Attachment 3 to IPN-97-041

Response to Request for Additional Information on the Resolution of Unresolved Safety Issue A-46

Indian Point 3 Nuclear Power Plant
Docket No. 50-286

ATOMETRICS

ATOMETRICS CALCULATION COVER SHEET

JO No. 18904-00

CALCULATION No. 18904-IP3-SQ017 REV No. 0

OBJECTIVE TO EVALUATE EXISTING CONDENSATE STORAGE TANK AT EL 73'-0" IN YARD.

METHOD/ASSUMPTIONS : AN EQUIVALENT STATIC ANALYSIS METHOD IS USED TO OBTAIN ANCHORAGE SEISMIC DEMAND BY INCORPORATING ONE HORIZONTAL PEAK ACCELERATION (g_h) EVELOPED FROM N-S & E-W DIRECTION. 2/3 OF HORIZONTAL ACCELERATION (g_h) IS USED TO OBTAIN VERTICAL SEISMIC DEMAND. THE COMBINED LOAD BY SRSS IS COMPARED TO ANCHORAGE ALLOWABLE LOAD CALCULATED BASED ON METHOD GIVEN IN GIP.

REFERENCES :
1. GENERIC IMPLEMENTATION PROCEDURE (GIP) FOR SEISMIC VERIFICATION OF NUCLEAR PLANT BY WINSTON AND STRAWN, JUNE, 1991
2. TECHNICAL REPORT TR-7366-3 "DIGITIZED DATA BY PERIOD DESIGN RESPONSE SPECTRA DATA BASE FOR IP3, MARCH 3, 1991.
3. DWG# F-14723, F-14733, IP3Y-91-14.1-0058, IP3V-91-14.1-0067

CONCLUSIONS

THE TANK CHAIR AND ANCHOR BOLT ARE ACCEPTABLE.

PREPARER	E. PARK / E Park (PRINT/SIGN)	10/17/95 (DATE)	CLASSIFICATIONS
REVIEWER	W.J. BROWN / W J Brown (PRINT/SIGN)	10/23/95 (DATE)	CONFIRMATION REQ'D? NO
APPROVER	J.E. Thompson / [signature] (PRINT/SIGN)	10/23/95 (DATE)	FILE LOCATIONS

CALCULATION REVISION STATUS

REVISION No.	DESCRIPTION OF CHANGE	PREP'D DATE	CHECK'D DATE
0	ORIGINAL ISSUE	SEE COVER SHEET	SEE COVER SHEET

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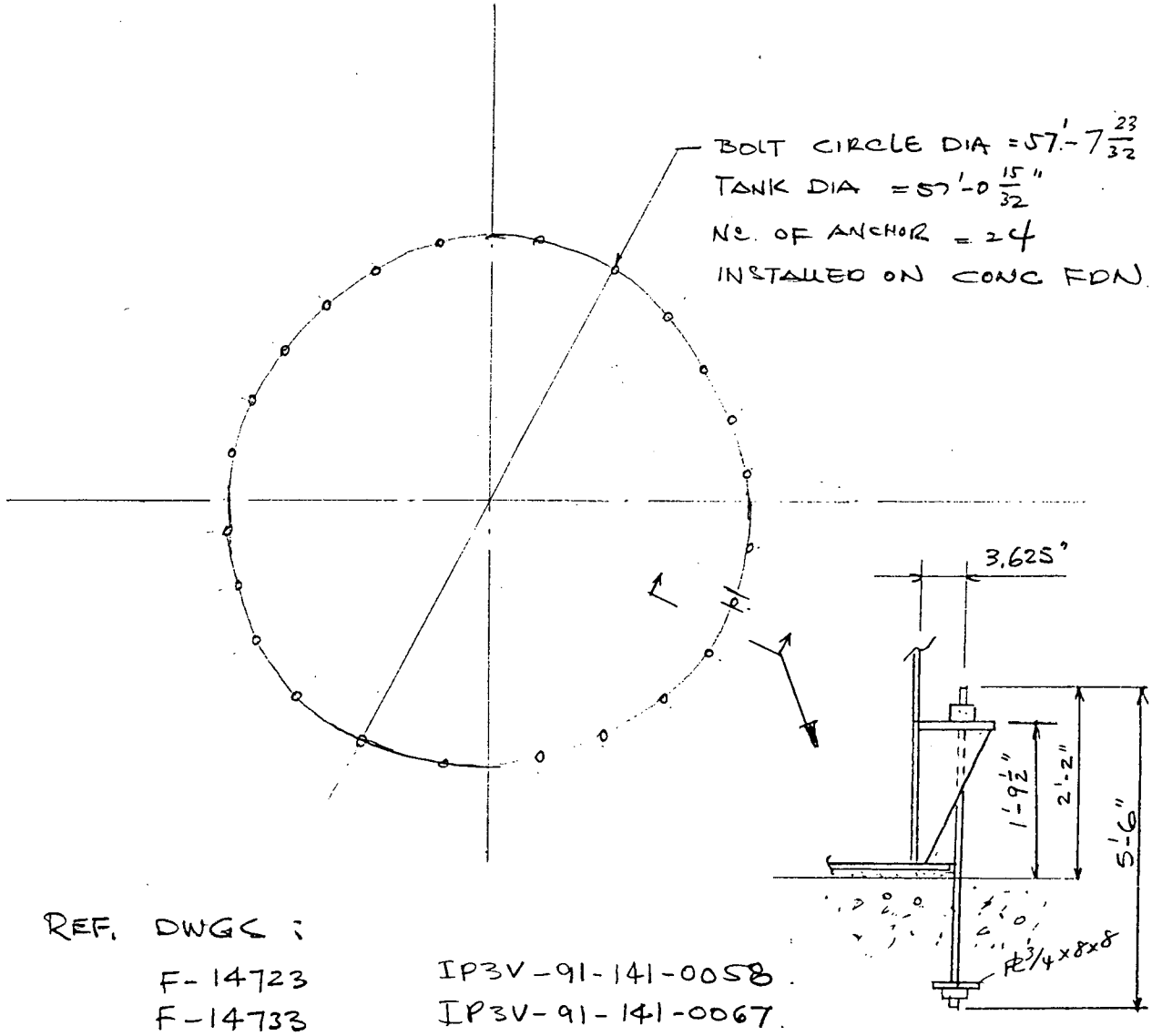
CONDENSATE STORAGE TANK.



REF. DWGS :

F-14723	IP3V-91-141-0058.
F-14733	IP3V-91-141-0067.

FIELD INSPECTION SKETCH

TYPICAL CHAIR.

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INPUT DATA.

TANK MATERIAL — A516 GR.60
F_y = 32 KSI (YIELD STRENGTH).

TANK, CHAIR, ANCHOR — MODULUS OF ELASTICITY = 29000 KSI

CHAIR MATERIAL — A516 GR.60 — F_y = 32 KSI

ANCHOR BOLT — MAT'L A307
2¼" ϕ x 5'-6" LG w/ 4 ⅝ x 8 x 8" HEAD.
CAST-IN-PLACE.

ALLOWABLE WELD STRESS = 24 KSI

CONCRETE COMPRESSIVE STRESS = f_c' = 3000 PSI

CALCULATE WT OF TANK WITH FLUID.

TANK CAPACITY = 600,000 GAL.

CIRCULAR LENGTH = $\pi D = \pi \times 57' = 179$ ft

CIRCULAR AREA = $\frac{\pi D^2}{4} = \frac{\pi \times 57^2}{4} = 2551.76$ ft^2

TOTAL TANK SHELL AREA.

$179' \times 36.5' + 3000$ ft^2 (ESTIMATED TANK TOP AREA.) $= 9534$ ft^2

AVERAGE TANK SHELL THICK = 0.32" = 5/16"

WT OF 5/16" PL. = 12.8 #/ft^2

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WT OF EMPTY TANK

1/4" THK BASE = $2552\ ft^2 \times 10.2\ \#/ft^2 = 26000 = 26^K$

TOP & SIDE = $9534 \times 12.8 = 122035\ \# = 122^K$

$W_E = 26 + 122 = 148 \cong 150^K$

Wt OF CONTENT

$1\ gal = 0.1337\ ft^3$

$600{,}000\ gal = 80220\ ft^3$

Water Density = $62.4\ \#/ft^3$

$600{,}000\ gal\ Water = 5005{,}728\ \# = \underline{5006^K}$

HEIGHT OF WATER

$$H = \frac{80220}{2551.76} = 31.44 \cong \underline{31.5'}$$

TOTAL DEAD WEIGHT w/CONTENT = $5156^K \cong \underline{5200^K}$

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TANK RADIUS $R = 28.5'$

HEIGHT $H' = 36.5'$

MAX FLUID LEVEL $H = 31.5'$

FREEBOARD $h_f = 6.04'$

SHELL SECTION	THICKNESS
#1 (BASE) (t_s)	0.456"
#2	0.366"
#3	0.275"
#4	0.25"
#5 (t_{min})	0.25"

AVERAGE THICK $t_{AV} = 0.32"$

EFFECTIVE SHELL THICK $t_{ef} = \frac{t_{av} + t_{min}}{2} = \frac{0.32 + 0.25}{2} = 0.285"$

CHAIR HEIGHT $h_c = 21.5"$

NUMBER OF BOLT $N = 24$

BOLT DIAMETER $d = 2\frac{1}{4}"\phi$

EFFECTIVE ANCHOR BOLT LENGTH

$h_b = (66" - 26" + 21.5" - .75 - 2.25 - 1") = 57.5"$

(.75 = PLATE THICK; 2.25 = NUT HGHT; 1" = PROJECTED LGTH.)

$H/R = \frac{31.5}{28.5} = 1.105$

$t_s/R = \frac{0.456}{28.5 \times 12} = 0.0013$

$t_{ef}/R = \frac{0.285}{28.5 \times 12} = 0.00083$

A_b = ANCHOR BOLT CROSS-SECTIONAL AREA

$= 3.25\ IN^2$

↖ TENSILE STRESS AREA.

t' = EQUIVALENT SHELL THICK. $= \left(\frac{NA_b}{2\pi R}\right)\left(\frac{E_b}{E_s}\right)$

$= \left(\frac{24 \times 3.25}{2\pi \times (28.5 \times 12)}\right)\left(\frac{29000}{29000}\right)$

$= 0.0363''$

C' = COEFFI OF TANK WALL THICK & LENGTH $= \left(\frac{t'}{t_s}\right)\left(\frac{h_c}{h_b}\right)$

$= \left(\frac{0.0363}{0.456}\right)\left(\frac{21.5}{57.5}\right)$

$= 0.0298$

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FLUID - STRUCTURE MODAL FREQUENCY

ENTER $R = 342''$

$t_{ef}/R = 0.00083$

$H/R = 1.105$

TO TABLE 7-3 IN GIP AND INTERPOLATE,

AT $H/R = 1.105$ F_f @ $R=300 = 23.78$

F_f @ $R=360 = 19.86$

AT $H/R = 1.105$ & $R = 342''$

$F_f = 21.04$ H_z $> f_n = 4.51$ @EL. 85' CONTAINMENT BLDG.

USE S_{af} = PEAK g = 0.414 @EL. 73'

↑ INTERPOLATED BETWEEN EL. 85' & EL. 43' CONTAINMENT BLDG

5% DAMPING.

DETERMINE BASE SHEAR DEMAND

ENTER $H/R = 1.105$ $t_{ef}/R = 0.00083$ TO FIGURE 7-3.

Q' = SHEAR LOAD COEFF. = 0.64

Q = SHEAR LOAD = $Q'W S_{af}$

$Q = (0.64)(5200^K)(0.414) = 1378^K$

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DETERMINE OVERTURNING MOMENT DEMAND

ENTER $H/R = 1.105$

$t_{ef}/R = 0.00083$. TO FIGURE 7-4.

FIND COEFF. $M' = 0.30$ APPROX.

OVERTURNING MOMENT.

$$M = M' W H S_{af}$$

$$= (0.30)(5200)(31.5)(0.414)$$

$$= 20{,}344 \text{ K-ft}$$

CALCULATE OVERTURNING MOMENT CAPACITY.

MOMENT CAPACITY TO BE DETERMINED BASED ON STRESSES IN LOAD TRANSMITTING COMPONENTS; FROM TANK SHELL TO CHAIR WELD TO CHAIR AND TO ANCHOR BOLT.

ANCHOR BOLT ALLOWABLE LOADS FOR 2¼" DIA ARE NOT GIVEN IN GIP APPEND. 7.

THEREFORE, ANCHOR ALLOW. LOADS TO BE ESTIMATED BY CONVENTIONAL METHOD WHICH IS SHOWN ON NEXT PAGE.

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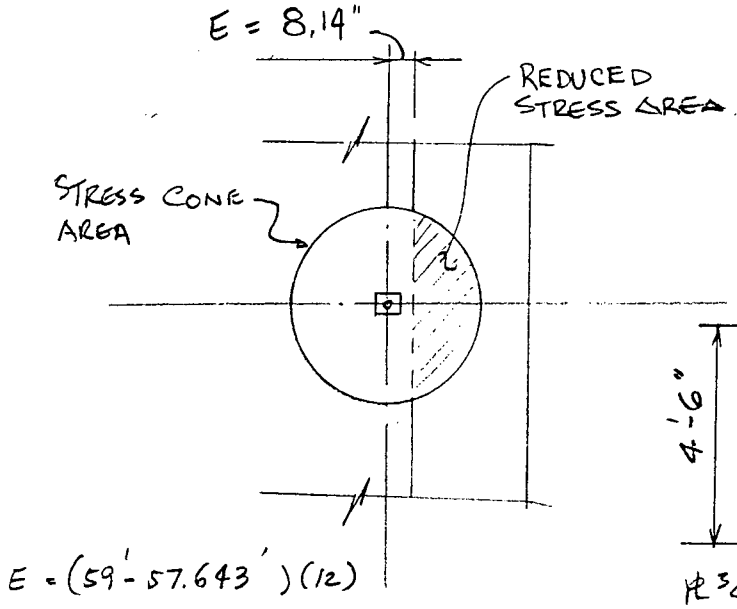
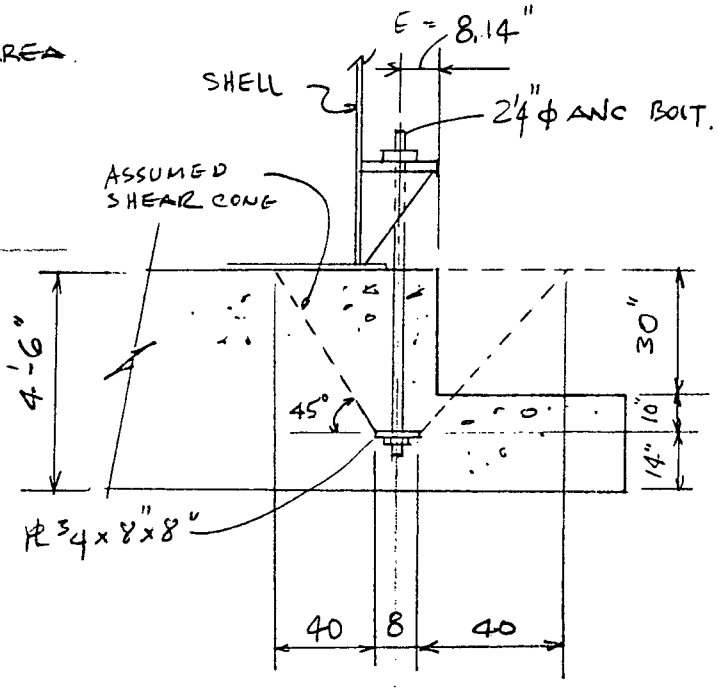
ANCHOR BOLT TENSILE CAPACITY.

— CAST-IN-PLACE BOLT AND HEADED STUDS —



$E = (59' - 57.643')(12)$
$= 8.14''$



TOTAL STRESS CONE AREA.

$$A_{e_{NOM}} = (0.96)\left(\frac{\pi}{4}\right)(D)^2 \qquad \text{(GIP APPEND. C)}$$

$$= (0.96)\left(\frac{\pi}{4}\right)(2\times 40 + 8)^2$$

$$= 5839 \ IN^2$$

STRESS AREA REDUCTION. (GIP APPND. C)

$$r = \frac{2L+D}{2} = \frac{2\times 40+8}{2} = 44$$

$$\theta = 2\cos^{-1}\left(\frac{2E}{2L+D}\right) = 2\cos^{-1}\frac{2\times 8.25}{2\times 40+8} = \underline{2.76}$$

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PROJECTED REDUCED AREA.

$$A_r = 2\pi r^2 - \left(\tfrac{1}{2}\right)\left[r^2\theta - 2rE\,\sin\left(\tfrac{\theta}{2}\right)\right]$$

$$= (2)\pi(44)^2 - \left(\tfrac{1}{2}\right)\left[(44)^2(2.76) - 2\times 44\times 8.25\,\sin\frac{2.76}{2}\right]$$

$$= 3767 \text{ IN}^2$$

CONC PULLOUT STRENGTH

$$P_u = (A_r)(4\phi\sqrt{f_c'})$$

$$= (3767)(4\times 0.85\times\sqrt{3000})$$

$$= 701512^{\#} = \underline{\underline{702^{K}}}$$

REF. GUIDE TO THE DESIGN OF ANCHOR BOLT AND OTHER STEEL EMBEDMENT BY R.W. CANNON CONCRETE INTERNATIONAL JULY, 1981

CHECK ANCHOR STEEL STRENGTH

A307 MAT'L.

$F_t = 20^{KSI}$ TENSILE STRESS AREA FOR $2\frac{1}{4}"\phi = \underline{\underline{3.25\ IN^2}}$

$P_u = 20\times 3.25 = \underline{\underline{65^{K}}}$ ← GOVERNS DESIGN.

$$F_b = \frac{P_u}{A_b} = \frac{65}{3.25} = 20^{KSI}$$ ALLOWABLE BOLT STRESS.

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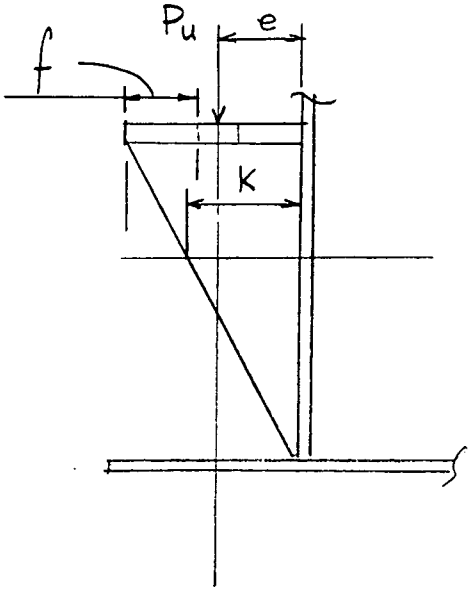
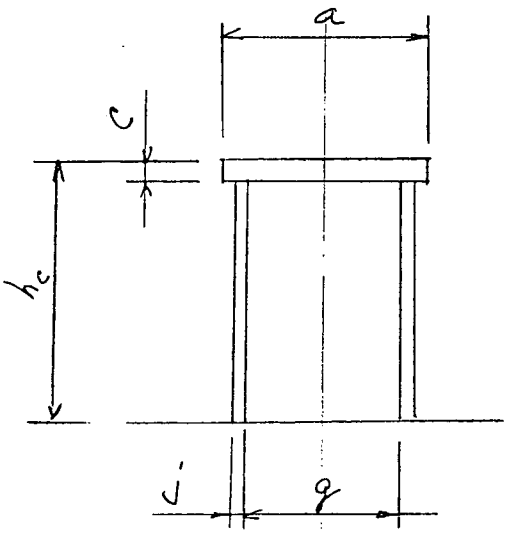
CHAIR TOP PLATE





TOP PL STRESS

$$\sigma = \left(\frac{(0.375g - 0.22d)\,P_u}{f c^2}\right)$$

$$= \frac{(0.375\times 5 - 0.22\times 2.375)\times 65}{2.69 \times 1.5^2}$$

$$= 14.5 \text{ ksi} < F_y = 32 \text{ ksi} \quad \underline{\text{OK}}$$

$g = 5''$
$d = 2.375'$
$P_u = 65^K$
$f = 2.69''$
$c = 1.5''$

TANK SHELL BENDING STRESS

$$Z = \frac{1.0}{\frac{0.177\, a\, t_b}{\sqrt{R\, t_s}} \left[\frac{t_b}{t_s}\right]^2 + 1.0}$$

$$= \frac{1.0}{\frac{.177 \times 7 \times 0.25}{\sqrt{342 \times .456}} \left[\frac{.25}{.456}\right]^2 + 1.0}$$

$$= 0.9926$$

INCLUDE WELD

$a = 6\frac{1}{2}"$

$t_b = 0.25"$

$t_s = 0.456$

$R = 342"$

$e = 3.625"$

$h_c = 21.5"$

$$\text{STRESS } \sigma = \left(\frac{P_u e}{t_s^2}\right)\left[\frac{1.32\, Z}{\frac{1.43 a h^2}{R t_s} + (4ah^2)^{0.333}} + \frac{0.031}{\sqrt{R t_s}}\right]$$

$$= \left(\frac{65 \times 3.625}{.456^2}\right)\left[\frac{1.32 \times 0.9926}{\frac{1.43 \times 7 \times 21.5^2}{342 \times .456} + (4 \times 7 \times 21.5^2)^{0.333}} + \frac{0.031}{\sqrt{342 \times .456}}\right]$$

29.67 23.405 ≈ 2.00342

$$= 30.9 \text{ ksi}$$

$\sigma = 30.9$ ksi $< F_y = 32$ ksi OK

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CHECK VERTICAL STIFFENER

$K = 7.5/2 = 3.75"$

$j = 0.5"$

$$\frac{K}{J} = \frac{3.75}{0.5} = 7.5 < \frac{95}{\sqrt{\frac{f_y}{1000}}} = 16.8 \quad \text{ok}$$

$j = 0.5 < 0.04(21.25 - 1.5) = 0.79"$ ← BRITTLE FAILURE

$$\frac{P_u}{2Kj} = \frac{65}{2 \times 3.75 \times .5} = 17.33^{ksi} < 21^{ksi} \quad \text{ok}$$

REDUE P_u BY RATIO OF $\frac{13.33}{21} = 0.825$

$\therefore P_u = 65 \times .825 = 53.6^K$

$F_b = \frac{53.6}{3.25} = 16.5^{ksi}$

CHECK WELD @ TANK SHELL

$$W_w = (P_u)\sqrt{\left[\frac{1}{a+2h}\right]^2 + \left[\frac{e}{ah + .667h^2}\right]^2}$$

$$= (65)\sqrt{\left(\frac{1}{7+2\times 21.25}\right)^2 + \left(\frac{3.625}{7\times 21.25 + .667 \times 21.25^2}\right)^2}$$

.000408

$$= 1.41^K$$

$$W_A = \frac{30600\, t_w}{\sqrt{2}} = \frac{30600 \times 0.1875}{\sqrt{2}} = 4057^{\#} = 4.1^K$$

$W_w = 1.41^K < 4.1^K$ ok

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TANK SHELL BUCKLING CAPACITY.

ELEPHANT-FOOT BUCKLING PRESSURE COEFF,

ENTER $S_{af} = 0.414$ & $H/R = 1.105$ TO FIG. 7-7 (GIP)

COEFF. $P_e' = 1.5$

BUCKLING PRESSURE $P_e = P_e' \gamma_f R$

$= (1.5)(62.4)(28.5')$

$= 2667.6\ ^{\#}/_{ft^2} = 18.5\ psi$

BUCKLING STRESS CAPACITY FACTOR σ_{pe}

ENTER $P_e = 18.5$ psi & $^{t_s}/_R = 0.0013$ TO FIG. 7-8

$\sigma_{pe} = 14\ ^{ksi} = 14000$ psi

DIAMOND-SHAPE BUCKLING PRESSURE COEFF.

ENTER $S_{af} = 0.414$, $H/R = 1.105$ TO FIG. 7-9.

COEFF. $P_d' = 1.4$

BUCKLING PRESSURE $P_d = P_d' \gamma_f R$

$= (1.4)(62.4)(28.5)$

$= 2490\ ^{\#}/_{ft^2} = 17.3\ ^{\#}/_{IN^2}$

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BUCKLING STRESS CAPACITY FACTOR

ENTER $P_d = 17.3$ psi, $t_s/R = 0.0013$ TO FIG. 7-10.

$\sigma_{pd} = 16^{ksi} = 16000^{psi}$

ALLOWABLE BUCKLING STRESS (σ_c)

$\sigma_c = 0.72 (\sigma_{pe})$

$= 0.72 \times 14000 = \underline{10,080 \text{ psi}}$

DETERMINE OVERTURNING MOMENT CAPACITY

DUCTILE FAILURE MODE

ENTER $c' = 0.0298 \simeq 0.03$

$\sigma_c = 10,080$ psi

$F_b = 20,000$ psi

$h_c = 21.5$"

$h_b = 57.5$"

$\left(\frac{\sigma_c}{F_b}\right)\left(\frac{h_c}{h_b}\right) = \left(\frac{10,080}{20,000}\right)\left(\frac{21.5}{57.5}\right) = 0.19 \simeq 0.2$

FROM FIG. 7-12 $M'_{cap} = 0.09$

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SINCE $j = 0.5 < 0.04(h-c) = 0.79$

FAILURE MODE IS BRITTLE, USE $F_b = 16.5$ KSI (PAGE 15.)

ENTER $c' = 0.03$ TO TABLE 7-4

FIND $M'_{cap} = 0.0667$ BY INTERPOLATION

MOMENT CAPACITY

$$M_{cap} = (M'_{cap})(2F_b)(R^2 t_s)(h_b/h_c)$$

$$= (0.0667)(2 \times 16.5)(342^2 \times 0.456)(57.5/21.5)$$

$$= 313969 \text{ K-IN}$$

$$= 26164 \text{ K-ft}$$

$M_{DEMAND} = 20{,}344^{K-1} < M_{cap} = 26{,}164^{K-1}$ OK

SHEAR CAPACITY

$$Q_{cap} = (0.55)(1 - 0.21g)(W)$$

$$= (0.55)(1 - 0.21 \times .414)(5006^{K})$$

$$= 2514^{K}$$

$Q_{DEMAND} = 1378^{k} < Q_{cap} = 2514^{K}$ OK

CHECK FREEBOARD CLEARANCE VS SLOSH HEIGHT.

ALTERNATE WAY TO CHECK SLOSH HEIGHT

ENTER $H/R = 1.105$, $R = 342$ IN
TO TABLE 7-5

$h_s' = 122.5$ IN PER ZPA OF 1g.

USE ZPA = 0.15

$h_s = h_s'(ZPA) = 122.5'' \times 0.15 = 18.375'' = 1.5'$

FREEBOARD $= 6.0' > h_s = 1.5'$ OK

NewYorkPower Authority

Project IP-3 SWG

Subject TANK CHAIR DTL. FIELD SURVEY

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Date 10-13-1995

Computed by

Checked by