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SUBJECT: GNB GATE VALVE STUB TUBE WELD STRESS ANALYSIS

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REMARKS:

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LOOKING AT A.S.M.E CHARTS FIG 8.20
P. 585, 586 FIG. 8.21
HARVEY —

$\frac{d}{t} = \frac{42.39}{.135} = 314$

LOOK AT $\frac{L}{d} = .25, .50, 1.0$ STUB ONLY

FACTOR A : .001, .00045, .00023

FACTOR B : 12000, 6500, 3500
AT $E = 29(10^3)$
UP TO 300°F ALTHOUGH STATED FOR CARBON STEEL

B DEFINED AS .5 CIRC CRITICAL STRESS ("HOOP")

CRITICAL STRESS σ_c : 24000 LB/IN² 13000 LB/IN², 7000 LB/IN²

AND CRITICAL PRESSURE IS:

$$P_c = \frac{2t\sigma_c}{D_o} = \frac{2(.135)\,7000}{42.39}$$

$$P_c = 44.59 \text{ LB/IN}^2 \text{ FOR } \frac{L}{d} = 1.00$$

≈ 40.00 IN LONG DUCT, STUB,

NEGLECTING A.S.ME FACTOR OF SAFETY, WHICH IMPROVES THIS VALUE.

IF THE DUCT STUB (10.63 LONG) IS TAKEN ALONE AND THE THICKNESS (AREA) DERATED BY .46 VALUE PREVIOUSLY FOUND, THE SHORTER LENGTH VALUES OFFSET TO SOME DEGREE THE REDUCED WELD SECTION. THE YIELD VALUES OF SST 304L SHOULD BE CHECKED,

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ASME DESIGN CRITERIA P. 582 AND BEYOND HARVEY-

CRITICAL LENGTH OF CYLINDER FOR COLLAPSE

8.5.11 $L_c = 1.11\, d \sqrt{\frac{d}{h}} = 1.11(42.39)\sqrt{\frac{42.39}{.135}}$

$d = 42.39$ $= 833.8$ IN.

$h = .135$

LONG CYLINDERS

8.2.37 CRITICAL PRESS. $p_c = \frac{2E}{(1-\mu^2)}\left(\frac{h}{d}\right)^3$

$= \frac{2(30)(10^6)}{1-(.3)^2}\left(\frac{.135}{42.39}\right)^3$

$= (65.93)\ 32.31\ (10^{-9})$

$= 2.13\ ^{LB}/_{IN^2}$

SHORT CYLINDERS

8.2.40 CRITICAL STRESS $= \frac{pr}{h}$

$= 15\left(\frac{24.7}{.135}\right) = 2744\ ^{LB}/_{IN^2}$

INTERMEDIATE CYLINDERS

8.5.13 CRITICAL PRESS, $p_c = \frac{2.6E\left(h/d\right)^{2.5}}{L/d}$

$\frac{h}{d} = 3.185(10^{-3})$ $p_c = \frac{44.66}{L/d}$

$\left(\frac{h}{d}\right)^{2.5} = 5.725(10^{-7})$ $p_c = 1761\ ^{LB}/_{IN^2}$

STUB ALONE

TAKE $\frac{L}{d} \geq \frac{10.63}{42.39}$

$= .251$

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INSIDE AREA OF WELD.

DEPTH LENGTH EFF
$.07(10.63).65 = .48\ IN^2$

OUTSIDE AREA OF WELD

LENGTH DEPTH EFF
$3(1.5)(.06).65 = .18\ IN^2$

ALTHOUGH WELD MIGHT BE THICKER WILL TAKE MINIMUM.

$.66\ IN^2$

FOR COMPARISON FULL AREA WOULD BE: $10.63(.135) = 1.44\ IN^2$

$$\text{AREA RATIO} = \frac{.66}{1.44} = .46$$

VACUUM:

$$S_{HOOP} = \frac{P(R)}{t}\frac{1}{.46} = \frac{15(24.7)}{.135}\frac{1}{.46}$$

$$= 5966\ LB/IN^2$$

$$S_{AXIAL\ (SHEAR)} = \frac{P(R)}{2t}\frac{1}{.46} = \frac{15(24.7)}{2(.135)}\frac{1}{.46}$$

$$= 2983\ LB/IN^2$$

COMBINED STRESS $= 6669\ LB/IN^2$

DUCT MATERIAL IS 304L SST Y.P. = 25000 LB/IN^2
(OBTAINED FROM CB&I) ANNEALED ?!

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USING EXPRESSION FROM;
HARVEY - "THEORY AND DESIGN OF PRESSURE VESSELS" VAN NOSTRAND/REINHOLD 19E.

SHORT TUBE
P.560 - 8.2.35
BUCKLING OF CIRCULAR RING (FOUR INFLECTION POINTS)

$$P_c = 2E\left(\frac{h}{d}\right)^3$$

CRITICAL PRESSURE

AND SUBSTITUTING IN STRESS = $P\frac{\frac{d}{2}}{h}$ (HOOP STRESS)

WE HAVE CRITICAL STRESS = $E\left(\frac{h}{d}\right)^2$

WHERE,
h = WALL THICK.
d = OUTSIDE DIA, IN
E = MODULUS LB/IN
P = PRESS LB/IN

$$\text{CRITICAL STRESS} = 30(10^6)\left(\frac{.1135}{49.39}\right)^2$$

$$= 724 \text{ LB/IN}^2$$

AND THIS IS WITH FULL THICKNESS, WELD AREA IS LESS, (.96 AREA RATIO)

OBVIOUSLY, IF TRUE, DUCT GAINS SOME AID FROM VALVE STRUCTURE JUNCTION,

FROM HARVEY P. 561 - 8.2.38
THE EXPRESSION FOR LONG TUBES IS!

$$\text{CRITICAL STRESS} = \frac{E}{1-\mu^2\left(\frac{h}{d}\right)^2}$$

WHERE;
μ = POISSON RATIO.

WHICH WOULD GIVE SLIGHTLY HIGHER VALUES, CRITICAL STRESS = 246 LB/IN²

THESE EXPRESSIONS ARE ALL FOR HIGH $\frac{d}{h}$ RATIO CYLINDERS WHICH WE HAVE HERE,