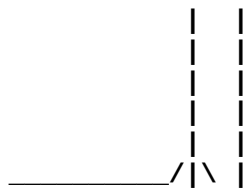
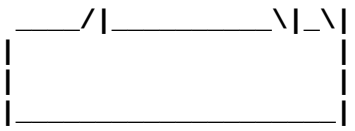
INPUT VALUES, Nozzle Description: Noz N1 From : 20

Pressure for Nozzle Reinforcement Calculations	P	50.000	psig
Temperature for Internal Pressure	Temp	300	F
Shell Material		SA-285 C	
Shell Allowable Stress at Temperature	S	13750.00	psi
Shell Allowable Stress At Ambient	Sa	13750.00	psi
Inside Diameter of Cylindrical Shell	D	108.2550	in.
Shell Actual Thickness	T	0.3100	in.
Shell Internal Corrosion Allowance	Cas	0.0000	in.
Shell External Corrosion Allowance	Caext	0.0000	in.
Distance from Bottom/Left Tangent		5.0000	ft.
User Entered Minimum Design Metal Temperature		-20.00	F
Nozzle Material		SA-36	
Nozzle Allowable Stress at Temperature	Sn	16600.00	psi
Nozzle Allowable Stress At Ambient	Sna	16600.00	psi
Nozzle Diameter Basis (for tr calc only)	Inbase	OD	
Layout Angle		0.00	deg
Nozzle Diameter	Dia	46.0000	in.
Nozzle Size and Thickness Basis	Idbn	Actual	
Actual Thickness of Nozzle	Thk	0.3750	in.
Nozzle Corrosion Allowance	Can	0.0625	in.
Joint Efficiency of Shell Seam at Nozzle	Es	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Nozzle Outside Projection	Ho	8.3750	in.
Weld leg size between Nozzle and Pad/Shell	Wo	0.2500	in.
Groove weld depth between Nozzle and Vessel	Wgnv	0.0000	in.
Pad Material		SA-515 60	
Pad Allowable Stress at Temperature	Sp	17100.00	psi
Pad Allowable Stress At Ambient	Spa	17100.00	psi
Diameter of Pad along vessel surface	Dp	52.0000	in.
Thickness of Pad	Tp	0.2500	in.
Weld leg size between Pad and Shell	Wp	0.2500	in.
Groove weld depth between Pad and Nozzle	Wgpn	0.2500	in.
Reinforcing Pad Width		3.0000	in.
ASME Code Weld Type per UW-16		None	

The Pressure Design option was Design Pressure + static head

Nozzle Sketch





Abutting Nozzle With Pad

NOZZLE CALCULATION, Description: Noz N1

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

Actual Nozzle Outside Diameter Used in Calculation	46.000	in.
Actual Nozzle Thickness Used in Calculation	0.375	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)
= (50.00*54.1275)/(13750*1.00-0.6*50.00)
= 0.1973 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)
= (50.00*23.0000)/(16600*1.00+0.4*50.00)
= 0.0692 in.

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

Effective material diameter limit,	Dl	90.7500	in.
Effective material thickness limit, no pad	Tlnp	0.7750	in.
Effective material thickness limit, pad side	Tlwp	0.7750	in.

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	8.951	NA	NA	sq.in.
Area in Shell	A1	5.116	NA	NA	sq.in.
Area in Nozzle Wall	A2	0.377	NA	NA	sq.in.
Area in Inward Nozzle	A3	0.000	NA	NA	sq.in.
Area in Welds	A4	0.125	NA	NA	sq.in.
Area in Pad	A5	1.500	NA	NA	sq.in.
TOTAL AREA AVAILABLE	Atot	7.118	NA	NA	sq.in.

Additional Area Needed, Ar - Atot		1.833	sq.in.

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations	90.00	Degs.

The area available without a pad is Insufficient.
The area available with the given pad is Insufficient.
RECOMMENDATION: Increase the Size of the Pad.

SELECTION OF POSSIBLE REINFORCING PADS:	Diameter	Thickness	
Based on given Pad Thickness:	59.3750	0.2500	in.
Based on given Pad Diameter:	52.0000	0.5625	in.
Based on Shell or Nozzle Thickness:	56.6875	0.3125	in.

Reinforcement Area Required for Nozzle [Ar]:
= (Dlr*Tr+2*Thk*Tr*(1-fr1)) UG-37(c)
= (45.3750*0.1973+2*(0.3750-0.0625)*0.1973*(1-1.0000))

= 8.951 sq.in.

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)
= (90.750-45.375)*(1.00*(0.3100-0.000)-0.197)-2*(0.375-0.062)
(1.00(0.3100-0.0000)-0.1973)*(1-1.0000)
= 5.116 sq.in.

Area Available in Nozzle Wall, no Pad [A2np]:
= (2 * min(Tlnp,ho)) * (Thk - Can - Trn) * fr2
= (2 * min(0.775 ,8.375)) * (0.3750 - 0.0625 - 0.0692) * 1.0000)
= 0.377 sq.in.

Area Available in Nozzle Wall, with Pad [A2wp]:
= (2 * min(Tlwp, ho))*(Thk - Can - Trn)* fr2
= (2 * min(0.775 ,8.375)) * (0.3750 - 0.0625 - 0.0692) * 1.0000)
= 0.377 sq.in.

Area Available in Welds, no Pad [A4np]:
= Wo² * fr2 + (Wi-Can/0.707)² * fr2
= 0.2500² * 1.0000 + (0.0000)² * 1.0000
= 0.062 sq.in.

Area Available in Welds, with Pad [A4wp]:
= Wo²*fr3+(Wi-Can/0.707)²*Fr2+Wp²*Fr4
= 0.2500² *1.00 + (0.0000)² *1.00 + 0.2500² * 1.00
= 0.125 sq.in.

Area Available in Pad [A5]:
= (min(Dp,DL)-(Nozzle OD))*(min(Tp,Tlwp,Te))*fr4
= (52.0000 - 46.0000) * 0.2500 * 1.0000
= 1.500 sq.in.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]
Wall Thickness per UG45(a), tra = 0.1317 in.
Wall Thickness per UG16(b), tr16b = 0.1562 in.
Wall Thickness per UG45(b)(1), trb1 = 0.1973 in.
Check UG16(b) Min. Thickness, trb1 = Max(trb1, tr16b) = 0.1973 in.
Std. Wall Pipe per UG45(b)(4), trb4 = 0.3906 in.
Wall Thickness per UG45(b), trb = Min(trb1, trb4) = 0.1973 in.

Final Required Thickness, tr45 = Max(tra, trb) = 0.1973 in.
Available Nozzle Neck Thickness = 0.3750 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 44.911 psig

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

Minimum Design Metal Temperature Results:	Nozzle	Pad	
Minimum Temp. w/o impact per UCS-66	18	-20	F
Minimum Temp. at required thickness	-122	-56	F
Minimum Temp. w/o impact per UG-20(f)	-20	-20	F

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

Minimum Temp. w/o impact per UCS-66	18	F
Minimum Temp. at required thickness	-55	F

Minimum Temp. w/o impact per UG-20(f) -20 F

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

Effective material diameter limit,	Dl	68.0625	in.
Effective material thickness limit, no pad	Tlnp	0.7750	in.
Effective material thickness limit, pad side	Tlwp	0.7750	in.

Summary of Reinforcement Areas for Large Nozzle (Per Appendix 1-7(a)):

AREA REQUIRED [Internal Pressure] AR 5.967 sq.in.

AREA AVAILABLE, A1 to A6		No Pad	With Pad	
Area Available in Shell	A1	2.558	2.558	sq.in.
Area Available in Nozzle Wall	A2	0.377	0.377	sq.in.
Area Available in Inward Nozzle	A3	0.000	0.000	sq.in.
Area Available in Welds	A4	0.063	0.125	sq.in.
Area Available in Pad	A5	0.000	1.500	sq.in.
Area Available in Hub	A6	0.000	0.000	sq.in.
TOTAL AREA AVAILABLE	Atot	2.997	4.560	sq.in.

The area available without a pad is Insufficient.
The area available with the given pad is Insufficient.
RECOMMENDATION: Increase the Size of the Pad.

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 43.330 psig

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

Note: The following Calculation is performed using the
internal design pressure (P) in the corroded condition.

Note: The flange could not be considered for moment of inertia calculations.

Additional Results for Large Nozzle Calulations per Appendix 1-7(b):

	Area	Distance	Inertia	d	$I+Ad^2$
Nozzle	1.7375	2.7800	4.4760	1.440	8.0774
Shell	1.5376	0.1550	0.0123	1.185	2.1725
Pad	0.7500	0.4350	0.0039	0.905	0.6186
Sum	4.0251				10.87

Membrane stress per Appendix 1-7 (1 or 2)	Sm	25403.88	psi
Allowable Membrane Stress	S	13750.00	psi
Bending stress at the inside of the Nozzle	Sb	20975.70	psi
Combined Membrane plus Bending Stress	Sm + Sb	46379.57	psi
Allowable Membrane + Bending Stress	1.5 * S	20625.00	psi
M.A.W.P for the Appendix 1-7 Stress calc		22.24	psig

Membrane Stress Calc for Large Nozzles per 1-7(b)(4) [Sm]:
= P * [R(Rn+tn+(rm*t)½) + Rn(t+te+(rmn*tn)½)] / As
= 50.000 * [54.127 (22.688 + 0.312 + 4.102) +
22.688 (3.232)] / 3.032
= 25403.875 psi

Note: The area As was computed per figure 1-7-1 for the Sm calculation.

Moment [M]:
= ($Rn^3/6$ + R * Rn * e) * P
= ($22.688^3/6$ + 54.127 * 22.688 * 1.185) * 50.000

= 170093.016 in.lbs.

Bending Stress Calc for Large Nozzles per 1-7(b)(4)(5) [Sb]:
= (M * (e + t/2)) / I
= (170093.016 * (1.185 + 0.310 / 2)) / 10.869
= 20975.695 psi

Weld Size Calculations, Description: Noz N1

Intermediate Calc. for nozzle/shell Welds Tmin 0.2500 in.
Intermediate Calc. for pad/shell Welds TminPad 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.
Pad Weld	0.1250 = 0.5*TminPad	0.1768 = 0.7 * Wp in.

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)
Weld Load [W]:
= (Ar - A1)* S
= (8.9506 - 5.1157) * 13750
= 52729.63 lb.

Weld Load [W1]:
= (A2+A5+A4-(Wi-Can/.707)²*Ffr2)*S
= (0.3771 + 1.5000 + 0.1250 - 0.0000 * 1.00) * 13750
= 27529.21 lb.

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:
= (pi/2) * Dlo * Wo * 0.49 * Snw
= (3.1416 / 2.0) * 46.0000 * 0.2500 * 0.49 * 16600
= 146934. lb.

Shear, Pad Element Weld [Spew]:
= (pi/2) * DP * WP * 0.49 * SEW
= (3.1416 / 2.0) * 52.0000 * 0.2500 * 0.49 * 13750
= 137582. lb.

Tension, Pad Groove Weld [Tpgw]:
= (pi/2) * Dlo * Wgpn * 0.74 * Seg
= (3.1416 / 2) * 46.0000 * 0.2500 * 0.74 * 16600
= 221900. lb.

Strength of Failure Paths:

PATH11 = (SPEW + SNGW) = (137582 + 0) = 137582 lb.

Summary of Failure Path Calculations:
Path 1-1 = 137582 lb., must exceed W = 52729 lb. or W1 = 27529 lb.

The Drop for this Nozzle is : 5.1297 in.
The Cut Length for this Nozzle is, Drop + Ho + H + T : 13.8147 in.