EJMA 1998, A2000 and ASME VIII-1 App 5

FEA Test Sample <- Vessel   www.pveng.com
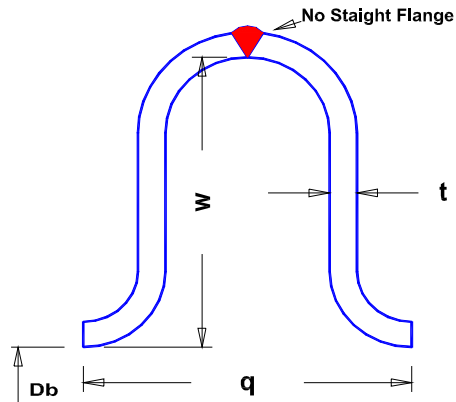**Test** <- Description

No Staight Flange

Materials and Conditions

SA-240 304ss <- Bellows material
27,557,164 <- Eb, bellows modulus of elasticity
20,000 <- Sab, allowed stress, bellows
3.00 <- Cm, material factor
300.0 <- P, operating pressure, psi

Dimensions

3.000 <- q, Convolution Pitch
0.250 <- t, bellows thickness
24.000 <- Db, inside diameter of bellows
4.000 <- w, convolution height

Do not include cuffs on
ends of joint in length q

Motion

0.000 <- xc, axial compression, inch $e = xc + xe$ $e = 0.000$
0.000 <- xe, axial extension, inch $= 0+0$ total motion
     $n = 1$ etheda $= 0$ $et = 0$

Constants *(per EJMA A-2)*

Dm =	Db+w+t	= 24+4+0.25	Dm = **28.250**
Kr =	2*(q+xe)/2*q	= 2*(3+0)/(2*3)	Kr = **1.000**
(Fig. C-24) fv =	q/(2.2*sqrt(Dm*t))	= 3/(2.2*sqrt(28.25*0.25))	fv = **0.513**
(Fig. C-24) fh =	q/(2*w)	= 3/(2*4)	fh = **0.375**
(C-24) Cp = **0.721**		(C-25) Cf = **1.509**	(C-26) Cd = **1.566**

Pressure and Deflection Stresses *(per EJMA)*

S2 = (P*Dm/(2*t))*(Kr/(0.571+2*w/q))   *circ stress from pressure (C-22)*   S2 = **5,235**
    = (300*28.25/(2*0.25))*(1/(0.571+2*4/3))

S3 = (P*w)/(2*t)   *meridional membrane from pressure (C-23)*   S3 = **2,400**
    = (300*4)/(2*0.25)

S4 = (P/2)*(w/t)^2*Cp   *meridional bending from pressure (C-24)*   S4 = **27,668**
    = (300/2)*(4/0.25)^2*0.721

S5 = (Eb*t^2*e)/(2*w^3*Cf)   *meridional membrane from deflection (C-25)*   S5 = **0**
    = (27557164*0.25^2*0)/(2*4^3*1.509)

S6 = (5*Eb*t*e)/(3*w^2*Cd)   *meridional bending from deflection (C-26)*   S6 = **0**
    = (5*27557164*0.25*0)/(3*4^2*1.566)

St = 0.7*(S3+S4)+(S5+S6)   *combined total stress (C-27)*   St = **21,047**
   = 0.7*(2400+27668)+(0+0)

Nc = (1.86e6/(St-54000))^3.4   *EJMA Predicted Cycle Life (C-27)*   Nc = **100,000,000**

Fi = 1.7*(Dm*Eb*t^3)/(w^3*Cf)   *Bellows axial spring rate, lb/in (C-29)*   Fi = **214,069**
   = 1.7*(28.25*27557164*0.25^3)/(4^3*1.509)

Stress Evaluation *(per EJMA)*

S2 <=	Sab	5,235	<=	20,000	**Acceptable** (C-24)	*material not in*
S3 + S4 <=	Cm*Sab	30,068	<=	60,000	**Acceptable** (C-24)	*creep range*

Stress Evaluation *(per ASME Appendix 5)*

S2 <=	1.5*Sab	5,235	<=	30,000	**Acceptable** (5-3(b)(1))
S3 <=	1.5*Sab	2,400	<=	30,000	**Acceptable** (5-3(b)(2))
S4 <=	1.5*Sab	27,668	<=	30,000	**Acceptable** (5-3(b)(1))
S4 + S5 <=	3*Sab	27,668	<=	60,000	**Acceptable** (5-3(b)(3)(b))
Nc >=	100	100,000,000	>=	100	**Acceptable**