld leg size between Nozzle and Pad/Shell	Wo	0.2500	in
Groove weld depth between Nozzle and Vessel	Wgnv	0.2250	in
Nozzle Inside Projection	H	0.0000	in
Weld leg size, Inside Nozzle to Shell	Wi	0.0000	in
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

NOZZLE CALCULATION, Description: Noz N4

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

Actual Nozzle Outside Diameter Used in Calculation		2.500	in.

Actual Nozzle Thickness Used in Calculation 0.300 in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Elliptical Head, Tr [Int. Press]
= (P*K1*D))/(2*S*E-0.2*P) per UG-37(a)(3)
= (101.48*0.90*15.5500)/(2 *20000.00*1.00-0.2*101.48)
= 0.0355 in

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*Ro)/(S*E+0.4*P) per Appendix 1-1 (a)(1)
= (101.48*1.2500)/(20000*1.00+0.4*101.48)
= 0.0063 in

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

Effective material diameter limit,	Dl	3.8000	in
Effective material thickness limit, no pad	Tlnp	0.5625	in

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	0.067	NA	NA	in^2
Area in Shell	A1	0.360	NA	NA	in^2
Area in Nozzle Wall	A2	0.147	NA	NA	in^2
Area in Inward Nozzle	A3	0.000	NA	NA	in^2
Area in Welds	A4	0.063	NA	NA	in^2
Area in Pad	A5	0.000	NA	NA	in^2
TOTAL AREA AVAILABLE	Atot	0.569	NA	NA	in^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)
= (1.9000*0.0355+2*(0.3000-0.0000)*0.0355*(1-1.0000))
= 0.067 in^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)
= (3.800-1.900)*(1.00*(0.2250-0.000)-0.036)-2*(0.300-0.000)
(1.00(0.2250-0.0000)-0.0355)*(1-1.0000)
= 0.360 in^2

Area Available in Nozzle Wall, no Pad [A2np]:
= (2 * min(Tlnp,ho)) * (Thk - Can - Trn) * fr2
= (2 * min(0.562 ,0.250)) * (0.3000 - 0.0000 - 0.0063) * 1.0000)
= 0.147 in^2

Area Available in Welds, no Pad [A4np]:
= Wo^(2) * fr2 + (Wi-Can/0.707)^(2) * fr2
= 0.2500^(2) * 1.0000 + (0.0000)^(2) * 1.0000
= 0.062 in^2

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

Wall Thickness per UG45(a), tra = 0.0063 in
Wall Thickness per UG16(b), tr16b = 0.0625 in
Wall Thickness per UG45(b)(1), trb1 = 0.0395 in
Check UG16(b) Min. Thickness, trb1 = Max(trb1, tr16b) = 0.0625 in
Std. Wall Pipe per UG45(b)(4), trb4 = 0.1776 in

Wall Thickness per UG45(b), trb = Min(trb1, trb4) = 0.0625 in

Final Required Thickness, tr45 = Max(tra, trb) = 0.0625 in
Available Nozzle Neck Thickness = 0.3000 in --> 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 470.109 psig

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

Minimum Design Metal Temperature (Nozzle Neck), Curve: B
Minimum Temp. w/o impact per UCS-66 -20 F
Minimum Temp. at required thickness -155 F

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,te), Curve: B
Minimum Temp. w/o impact per UCS-66 -20 F
Minimum Temp. at required thickness -155 F
Minimum Temp. w/o impact per UG-20(f) -20 F

Weld Size Calculations, Description: Noz N4

Intermediate Calc. for nozzle/shell Welds Tmin 0.2500 in

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.1750 = 0.7 * TMIN	0.1768 = 0.7 * Wo in

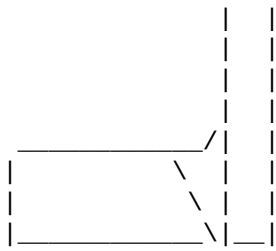
The Drop for this Nozzle is : 0.0552 in
The Cut Length for this Nozzle is, Drop + Ho + H + T : 0.5302 in

INPUT VALUES, Nozzle Description: Noz N3, N2 From : 20

Pressure for Nozzle Reinforcement Calculations	P	101.101	psig
Temperature for Internal Pressure	Temp	300	F
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	20000.00	psi
Shell Allowable Stress At Ambient	Sa	20000.00	psi
Inside Diameter of Cylindrical Shell	D	15.5000	in
Shell Actual Thickness	T	0.2500	in
Shell Internal Corrosion Allowance	Cas	0.0000	in
Shell External Corrosion Allowance	Caext	0.0000	in
Distance from Bottom/Left Tangent		6.5000	in
User Entered Minimum Design Metal Temperature		-20.00	F
Nozzle Material		SA-105	
Nozzle Allowable Stress at Temperature	Sn	20000.00	psi
Nozzle Allowable Stress At Ambient	Sna	20000.00	psi
Nozzle Diameter Basis (for tr calc only)	Inbase	OD	
Layout Angle		270.00	deg
Nozzle Diameter	Dia	3.0000	in.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	0.3125	in
Nozzle Corrosion Allowance	Can	0.0000	in
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	0.2500	in
Weld leg size between Nozzle and Pad/Shell	Wo	0.2500	in
Groove weld depth between Nozzle and Vessel	Wgnv	0.2500	in
Nozzle Inside Projection	H	0.0000	in
Weld leg size, Inside Nozzle to Shell	Wi	0.0000	in
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

NOZZLE CALCULATION, Description: Noz N3, N2

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

Actual Nozzle Outside Diameter Used in Calculation	3.000	in.
Actual Nozzle Thickness Used in Calculation	0.312	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (101.10*7.7500)/(20000*1.00-0.6*101.10)
= 0.0393 in

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*Ro)/(S*E+0.4*P) per Appendix 1-1 (a)(1)
= (101.10*1.5000)/(20000*1.00+0.4*101.10)
= 0.0076 in

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

Effective material diameter limit,	Dl	4.7500	in
Effective material thickness limit, no pad	Tlnp	0.6250	in

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	0.093	NA	NA	in^2
Area in Shell	A1	0.500	NA	NA	in^2
Area in Nozzle Wall	A2	0.152	NA	NA	in^2
Area in Inward Nozzle	A3	0.000	NA	NA	in^2
Area in Welds	A4	0.063	NA	NA	in^2
Area in Pad	A5	0.000	NA	NA	in^2
TOTAL AREA AVAILABLE	Atot	0.715	NA	NA	in^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)
= (2.3750*0.0393+2*(0.3125-0.0000)*0.0393*(1-1.0000))
= 0.093 in^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)
= (4.750-2.375)*(1.00*(0.2500-0.000)-0.039)-2*(0.312-0.000)
(1.00(0.2500-0.0000)-0.0393)*(1-1.0000)
= 0.500 in^2

Area Available in Nozzle Wall, no Pad [A2np]:
= (2 * min(Tlnp,ho)) * (Thk - Can - Trn) * fr2
= (2 * min(0.625 ,0.250)) * (0.3125 - 0.0000 - 0.0076) * 1.0000)
= 0.152 in^2

Area Available in Welds, no Pad [A4np]:
= Wo^(2) * fr2 + (Wi-Can/0.707)^(2) * fr2
= 0.2500^(2) * 1.0000 + (0.0000)^(2) * 1.0000
= 0.062 in^2

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

Wall Thickness per UG45(a), tra = 0.0076 in
Wall Thickness per UG16(b), tr16b = 0.0625 in
Wall Thickness per UG45(b)(1), trb1 = 0.0393 in
Check UG16(b) Min. Thickness, trb1 = Max(trb1, tr16b) = 0.0625 in
Std. Wall Pipe per UG45(b)(4), trb4 = 0.1890 in
Wall Thickness per UG45(b), trb = Min(trb1, trb4) = 0.0625 in

Final Required Thickness, tr45 = Max(tra, trb) = 0.0625 in
Available Nozzle Neck Thickness = 0.3125 in --> 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 431.344 psig

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

Minimum Design Metal Temperature (Nozzle Neck), Curve: B
Minimum Temp. w/o impact per UCS-66 -20 F
Minimum Temp. at required thickness -155 F

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,te), Curve: B
Minimum Temp. w/o impact per UCS-66 -20 F
Minimum Temp. at required thickness -155 F
Minimum Temp. w/o impact per UG-20(f) -20 F

Weld Size Calculations, Description: Noz N3, N2

Intermediate Calc. for nozzle/shell Welds Tmin 0.2500 in

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.1750 = 0.7 * TMIN	0.1768 = 0.7 * Wo in

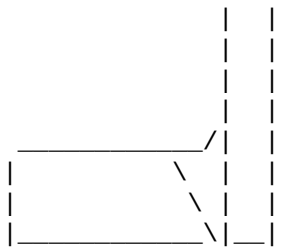
The Drop for this Nozzle is : 0.1465 in
The Cut Length for this Nozzle is, Drop + Ho + H + T : 0.6465 in

INPUT VALUES, Nozzle Description: Noz N5, N6 From : 20

Pressure for Nozzle Reinforcement Calculations	P	101.101	psig
Temperature for Internal Pressure	Temp	300	F
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	20000.00	psi
Shell Allowable Stress At Ambient	Sa	20000.00	psi
Inside Diameter of Cylindrical Shell	D	15.5000	in
Shell Actual Thickness	T	0.2500	in
Shell Internal Corrosion Allowance	Cas	0.0000	in
Shell External Corrosion Allowance	Caext	0.0000	in
Distance from Bottom/Left Tangent		6.5000	in
User Entered Minimum Design Metal Temperature		-20.00	F
Nozzle Material		SA-106 B	
Nozzle Allowable Stress at Temperature	Sn	17100.00	psi
Nozzle Allowable Stress At Ambient	Sna	17100.00	psi
Nozzle Diameter Basis (for tr calc only)	Inbase	ID	
Layout Angle		0.00	deg
Nozzle Diameter	Dia	2.0000	in.
Nozzle Size and Thickness Basis	Idbn	Nominal	
Nominal Thickness of Nozzle	Thknom	80	
Nozzle Flange Material		SA-105	
Nozzle Flange Type		Slip on	
Nozzle Corrosion Allowance	Can	0.0000	in
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	6.0000	in
Weld leg size between Nozzle and Pad/Shell	Wo	0.2500	in
Groove weld depth between Nozzle and Vessel	Wgnv	0.2500	in
Nozzle Inside Projection	H	0.0000	in
Weld leg size, Inside Nozzle to Shell	Wi	0.0000	in
ASME Code Weld Type per UW-16		C	
Class of attached Flange		150	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head

Nozzle Sketch



Insert Nozzle No Pad, no Inside projection

NOZZLE CALCULATION, Description: Noz N5, N6

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

Actual Nozzle Inside Diameter Used in Calculation 1.939 in.
Actual Nozzle Thickness Used in Calculation 0.218 in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (101.10*7.7500)/(20000*1.00-0.6*101.10)
= 0.0393 in

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (101.10*0.97)/(17100*1.00-0.6*101.10)
= 0.0058 in

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

Effective material diameter limit, Dl 3.8780 in
Effective material thickness limit, no pad Tlnp 0.5450 in

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	0.079	NA	NA	in^2
Area in Shell	A1	0.395	NA	NA	in^2
Area in Nozzle Wall	A2	0.198	NA	NA	in^2
Area in Inward Nozzle	A3	0.000	NA	NA	in^2
Area in Welds	A4	0.053	NA	NA	in^2
Area in Pad	A5	0.000	NA	NA	in^2
TOTAL AREA AVAILABLE	Atot	0.646	NA	NA	in^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)
= (1.9390*0.0393+2*(0.2180-0.0000)*0.0393*(1-0.8550))
= 0.079 in^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)
= (3.878-1.939)*(1.00*(0.2500-0.000)-0.039)-2*(0.218-0.000)
(1.00(0.2500-0.0000)-0.0393)*(1-0.8550)
= 0.395 in^2

Area Available in Nozzle Wall, no Pad [A2np]:
= (2 * min(Tlnp,ho)) * (Thk - Can - Trn) * fr2
= (2 * min(0.545 ,6.000)) * (0.2180 - 0.0000 - 0.0058) * 0.8550)
= 0.198 in^2

Area Available in Welds, no Pad [A4np]:
= Wo^(2) * fr2 + (Wi-Can/0.707)^(2) * fr2
= 0.2500^(2) * 0.8550 + (0.0000)^(2) * 0.8550
= 0.053 in^2

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

Wall Thickness per UG45(a), tra = 0.0058 in

```
Wall Thickness per UG16(b),   tr16b = 0.0625 in
Wall Thickness per UG45(b)(1), trb1 = 0.0393 in
Check UG16(b) Min. Thickness,  trb1 = Max(trb1, tr16b) = 0.0625 in
Std. Wall Pipe per UG45(b)(4), trb4 = 0.1347 in
Wall Thickness per UG45(b),     trb = Min(trb1, trb4) = 0.0625 in

Final Required Thickness,      tr45 = Max(tra, trb) = 0.0625 in
Available Nozzle Neck Thickness     = .875 * 0.2180 = 0.1908 in --> 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              441.756  psig
```

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              -20  F
Minimum Temp. at required thickness             -155  F
```

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

```
Minimum Temp. w/o impact per UCS-66              -20  F
Minimum Temp. at required thickness             -155  F
Minimum Temp. w/o impact per UG-20(f)            -20  F
```

ANSI Flange MDMT including temperature reduction per UCS-66.1:

```
Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c)         -20  F
Flange MDMT with Temperature reduction per UCS-66(b)(1)(b)     -55  F
```

Where the Temperature Reduction per UCS-66(b)(1)(b) is:

```
 Stress ratio, P / Ambient Rating = 101.10 / 285.00 = 0.355
```

Weld Size Calculations, Description: Noz N5, N6

```
Intermediate Calc. for nozzle/shell Welds   Tmin      0.2180  in
```

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.1526 = 0.7 * TMIN	0.1768 = 0.7 * Wo in

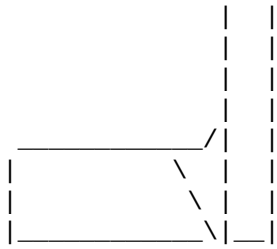
The Drop for this Nozzle is : 0.0915 in
The Cut Length for this Nozzle is, Drop + Ho + H + T : 6.3415 in

INPUT VALUES, Nozzle Description: Noz N1 From : 30

Pressure for Nozzle Reinforcement Calculations	P	100.000	psig
Temperature for Internal Pressure	Temp	300	F
Shell Material		SA-516 70	
Shell Allowable Stress at Temperature	S	20000.00	psi
Shell Allowable Stress At Ambient	Sa	20000.00	psi
Inside Diameter of Elliptical Head	D	15.5500	in
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Actual Thickness	T	0.2250	in
Head Internal Corrosion Allowance	Cas	0.0000	in
Head External Corrosion Allowance	Caext	0.0000	in
Distance from Head Centerline	L1	0.0000	in
User Entered Minimum Design Metal Temperature		-20.00	F
Nozzle Material		SA-105	
Nozzle Allowable Stress at Temperature	Sn	20000.00	psi
Nozzle Allowable Stress At Ambient	Sna	20000.00	psi
Nozzle Diameter Basis (for tr calc only)	Inbase	OD	
Layout Angle		0.00	deg
Nozzle Diameter	Dia	2.5000	in.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	0.3000	in
Nozzle Corrosion Allowance	Can	0.0000	in
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	0.2500	in
Weld leg size between Nozzle and Pad/Shell	Wo	0.2500	in
Groove weld depth between Nozzle and Vessel	Wgnv	0.2250	in
Nozzle Inside Projection	H	0.0000	in
Weld leg size, Inside Nozzle to Shell	Wi	0.0000	in
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

NOZZLE CALCULATION, Description: Noz N1

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

Actual Nozzle Outside Diameter Used in Calculation		2.500	in.

Actual Nozzle Thickness Used in Calculation 0.300 in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Elliptical Head, Tr [Int. Press]
= (P*K1*D))/(2*S*E-0.2*P) per UG-37(a)(3)
= (100.00*0.90*15.5500)/(2 *20000.00*1.00-0.2*100.00)
= 0.0350 in

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*Ro)/(S*E+0.4*P) per Appendix 1-1 (a)(1)
= (100.00*1.2500)/(20000*1.00+0.4*100.00)
= 0.0062 in

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

Effective material diameter limit,	Dl	3.8000	in
Effective material thickness limit, no pad	Tlnp	0.5625	in

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	0.067	NA	NA	in^2
Area in Shell	A1	0.361	NA	NA	in^2
Area in Nozzle Wall	A2	0.147	NA	NA	in^2
Area in Inward Nozzle	A3	0.000	NA	NA	in^2
Area in Welds	A4	0.063	NA	NA	in^2
Area in Pad	A5	0.000	NA	NA	in^2
TOTAL AREA AVAILABLE	Atot	0.570	NA	NA	in^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)
= (1.9000*0.0350+2*(0.3000-0.0000)*0.0350*(1-1.0000))
= 0.067 in^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)
= (3.800-1.900)*(1.00*(0.2250-0.000)-0.035)-2*(0.300-0.000)
(1.00(0.2250-0.0000)-0.0350)*(1-1.0000)
= 0.361 in^2

Area Available in Nozzle Wall, no Pad [A2np]:
= (2 * min(Tlnp,ho)) * (Thk - Can - Trn) * fr2
= (2 * min(0.562 ,0.250)) * (0.3000 - 0.0000 - 0.0062) * 1.0000)
= 0.147 in^2

Area Available in Welds, no Pad [A4np]:
= Wo^(2) * fr2 + (Wi-Can/0.707)^(2) * fr2
= 0.2500^(2) * 1.0000 + (0.0000)^(2) * 1.0000
= 0.062 in^2

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

Wall Thickness per UG45(a), tra = 0.0062 in
Wall Thickness per UG16(b), tr16b = 0.0625 in
Wall Thickness per UG45(b)(1), trb1 = 0.0389 in
Check UG16(b) Min. Thickness, trb1 = Max(trb1, tr16b) = 0.0625 in
Std. Wall Pipe per UG45(b)(4), trb4 = 0.1776 in

Wall Thickness per UG45(b), trb = Min(trb1, trb4) = 0.0625 in

Final Required Thickness, tr45 = Max(tra, trb) = 0.0625 in
Available Nozzle Neck Thickness = 0.3000 in --> 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 470.112 psig

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

Minimum Design Metal Temperature (Nozzle Neck), Curve: B
Minimum Temp. w/o impact per UCS-66 -20 F
Minimum Temp. at required thickness -155 F

Nozzle MDMT Thickness Calc. per UCS-66 (a)1(b), MIN(tn,t,te), Curve: B
Minimum Temp. w/o impact per UCS-66 -20 F
Minimum Temp. at required thickness -155 F
Minimum Temp. w/o impact per UG-20(f) -20 F

ANSI Flange MDMT including temperature reduction per UCS-66.1:
Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) -20 F
Flange MDMT with Temperature reduction per UCS-66(b)(1)(b) -55 F

Where the Temperature Reduction per UCS-66(b)(1)(b) is:
Stress ratio, P / Ambient Rating = 100.00 / 285.00 = 0.351

Weld Size Calculations, Description: Noz N1

Intermediate Calc. for nozzle/shell Welds Tmin 0.2500 in

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	0.1750 = 0.7 * TMIN	0.1768 = 0.7 * Wo in

The Drop for this Nozzle is : 0.0552 in
The Cut Length for this Nozzle is, Drop + Ho + H + T : 0.5302 in

Nozzle Schedule:

Description	Nominal Size in.	Flange Sch/Type Cls		Noz. O/Dia in	Wall Thk in	Re-Pad ODia in	Re-Pad Thick in	Cut Length in
Noz N5, N6	2.000	80	SlipOn	2.375	0.218	-	-	6.34
Noz N4	2.500	-	None	2.500	0.300	-	-	0.53
Noz N1	2.500	-	None	2.500	0.300	-	-	0.53
Noz N3, N2	3.000	-	None	3.000	0.312	-	-	0.65

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 in	Noz Shl/Pad Weld in	Pad OD Weld in	Pad Grve Weld in	Inside Weld in
Noz N5,	SA-106 B	0.250	0.250	-	-	-
Noz N4	SA-105	0.225	0.250	-	-	-
Noz N1	SA-105	0.225	0.250	-	-	-
Noz N3,	SA-105	0.250	0.250	-	-	-

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

Nozzle Miscellaneous Data:

Nozzle	Elevation/Distance From Datum in	Layout Angle deg.	Projection Outside in	Projection Inside in	Installed In Component
Noz N5, N6	6.500	0.00	6.00	0.00	Shell
Noz N4		0.00	0.25	0.00	Bottom Head
Noz N1		0.00	0.25	0.00	Top Head
Noz N3, N2	6.500	270.00	0.25	0.00	Shell

Nozzle Calculation Summary

Description	Internal psig	Ext	MAPNC psig	UG45 [tr]	Weld Path	Areas
Noz N4	468.63	...	...	OK 0.062	OK	Passed
Noz N3, N2	430.24	...	...	OK 0.062	OK	Passed
Noz N5, N6	441.76	...	...	OK 0.062	OK	Passed
Noz N1	470.11	...	...	OK 0.062	OK	Passed
Min. - Nozzles	430.24 Noz N3, N2					
Min. Shell&Flgs	228.90					

Computed Vessel M.A.W.P. 228.90 psig

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

Check the Spatial Relationship between the Nozzles

From Node	Nozzle Description	Y Coordinate,	Layout Angle,	Dia. Limit
10	Noz N4	0.000	0.000	3.800
20	Noz N3, N2	6.500	270.000	4.750
20	Noz N5, N6	6.500	0.000	3.878
30	Noz N1	0.000	0.000	3.800

The nozzle spacing is computed by the following:
= Sqrt(ll^(2) + lc^(2)) where
ll - Arc length along the inside vessel surface in the long. direction.
lc - Arc length along the inside vessel surface in the circ. direction

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

Design Code: ASME Code Section VIII Division 1, 2007

Diameter Spec : 16.000 in OD		
Vessel Design Length, Tangent to Tangent	33.00	in
Distance of Bottom Tangent above Grade	0.00	in
Specified Datum Line Distance	0.00	in
Shell/Head Matl	SA-516 70	
Nozzle Material	SA-105	
Nozzle Material	SA-106 B	
Internal Design Temperature	300	F
Internal Design Pressure	100.00	psig
External Design Temperature	0	F
Maximum Allowable Working Pressure	228.90	psig
External Max. Allowable Working Pressure	233.91	psig
Hydrostatic Test Pressure	130.00	psig
Required Minimum Design Metal Temperature	-20	F
Warmest Computed Minimum Design Metal Temperature	-55	F
Wind Design Code	No Wind Loads	
Earthquake Design Code	No Seismic	

Element Pressures and MAWP: psig

Element Desc	Internal	External	M.A.W.P	Corr. All.
Bottom Head	101.481	0.000	489.061	0.0000
Shell	101.282	0.000	441.756	0.0000
Top Head	100.199	0.000	490.397	0.0000

Liquid Level: 41.00 in Dens.: 62.400 lbm/ft^3 Sp. Gr.: 1.000

Element Type	"To" Elev in	Length in	Element Thk in	R e q d T h k Int.	Ext.	Joint Eff Long	Circ
Ellipse	1.50	1.500	0.250	0.062	No Calc	0.85	0.70
Cylinder	31.50	30.000	0.250	0.062	No Calc	0.70	0.70
Ellipse	33.00	1.500	0.250	0.062	No Calc	0.85	0.70

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

Note: Wind and Earthquake moments include the effects of user defined forces and moments if any exist in the job and were specified to act (compute loads and stresses) during these cases. Also included are moment effects due to eccentric weights if any are present in the input.

Weights:

Fabricated	- Bare W/O Removable Internals	178.6	lbm
Shop Test	- Fabricated + Water (Full)	439.1	lbm
Shipping	- Fab. + Rem. Intls.+ Shipping App.	178.6	lbm
Erected	- Fab. + Rem. Intls.+ Insul. (etc)	178.6	lbm
Empty	- Fab. + Intls. + Details + Wghts.	178.6	lbm
Operating	- Empty + Operating Liquid (No CA)	440.3	lbm
Field Test	- Empty Weight + Water (Full)	439.1	lbm

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: An ANSI Flange is limiting the MAWP and this may affect the
pressure used in the Nozzle Reinforcement Calculations.

Please review all reports carefully!