

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

Units Listed
 Numbers Checked
 Sources Referenced
 Inputs Listed

Item
Chk

LONG →

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

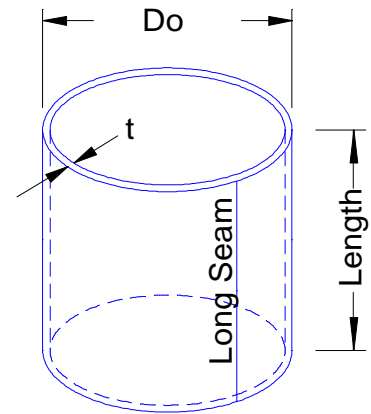
CIRC SECTION: OD = 20", F = 0.5

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

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	EI - 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 = $t_{min} < 0.5 \cdot (Do/2)$
ckValidity2 = $P < 0.385 \cdot S \cdot EI$

$0.669 < 0.5 \cdot (60/2) =$ **Acceptable**
 $455 < 0.385 \cdot 20000 \cdot 1 =$ **Acceptable**

Variables:

$Td = 0.000$	$0 =$ 0.000
$UT_{[in]} = t \cdot UTP + UTI$	$1 \cdot 0 + 0 =$ 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] = $((Do/2 - t)^2) \cdot \pi \cdot L / 1728$	$((60/2 - 1)^2) \cdot 3.1416 \cdot 100 / 1728 =$ 152.898
Weight [lb] = $(Do - t) \cdot \pi \cdot L \cdot t \cdot 40.84 / 144$	$(60 - 1) \cdot 3.1416 \cdot 100 \cdot 1 \cdot 40.84 / 144 =$ 5256.84

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

$ta_{[in]} = P \cdot Ri / (S \cdot EI - 0.6 \cdot P)$	$455 \cdot 29 / (20000 \cdot 1 - 0.6 \cdot 455) =$ 0.669
$tb_{[in]} = P \cdot Ri / (2 \cdot S \cdot Ec + 0.4 \cdot P)$	$455 \cdot 29 / (2 \cdot 20000 \cdot 1 + 0.4 \cdot 455) =$ 0.328
$tmin_{[in]} = \text{MAX}(ta, tb, tminUG16b)$	$\text{MAX}(0.669, 0.328, 0) =$ 0.669
$tr1_{[in]} = P \cdot Ri / (S \cdot 1 - 0.6 \cdot P)$ Required Wall Thick	$455 \cdot 29 / (20000 \cdot 1 - 0.6 \cdot 455) =$ 0.669
Checkt = $tmin \leq nt$	$0.669 \leq 1 =$ Acceptable
$PMaxA_{[psi]} = (S \cdot EI \cdot nt) / (Ri + 0.6 \cdot nt)$	$(20000 \cdot 1 \cdot 1) / (29 + 0.6 \cdot 1) =$ 676
$PMaxB_{[psi]} = (2 \cdot S \cdot Ec \cdot nt) / (Ri - 0.4 \cdot nt)$	$(2 \cdot 20000 \cdot 1 \cdot 1) / (29 - 0.4 \cdot 1) =$ 1399
$PMax_{[psi]} = \text{Min}(PMaxA, PMaxB)$	$\text{MIN}(676, 1399) =$ 676
CheckP = $PMax \geq P$	$676 \geq 455 =$ Acceptable

Sample F Value <- Vessel
Calculation for the circ section (at 90°) <- 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 <- lp, interior projection

Reinforcing:

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

Variables:

UT = Nt*UTp = 1 * 0
Rn = Do/2 - (Nt-nca) + UT = 20/2 - (1-0) + 0
t = Vt-sca = 1 - 0
ti = Nt-2*nca = 1 - 2 * 0
tn = Nt-nca = 1-0
d = Do-2*tn = 20 - 2*1
fr1 = MIN(Sn/Sv,1) = MIN(20000/20000, 1)
fr2 = MIN(Sn/Sv,1) = MIN(20000/20000, 1)
h = MIN(lp-sca,2.5*t,2.5*ti) = MIN(1-0,2.5*1,2.5*1)
tcLeg41 = Min(0.25,0.7*Min(0.75,tn,t)) = Min(0.25,0.7*Min(0.75,1,1))
tcLeg43 = Min(0.25,0.7*Min(0.75,t,tn)) = Min(0.25,0.7*Min(0.75,1,1))
F = Min(Fenterered, 1)

Undertolerance UT = **0.000**
Effective Radius Rn = **9.000**
Effective Shell Thickness t = **1.000**
Nom Thick of Int. Proj. ti = **1.000**
Avail. Nozzle Thick. No UT tn = **1.000**
Opening Dia. d = **18.000**

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

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

Dot = Do/trnE Dot = **0.000**
trn = **0.208** Acceptable
E=1 trnR = **0.208**
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")

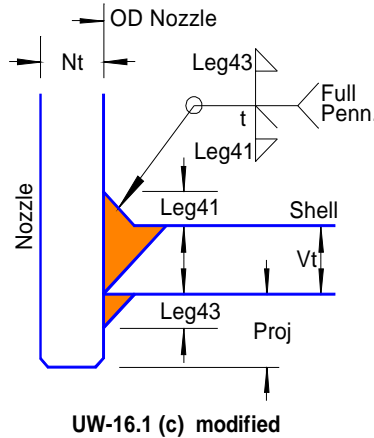
App. 1-7 calculations not required

Area Replacement: Fig UG-37.1

A = 1.0*d*tr*F + 2*tn*tr*F*(1-fr1) **Note A Required ->**
= 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))
A1 = max(d, 2*(t+tn)) * (E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)
= 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)
= 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))
= 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))
= 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)
= Min(5*1*1*1, 5*1*1*1, 2*1*1*1)
A41 = Leg41^2*fr2 = 0.375^2*1
A43 = (Leg43-nca)^2*fr2 = (0.375-0)^2*1

	Pressure From: Internal	External
A Required (internal) =	6.020	
A Required (external) =		0.000
A1 =	11.980	
A1e =		18.000
A2 =	3.170	
A2e =		5.000
A3 =	2.000	2.000
A41 =	0.141	0.141
A43 =	0.141	0.141
Actual Area =	17.431	25.281
Actual-Required =	11.411	25.281

Acceptable



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 <- lp, interior projection

Reinforcing:

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

Variables:

UT = Nt*UTp = 1 * 0
Rn = Do/2 - (Nt-nca) + UT = 20/2 - (1-0) + 0
t = Vt-sca = 1 - 0
ti = Nt-2*nca = 1 - 2 * 0
tn = Nt-nca = 1-0
d = Do-2*tn = 20 - 2*1
fr1 = MIN(Sn/Sv,1) = MIN(20000/20000, 1)
fr2 = MIN(Sn/Sv,1) = MIN(20000/20000, 1)
h = MIN(lp-sca,2.5*t,2.5*ti) = MIN(1-0,2.5*1,2.5*1)
tcLeg41 = Min(0.25,0.7*Min(0.75,tn,t)) = Min(0.25,0.7*Min(0.75,1,1))
tcLeg43 = Min(0.25,0.7*Min(0.75,t,tn)) = Min(0.25,0.7*Min(0.75,1,1))
F = Min(Fenterered, 1)

Undertolerance UT = **0.000**
Effective Radius Rn = **9.000**
Effective Shell Thickness t = **1.000**
Nom Thick of Int. Proj. ti = **1.000**
Avail. Nozzle Thick. No UT tn = **1.000**
Opening Dia. d = **18.000**
fr1 = **1.000**
fr2 = **1.000**
h = **1.000**
tc41 = **0.250**
tc43 = **0.250**
F = **1.000**

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

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

Dot = Do/trnE Dot = **0.000**
trn = **0.208** **Acceptable**
E=1 trnR = **0.208**
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

A = 1.0*d*tr*F + 2*tn*tr*F*(1-fr1) **Note A Required ->**
= 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))
A1 = max(d, 2*(t+tn)) * (E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)
= 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)
= 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))
= 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))
= min((1-0)*1*Min(5*1,2*2), (1-0)*1*Min(5*1,2*2))
A3 = Min(5*ti*fr2, 5*ti*ti*fr2, 2*h*ti*fr2)
= Min(5*1*1*1, 5*1*1*1, 2*1*1*1)
A41 = Leg41^2*fr2 = 0.375^2*1
A43 = (Leg43-nca)^2*fr2 = (0.375-0)^2*1

	Pressure From:	Internal	External
A Required (internal) =		12.040	
A Required (external) =			0.000
A1 =		5.960	
A1e =			18.000
A2 =		3.170	
A2e =			5.000
A3 =		2.000	2.000
A41 =		0.141	0.141
A43 =		0.141	0.141
Actual Area =		11.411	25.281
Actual-Required =	ERROR	(0.629)	25.281

Sample F Value <- Vessel
Calculation for the longitudinal section (at 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
 16.000 <- Do, outside diameter <- **Note Do**
 1.000 <- Nt, wall thick, uncorroded
 0.0% <- UTP, undertolerance (%)
 2.000 <- L, exterior Projection
 1.000 <- lp, interior projection

Reinforcing:

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

Variables:

UT = Nt*UTp = 1 * 0
 Rn = Do/2 - (Nt-nca) + UT = 16/2 - (1-0) + 0
 t = Vt-sca = 1 - 0
 ti = Nt-2*nca = 1 - 2 * 0
 tn = Nt-nca = 1-0
 d = Do-2*tn = 16 - 2*1
 fr1 = MIN(Sn/Sv,1) = MIN(20000/20000, 1)
 fr2 = MIN(Sn/Sv,1) = MIN(20000/20000, 1)
 h = MIN(lp-sca,2.5*t,2.5*ti) = MIN(1-0,2.5*1,2.5*1)
 tcLeg41 = Min(0.25,0.7*Min(0.75,tn,t)) = Min(0.25,0.7*Min(0.75,1,1))
 tcLeg43 = Min(0.25,0.7*Min(0.75,t,tn)) = Min(0.25,0.7*Min(0.75,1,1))
 F = Min(Fenterered, 1)

Undertolerance UT = 0.000
 Effective Radius Rn = 7.000
 Effective Shell Thickness t = 1.000
 Nom Thick of Int. Proj. ti = 1.000
 Avail. Nozzle Thick. No UT tn = 1.000
 Opening Dia. d = 14.000

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

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

Dot = Do/trnE Dot = 0.000
 trn = 0.161 Acceptable
 E=1 trnR = 0.161
 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

A = 1.0*d*tr*F + 2*tn*tr*F*(1-fr1) **Note A Required ->**
 = 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))
 A1 = max(d, 2*(t+tn)) * (E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)
 = 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)
 = 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))
 = 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))
 = min((1-0)*1*Min(5*1,2*2), (1-0)*1*Min(5*1,2*2))
 A3 = Min(5*ti*fr2, 5*ti*ti*fr2, 2*h*ti*fr2)
 = Min(5*1*1*1, 5*1*1*1, 2*1*1*1)
 A41 = Leg41^2*fr2 = 0.375^2*1
 A43 = (Leg43-nca)^2*fr2 = (0.375-0)^2*1

	Pressure From: Internal	External
A Required (internal) =	9.364	
A Required (external) =		0.000
A1 =	4.636	
A1e =		14.000
A2 =	3.354	
A2e =		5.000
A3 =	2.000	2.000
A41 =	0.141	0.141
A43 =	0.141	0.141
Actual Area =	10.271	21.281
Actual-Required =	0.907	21.281

Acceptable

