PVEng

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Pressure Vessel Engineering Ltd. provides: ASME Vessel Code Calculations - Finite Element Analysis (FEA) - Solid Modeling / Drafting - Canadian Registration Number (CRN) Assistance

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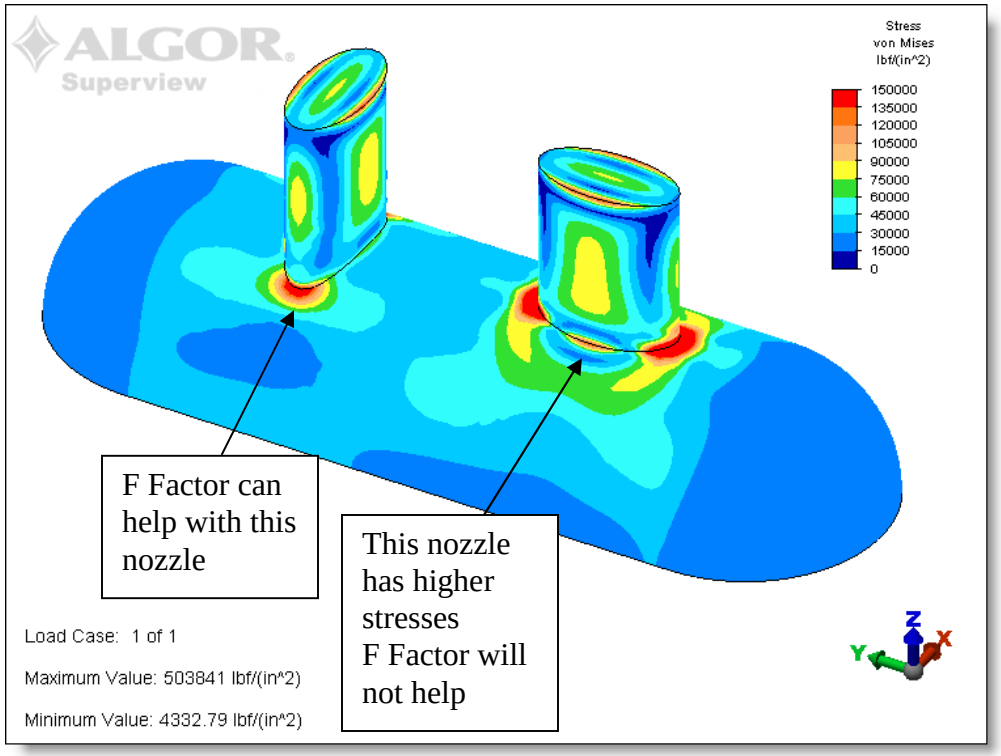
Using the ASME VIII-1 Nozzle F Factor (UG-37):

The stresses around a nozzle located in a cylindrical shell are not the same in all directions. If a non-round nozzle is oriented in the correct direction, ASME allows us to take advantage of this.



This is a FEA plot of a pressure vessel with two identical elliptical nozzles, but oriented in different directions. ASME says that the two nozzles have different stresses around them, as the FEA results confirm. A cylindrical shell circ stress is 2x the longitudinal stress. The nozzle that cuts more material in the circ direction has higher stresses.

- The default F factor is 1.0 – this effect can be ignored if desired
- F Factor can reduce the required amount of area replacement to ½ in certain directions – this allows less conservative nozzle designs if the non-round nozzle is oriented favorably.
- F Factors other than 1.0 can only be used for integral (full penetration welded, no re-pad) nozzles.
- The nozzle will need to be calculated twice – once in the longitudinal direction at F = 1.0 and once in the circ direction at F=0.5. Different d values will be used for the different directions.

An example follows:

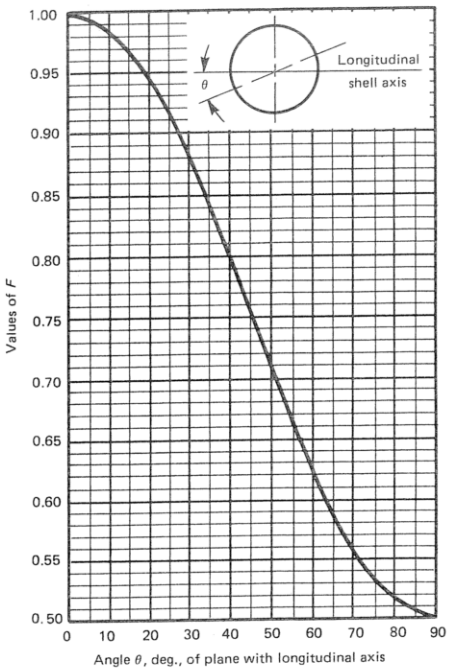


FIG. UG-37 CHART FOR DETERMINING VALUE OF *F*, AS REQUIRED IN UG-37

> F = correction factor which compensates for the variation in internal pressure stresses on different planes with respect to the axis of a vessel. A value of 1.00 shall be used for all configurations except that Fig. UG-37 may be used for integrally reinforced openings in cylindrical shells and cones. [See UW-16(c)(1).]

ASME figure UG-37. At angle of 0 degrees, the maximum circ stress exists, F = 1.0. At angle 90 degrees, the maximum longitudinal stress exist, which is half the circ stress. F = 0.5

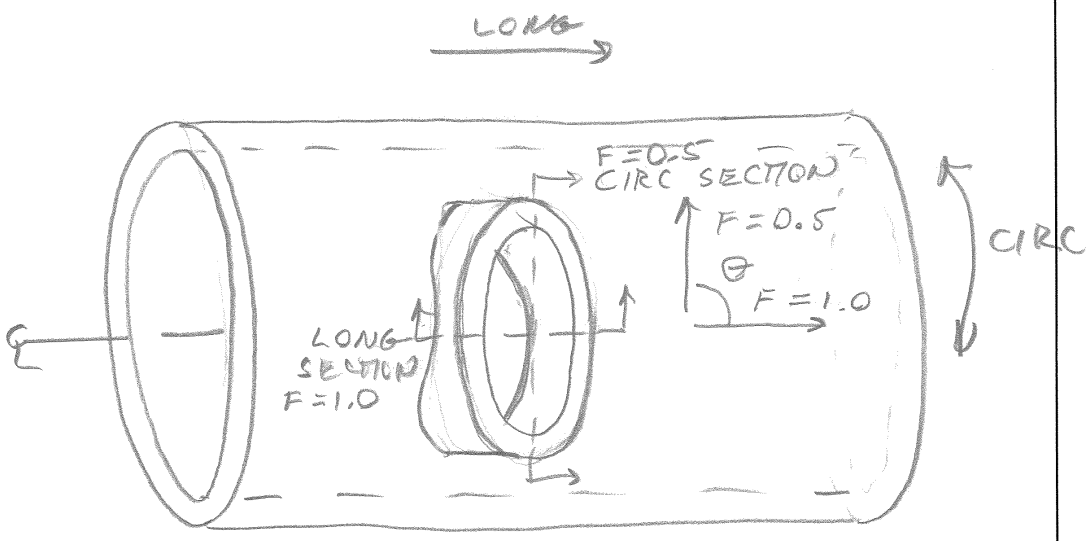
The enclosed example shows an elliptical manway nozzle that takes advantage of the F factor to get a higher pressure rating than otherwise possible.

Laurence Brundrett
Aug 6 2008 (rev 1)

File	Customer / Project	Date
PVE- 2923	NOZZLE 'F' FACTOR	AUG 1/08
By: L / Reviewed:	Subject: SAMPLE PROBLEM	Page:

❑ Units Listed ❑ Numbers Checked ❑ Sources Referenced ❑ Inputs Listed

Item | Chk



SAMPLE PROBLEM

SHELL :
20,000 ALLOWABLE PSI
60" OD
1" THK
455 PSI

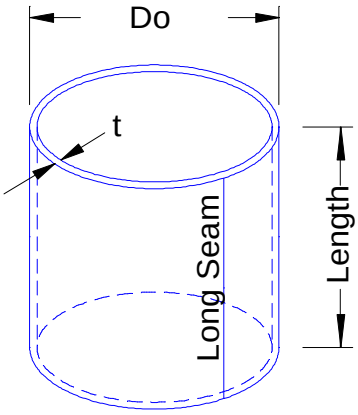
NOZZLE 14 x 18" MANWAY 6 x 1 RING
16" x 20" OD

LONG SECTION: OD = 16", F = 1.0
CIRC SECTION: OD = 20", F = 0.5

WITH NO F FACTOR OD = 20", F = 1.0

Pipe and Shell ver 4.08

Host Shell **Description**



Options:

Interior	**ip?** - Calculate interior pressure
No Exterior	**ep?** - Calculate exterior pressure
Rolled Plate	**pr?** - Pipe or rolled plate
Non-Threaded	**pt?** - Type of pipe
No	**relief?** - Stress Relief Calculations Required

Dimensions:

60.000	**Do** [in] - outside diameter
1.0000	**t [in] - nominal wall thickness**
	tminUG16b [in] - minimum wall per UG-16(b)
100.000	**L** [in] - length for volume and weight
0.000	**Corr** [in] - corrosion allowance

Material and Conditions:

	Material
20,000	**S** [psi] - allowable stress level
1.00	**El** - longitudinal efficiency (circ. stress)
1.00	**Ec** - circ. connecting efficiency (longitudinal stress)
0.000%	**UTP** [%] - undertolerance allowance
0.000	**UTI** [in] - undertolerance allowance
455.00	**P** [psi] - interior pressure

Stress Classification:

NOTE: Both validity checks need to be "Acceptable" in order to use this sheet
If not, refer to sheet "Thick Cylindrical Shell"

ckValidity1 =	tmin < 0.5*(Do/2)	0.669 < 0.5*(60/2) =	**Acceptable**
ckValidity2 =	P< 0.385*S*El	455< 0.385*20000*1 =	**Acceptable**

Variables:

Td =	0.000	0 =	**0.000**
UT [in] =	t*UTP+UTI	1*0+0 =	**0.000**
nt [in] =	t-Corr-UT-Td	1-0-0-0 =	**1.000**
Ri [in] =	Do/2-nt	60/2-1 =	**29.000**
Volume [cuft] =	((Do/2-t)^2)*π*L/1728	((60/2-1)^2)*3.1416*100/1728 =	**152.898**
Weight [lb] =	(Do-t)*π*L*t*40.84/144	(60-1)*3.1416*100*1*40.84/144 =	**5256.84**

Interior Pressure: VIII-1 UG-27(c)(1,2)

ta [in] =	P*Ri/(S*El-0.6*P)	455*29/(20000*1-0.6*455) =	**0.669**
tb [in] =	P*Ri/(2*S*Ec+0.4*P)	455*29/(2*20000*1+0.4*455) =	**0.328**
tmin [in] =	MAX(ta,tb,tminUG16b)	MAX(0.669,0.328,0) =	**0.669**
tr1 [in] =	P*Ri/(S*1-0.6*P) **Required Wall Thick**	455*29/(20000*1-0.6*455) =	**0.669**
Checkt =	tmin <= nt	0.669 <= 1 =	**Acceptable**
PMaxA [psi] =	(S*El*nt)/(Ri+0.6*nt)	(20000*1*1)/(29+0.6*1) =	**676**
PMaxB [psi] =	(2*S*Ec*nt)/(Ri-0.4*nt)	(2*20000*1*1)/(29-0.4*1) =	**1399**
PMax [psi] =	Min(PMaxA,PMaxB)	MIN(676,1399) =	**676**
CheckP =	PMax >= P	676 >= 455 =	**Acceptable**

Nozzle Reinforcement ver 3.90

UW16(c)mod <- SavedDesign 6-Aug-08 Page 1

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Automatic dh - not hillside
Automatic Limit Diameter
Curved Shell or Head Section

Sample F Value <- Vessel
Calculation for the circ section (at 90º) <- Description

Shell:

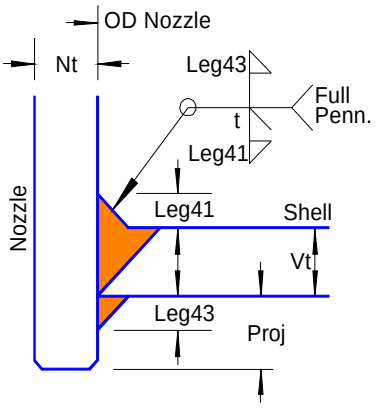
	<- Shell Material
20,000	<- Sv, shell allowable stress level, PSI
1.00	<- E1, efficiency of shell at nozzle
58.00	<- Ds, Shell ID
1.000	<- Vt, shell wall thick, uncorroded, UT removed
0.669	<- tr, required shell wall thickness int. press.(E=1)
0.000	<- trE, required shell wall thickness ext. press.(E=1)

Nozzle:

	<- Nozzle Material
20,000	<- Sn, allowable stress level (Sn)
1	<- B, from A = ***0.09590***
1.00	<- E, nozzle efficiency
455.00	<- P, internal design pressure
0.0	<- Pa, external design pressure
20.000	<- Do, outside diameter **<- Note Do**
1.000	<- Nt, wall thick, uncorroded
0.0%	<- UTp, undertolerance (%)
2.000	<- L, exterior Projection
1.000	<- Ip, interior projection

Reinforcing:

0.375	<- Leg41, size of weld fillet
0.375	<- Leg43, size of weld fillet
0.500	<- F **<-- Note F Value**



UW-16.1 (c) modified

Variables:

UT =	Nt*UTp	= 1 * 0	*Undertolerance*	UT =	***0.000***
Rn =	Do/2 - (Nt-nca) + UT	= 20/2 - (1-0) + 0	*Effective Radius*	Rn =	***9.000***
t =	Vt-sca	= 1 - 0	*Effective Shell Thickness*	t =	***1.000***
ti =	Nt-2*nca	= 1 - 2 * 0	*Nom Thick of Int. Proj.*	ti =	***1.000***
tn =	Nt-nca	= 1-0	*Avail. Nozzle Thick. No UT*	tn =	***1.000***
d =	Do-2*tn	= 20 - 2*1	*Opening Dia.*	d =	***18.000***
fr1 =	MIN(Sn/Sv,1)	= MIN(20000/20000, 1)		fr1 =	***1.000***
fr2 =	MIN(Sn/Sv,1)	= MIN(20000/20000, 1)		fr2 =	***1.000***
h =	MIN(Ip-sca,2.5*t,2.5*ti)	= MIN(1-0,2.5*1,2.5*1)		h =	***1.000***
tcLeg41 =	Min(0.25,0.7*Min(0.75,tn,t))	= Min(0.25,0.7*Min(0.75,1,1))		tc41 =	***0.250***
tcLeg43 =	Min(0.25,0.7*Min(0.75,t,tn))	= Min(0.25,0.7*Min(0.75,1,1))		tc43 =	***0.250***
F =	Min(Fenterered, 1)			F =	***0.500***

Pipe Required Wall Thickness - trn from internal, trnE from external pressure

LDo =	L/Do	LDo = ***0.100***	Dot =	Do/trnE	Dot =	***0.000***	
trn =	(P*Rn)/(Sn*E - 0.6*P) <= tn-UT	= (455*9)/(20000*1 - 0.6*455)			trn =	***0.208***	**Acceptable**
trnR =	(P*Rn)/(Sn*1 - 0.6*P)	= (455*9)/(20000*1 - 0.6*455)		*E=1*	trnR =	***0.208***	
trnE =	(3*Do*Pa)/(4*B) <= tn-ut	= (3*20*0)/(4*1)			trnE =	***0.000***	**Acceptable**

Geometry Constraints:

0.7*Leg41 >=	tc41	0.7*0.375 >=	0.25	***0.263***	>=	***0.250***	**Acceptable**
0.7*Leg43-nca >=	tc43	0.7*0.375-0 >=	0.25	***0.263***	>=	***0.250***	**Acceptable**

Appendix 1-7 Necessary Check

when Ds>60,if(2*Rn<=Ds/3,if(2*Rn<=40, "App. 1-7 calculations not required","App. 1-7 calculations required"),"App. 1-7 calculations required")
when Ds<=60,if(2*Rn<Ds/2,if(2*Rn<20,"App. 1-7 calculations not required","App. 1-7 calculations required"),"App. 1-7 calculations required")

App. 1-7 calculations not required

Area Replacement: Fig UG-37.1

				Pressure From:	**Internal**	**External**
A =	1.0*d*tr*F + 2*tn*tr*F*(1-fr1)	**Note A Required ->**	A Required (internal) =		***6.020***	
=	1.0*18*0.669*0.5 + 2*1*0.669*0.5*(1-1)					
Ae =	0.5*(d*trE*1 + 2*tn*trE*1*(1-fr1))	= 0.5*(18*0*1 + 2*1*0*1*(1-1))	A Required (external) =			***0.000***
A1 =	max(d, 2*(t+tn)) * (E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)		A1 =		***11.980***	
=	max(18,2*(1+1))* (1*1-0.5*0.669)-2*1*(1*1-0.5*0.669)*(1-1)					
A1e =	max(d, 2*(t+tn)) * (E1*t-F*trE)-2*tn*(E1*t-F*trE)*(1-fr1)		A1e =			***18.000***
=	max(18,2*(1+1))* (1*1-0.5*0)-2*1*(1*1-0.5*0)*(1-1)					
A2 =	min((tn-trnR)*fr2*Min(5*t,2*L) , (tn-trnR)*fr2*Min(5*tn,2*L))		A2 =		***3.170***	
=	min((1-0.208)*1*Min(5*1,2*2) , (1-0.208)*1*Min(5*1,2*2))					
A2e =	min((tn-trnE)*fr2*Min(5*t,2*L) , (tn-trnE)*fr2*Min(5*tn,2*L))		A2e =			***5.000***
=	min((1-0)*1*Min(5*1,2*2) , (1-0)*1*Min(5*1,2*2))					
A3 =	Min(5*t*ti*fr2, 5*ti*ti*fr2, 2*h*ti*fr2)		A3 =		***2.000***	***2.000***
=	Min(5*1*1*1, 5*1*1*1, 2*1*1*1)					
A41 =	Leg41^2*fr2	= 0.375^2*1	A41 =		***0.141***	***0.141***
A43 =	(Leg43-nca)^2*fr2	= (0.375-0)^2*1	A43 =		***0.141***	***0.141***
			Actual Area =		***17.431***	***25.281***
		Acceptable	Actual-Required =		***11.411***	***25.281***

Nozzle Reinforcement ver 3.90

UW16(c)mod <- SavedDesign 6-Aug-08 Page 1

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Automatic dh - not hillside
Automatic Limit Diameter
Curved Shell or Head Section

Sample F Value <- Vessel
Calculation for the longitudinal section (at 0º) <- Description

Shell:

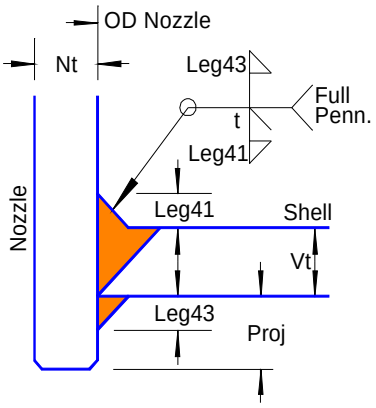
	<- Shell Material
20,000	<- Sv, shell allowable stress level, PSI
1.00	<- E1, efficiency of shell at nozzle
58.00	<- Ds, Shell ID
1.000	<- Vt, shell wall thick, uncorroded, UT removed
0.669	<- tr, required shell wall thickness int. press.(E=1)
0.000	<- trE, required shell wall thickness ext. press.(E=1)

Nozzle:

	<- Nozzle Material
20,000	<- Sn, allowable stress level (Sn)
1	<- B, from A = ***0.09590***
1.00	<- E, nozzle efficiency
455.00	<- P, internal design pressure
0.0	<- Pa, external design pressure
16.000	<- Do, outside diameter **<- Note Do**
1.000	<- Nt, wall thick, uncorroded
0.0%	<- UTp, undertolerance (%)
2.000	<- L, exterior Projection
1.000	<- Ip, interior projection

Reinforcing:

0.375	<- Leg41, size of weld fillet
0.375	<- Leg43, size of weld fillet
1.000	<- F **<-- Note F Value**



UW-16.1 (c) modified

Variables:

UT =	Nt*UTp	= 1 * 0	*Undertolerance*	UT =	***0.000***
Rn =	Do/2 - (Nt-nca) + UT	= 16/2 - (1-0) + 0	*Effective Radius*	Rn =	***7.000***
t =	Vt-sca	= 1 - 0	*Effective Shell Thickness*	t =	***1.000***
ti =	Nt-2*nca	= 1 - 2 * 0	*Nom Thick of Int. Proj.*	ti =	***1.000***
tn =	Nt-nca	= 1-0	*Avail. Nozzle Thick. No UT*	tn =	***1.000***
d =	Do-2*tn	= 16 - 2*1	*Opening Dia.*	d =	***14.000***
fr1 =	MIN(Sn/Sv,1)	= MIN(20000/20000, 1)		fr1 =	***1.000***
fr2 =	MIN(Sn/Sv,1)	= MIN(20000/20000, 1)		fr2 =	***1.000***
h =	MIN(Ip-sca,2.5*t,2.5*ti)	= MIN(1-0,2.5*1,2.5*1)		h =	***1.000***
tcLeg41 =	Min(0.25,0.7*Min(0.75,tn,t))	= Min(0.25,0.7*Min(0.75,1,1))		tc41 =	***0.250***
tcLeg43 =	Min(0.25,0.7*Min(0.75,t,tn))	= Min(0.25,0.7*Min(0.75,1,1))		tc43 =	***0.250***
F =	Min(Fenterered, 1)			F =	***1.000***

Pipe Required Wall Thickness - trn from internal, trnE from external pressure

LDo =	L/Do	LDo = ***0.125***	Dot =	Do/trnE	Dot =	***0.000***	
trn =	(P*Rn)/(Sn*E - 0.6*P) <= tn-UT	= (455*7)/(20000*1 - 0.6*455)			trn =	***0.161***	**Acceptable**
trnR =	(P*Rn)/(Sn*1 - 0.6*P)	= (455*7)/(20000*1 - 0.6*455)		*E=1*	trnR =	***0.161***	
trnE =	(3*Do*Pa)/(4*B) <= tn-ut	= (3*16*0)/(4*1)			trnE =	***0.000***	**Acceptable**

Geometry Constraints:

0.7*Leg41 >=	tc41	0.7*0.375 >=	0.25	***0.263***	>=	***0.250***	**Acceptable**
0.7*Leg43-nca >=	tc43	0.7*0.375-0 >=	0.25	***0.263***	>=	***0.250***	**Acceptable**

Appendix 1-7 Necessary Check

when Ds>60,if(2*Rn<=Ds/3,if(2*Rn<=40, "App. 1-7 calculations not required","App. 1-7 calculations required"),"App. 1-7 calculations required")
when Ds<=60,if(2*Rn<Ds/2,if(2*Rn<20,"App. 1-7 calculations not required","App. 1-7 calculations required"),"App. 1-7 calculations required")

App. 1-7 calculations not required

Area Replacement: Fig UG-37.1

				Pressure From:	**Internal**	**External**
A =	1.0*d*tr*F + 2*tn*tr*F*(1-fr1)	**Note A Required ->**	A Required (internal) =		***9.364***	
=	1.0*14*0.669*1 + 2*1*0.669*1*(1-1)					
Ae =	0.5*(d*trE*1 + 2*tn*trE*1*(1-fr1))	= 0.5*(14*0*1 + 2*1*0*1*(1-1))	A Required (external) =			***0.000***
A1 =	max(d, 2*(t+tn)) * (E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)		A1 =		***4.636***	
=	max(14,2*(1+1))* (1*1-1*0.669)-2*1*(1*1-1*0.669)*(1-1)					
A1e =	max(d, 2*(t+tn)) * (E1*t-F*trE)-2*tn*(E1*t-F*trE)*(1-fr1)		A1e =			***14.000***
=	max(14,2*(1+1))* (1*1-1*0)-2*1*(1*1-1*0)*(1-1)					
A2 =	min((tn-trnR)*fr2*Min(5*t,2*L) , (tn-trnR)*fr2*Min(5*tn,2*L))		A2 =		***3.354***	
=	min((1-0.161)*1*Min(5*1,2*2) , (1-0.161)*1*Min(5*1,2*2))					
A2e =	min((tn-trnE)*fr2*Min(5*t,2*L) , (tn-trnE)*fr2*Min(5*tn,2*L))		A2e =			***5.000***
=	min((1-0)*1*Min(5*1,2*2) , (1-0)*1*Min(5*1,2*2))					
A3 =	Min(5*t*ti*fr2, 5*ti*ti*fr2, 2*h*ti*fr2)		A3 =		***2.000***	***2.000***
=	Min(5*1*1*1, 5*1*1*1, 2*1*1*1)					
A41 =	Leg41^2*fr2	= 0.375^2*1	A41 =		***0.141***	***0.141***
A43 =	(Leg43-nca)^2*fr2	= (0.375-0)^2*1	A43 =		***0.141***	***0.141***
			Actual Area =		***10.271***	***21.281***
		Acceptable	Actual-Required =		***0.907***	***21.281***

Nozzle Reinforcement ver 3.90

UW16(c)mod <- SavedDesign 6-Aug-08 Page 1

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Automatic dh - not hillside
Automatic Limit Diameter
Curved Shell or Head Section

Sample F Value <- Vessel
Calculation with no F allowance (F = 1.0) <- Description

Shell:

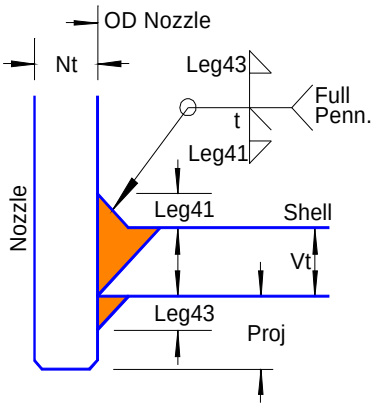
	<- Shell Material
20,000	<- Sv, shell allowable stress level, PSI
1.00	<- E1, efficiency of shell at nozzle
58.00	<- Ds, Shell ID
1.000	<- Vt, shell wall thick, uncorroded, UT removed
0.669	<- tr, required shell wall thickness int. press.(E=1)
0.000	<- trE, required shell wall thickness ext. press.(E=1)

Nozzle:

	<- Nozzle Material
20,000	<- Sn, allowable stress level (Sn)
1	<- B, from A = ***0.09590***
1.00	<- E, nozzle efficiency
455.00	<- P, internal design pressure
0.0	<- Pa, external design pressure
20.000	<- Do, outside diameter **<- Note Do**
1.000	<- Nt, wall thick, uncorroded
0.0%	<- UTp, undertolerance (%)
2.000	<- L, exterior Projection
1.000	<- Ip, interior projection

Reinforcing:

0.375	<- Leg41, size of weld fillet
0.375	<- Leg43, size of weld fillet
1.000	<- F **<-- Note F Value**



UW-16.1 (c) modified

Variables:

UT =	Nt*UTp	= 1 * 0	*Undertolerance*	UT =	***0.000***
Rn =	Do/2 - (Nt-nca) + UT	= 20/2 - (1-0) + 0	*Effective Radius*	Rn =	***9.000***
t =	Vt-sca	= 1 - 0	*Effective Shell Thickness*	t =	***1.000***
ti =	Nt-2*nca	= 1 - 2 * 0	*Nom Thick of Int. Proj.*	ti =	***1.000***
tn =	Nt-nca	= 1-0	*Avail. Nozzle Thick. No UT*	tn =	***1.000***
d =	Do-2*tn	= 20 - 2*1	*Opening Dia.*	d =	***18.000***
fr1 =	MIN(Sn/Sv,1)	= MIN(20000/20000, 1)		fr1 =	***1.000***
fr2 =	MIN(Sn/Sv,1)	= MIN(20000/20000, 1)		fr2 =	***1.000***
h =	MIN(Ip-sca,2.5*t,2.5*ti)	= MIN(1-0,2.5*1,2.5*1)		h =	***1.000***
tcLeg41 =	Min(0.25,0.7*Min(0.75,tn,t))	= Min(0.25,0.7*Min(0.75,1,1))		tc41 =	***0.250***
tcLeg43 =	Min(0.25,0.7*Min(0.75,t,tn))	= Min(0.25,0.7*Min(0.75,1,1))		tc43 =	***0.250***
F =	Min(Fenterered, 1)			F =	***1.000***

Pipe Required Wall Thickness - trn from internal, trnE from external pressure

LDo =	L/Do	LDo = ***0.100***		Dot = Do/trnE	Dot =	***0.000***	
trn =	(P*Rn)/(Sn*E - 0.6*P) <= tn-UT	= (455*9)/(20000*1 - 0.6*455)			trn =	***0.208***	**Acceptable**
trnR =	(P*Rn)/(Sn*1 - 0.6*P)	= (455*9)/(20000*1 - 0.6*455)		*E=1*	trnR =	***0.208***	
trnE =	(3*Do*Pa)/(4*B) <= tn-ut	= (3*20*0)/(4*1)			trnE =	***0.000***	**Acceptable**

Geometry Constraints:

0.7*Leg41 >=	tc41	0.7*0.375 >=	0.25	***0.263***	>=	***0.250***	**Acceptable**
0.7*Leg43-nca >=	tc43	0.7*0.375-0 >=	0.25	***0.263***	>=	***0.250***	**Acceptable**

Appendix 1-7 Necessary Check

when Ds>60,if(2*Rn<=Ds/3,if(2*Rn<=40, "App. 1-7 calculations not required","App. 1-7 calculations required"),"App. 1-7 calculations required")
when Ds<=60,if(2*Rn<Ds/2,if(2*Rn<20,"App. 1-7 calculations not required","App. 1-7 calculations required"),"App. 1-7 calculations required")

App. 1-7 calculations not required

Area Replacement: Fig UG-37.1

				Pressure From:	**Internal**	**External**
A =	1.0*d*tr*F + 2*tn*tr*F*(1-fr1)	**Note A Required ->**		A Required (internal) =	***12.040***	
=	1.0*18*0.669*1 + 2*1*0.669*1*(1-1)					
Ae =	0.5*(d*trE*1 + 2*tn*trE*1*(1-fr1))	= 0.5*(18*0*1 + 2*1*0*1*(1-1))		A Required (external) =		***0.000***
A1 =	max(d, 2*(t+tn)) * (E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)			A1 =	***5.960***	
=	max(18,2*(1+1))* (1*1-1*0.669)-2*1*(1*1-1*0.669)*(1-1)					
A1e =	max(d, 2*(t+tn)) * (E1*t-F*trE)-2*tn*(E1*t-F*trE)*(1-fr1)			A1e =		***18.000***
=	max(18,2*(1+1))* (1*1-1*0)-2*1*(1*1-1*0)*(1-1)					
A2 =	min((tn-trnR)*fr2*Min(5*t,2*L) , (tn-trnR)*fr2*Min(5*tn,2*L))			A2 =	***3.170***	
=	min((1-0.208)*1*Min(5*1,2*2) , (1-0.208)*1*Min(5*1,2*2))					
A2e =	min((tn-trnE)*fr2*Min(5*t,2*L) , (tn-trnE)*fr2*Min(5*tn,2*L))			A2e =		***5.000***
=	min((1-0)*1*Min(5*1,2*2) , (1-0)*1*Min(5*1,2*2))					
A3 =	Min(5*t*ti*fr2, 5*ti*ti*fr2, 2*h*ti*fr2)			A3 =	***2.000***	***2.000***
=	Min(5*1*1*1, 5*1*1*1, 2*1*1*1)					
A41 =	Leg41^2*fr2	= 0.375^2*1		A41 =	***0.141***	***0.141***
A43 =	(Leg43-nca)^2*fr2	= (0.375-0)^2*1		A43 =	***0.141***	***0.141***
				Actual Area =	***11.411***	***25.281***
			ERROR	Actual-Required =	***(0.629)***	***25.281***