GE Nuclear Energy

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REV. 0	

REVISION STATUS SHEET

DOC TITLE SHROUD STABILIZERS

LEGEND OR DESCRIPTION OF GROUPS

TYPE: STRESS REPORT

FMF: PEACH BOTTOM 2 AND 3

MPL NO: PRODUCT SUMMARY SEC. 7

THIS ITEM IS OR CONTAINS A SAFETY RELATED ITEM YES ☒ NO ☐ EQUIP CLASS CODE P

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PRINTS TO

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1. SCOPE

1.1 This document is the ASME Code Section III Paragraph N-142 Stress Report for the shroud stabilizers for horizontal girth welds H1 through H7 in the core shroud.

2. APPLICABLE DOCUMENTS

2.1 General Electric Documents. The following documents form a part of this stress report to the extent specified herein.

2.1.1 Supporting Documents

a. Code Design Specification 25A5480 Rev 0

b. Shroud Repair Hardware Design Specification 25A5579 Rev 0

2.1.2 Supplemental Documents. Documents under the following identities are to be used with this stress report.

None

2.2 Codes and Standards. The following documents of the specified issue form a part of this specification to the extent specified herein.

2.2.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code

a. Section III, 1965 Edition and Addenda through Winter 1965

2.2.2 Other Documents

a. General Electric Drawing 886D449 P2, Sht. 1 Rev. 11

b. General Electric Drawing 886D449, Sht. 7, Rev. 8, "Vessel Loadings"

c. Babcock and Wilcox Report dated May 16, 1973, "Stress Report for Peach Bottom Unit 2 Reactor Vessel" (VPF #1896-146-1)

(1) Report No. 20 "Shell Analysis", Rev. 0

(2) Report No. 11 "Shroud Support System Analysis", Rev. 2

(3) Report No. 10 "Brackets", Rev. 0.

(4) Report No. 8, "Support Skirt Analysis", Rev. 0

d. Babcock and Wilcox Report dated September 5, 1973, "Stress Report for Peach Bottom Unit 3 Reactor Vessel" (#610-0146-51/52)

(1) Report No. 20 "Shell Analysis", Rev. 0

(2) Report No. 11 "Shroud Support System Analysis", Rev. 2

(3) Report No. 10 "Brackets", Rev. 0.

(4) Report No. 8, "Support Skirt Analysis", Rev. 0

e. "Theory of Plates and Shells", by S. Timoshenko, 2nd Edition

f. "Roark's Formulas for Stress and Strain", by W.C. Young, 6th Edition

g. General Electric Drawing No. 112D6490, Rev. 0, "Detail Support, Lower."

h. "Reactor Pressure Vessel Power Rerate Stress Report Reconciliation for Peach Bottom Nuclear Power Plant Units 2 and 3", G.E. Report No. NEDC-32166, Class II, dated January 1993

i. "Fatigue Evaluation of the Peach Bottom II and III Reactor Vessels", G.E. Report No. GE-NE-523-61-0493, dated May 1993.

j. General Electric Drawing No. 729E762, Rev. 0, " Reactor Thermal Cycles."

k. General Electric Drawing No.VPF # 1896-64-7, "Shroud Support."

3. GENERAL DESCRIPTION

3.1 The purpose of the shroud stabilizers is to structurally replace all of the horizontal girth welds in the core shroud and shroud support. These welds were required to both horizontally and vertically support the core top guide, core support plate, and shroud head, and to prevent core bypass flow to the downcomer region. The core top guide and core support plate horizontally support the fuel assemblies and maintain the correct fuel channel spacing to permit control rod insertion.

3.2 The design requirements for the shroud stabilizers were separated into two documents. The first document addressed those requirements that were not under the jurisdiction of the ASME Code (Paragraph 2.1.1.b). The second document addressed those requirements that were under the jurisdiction of the ASME Code (Paragraph 2.1.1.a).

3.3 This Stress Report documents the acceptability of the structural integrity requirements of the Code Design Specification defined in Paragraph 2.1.1.a.

4. ANALYSIS

4.1 The Design Specification (2.1.1.a) defines three new design mechanical loads on the reactor pressure vessel. These loads and their point of application are shown in Figure 1 and Table 1. These loads are separated by a distance of greater than $2.5\sqrt{Rt} = 70"$ (2.2.1.a) and therefore, can be treated as separate forces. Each of F1, F2, and F3 are addressed below.

4.2 The force F1 (= 89600 lbs) is applied to the reactor pressure vessel (RPV) shell 72 inches above the shroud support plate. It is a local force applied in the radial direction by the shroud repair during a maximum credible earthquake (MCE). At this elevation the RPV shell is 6.125 inches thick minimum (2.2.2.c(1)).

4.2.1 Compute stresses induced in RPV due to F_1 = 89.6 kips applied at approximately 72 inches above the support plate during MCE:

Use theory of plate and shells by S. Timoshenko (2.2.2.e, pg. 471)

R_i = 125.5" Inside R of RPV

h = 6.125" Thickness of RPV exclusive of cladding

α = 125.5 + 6.125/2 = 128.563" mean radius

$$\beta = \left(\frac{3(1-\nu^2)}{\alpha^2 h^2}\right)^{1/4}$$

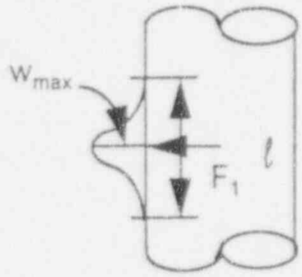
ν = 0.29 Poisson's ratio (2.2.2.c(1))

$$\beta = \left(\frac{3(1-0.29^2)}{128.563^2 \times 6.125^2}\right)^{1/4} = 0.046$$

$M_{Max} = P/4\beta$ and $P = F_1/2l$

where l is contact width of upper contact plate, 5 in.

$$M_{MAX} = \frac{F_1}{(2)(5)(4\beta)} = 48.7\, in - k / in$$



From paragraph 2.2.2.e page 474 deflection under load is

$$W_{MAX} = \frac{P_1 \alpha^2 \beta}{2Eh} = \frac{8.96 \times 128.563^2 \times 0.046}{2 \times 28.7 \times 10^3 \times 6.125} = 0.0193\text{"}$$; since E = 28.7 x 10^3 ksi (2.2.2.c(1)

$\sigma_l = 6M_{MAX}/h^2 = 7.81$ ksi

$\sigma_t = EW_{MAX}/\alpha + 6\,\nu\, M_{MAX}/h^2 = 2.26$ksi

$\sigma_1 = 7.81$ ksi

$\sigma_2 = 2.26$ ksi

4.2.2 The maximum value of P_l stress intensity due to this load is negligible and the maximum value of Pb stress intensity due to this load is 7.81 ksi. These stress intensities occur directly under the point of load application.

4.2.3 The existing primary membrane stress intensities in the shell per the original Stress Report (Paragraph 2.2.2.c(1), Page B-9-20) are 26.8 ksi (Pl) and 28.2 ksi (P_l + Pb).

4.2.4 The new value of P_l is same as original value of 26.8 ksi. The new value of Pl + Pb can be conservatively calculated as 28.2 + 7.81 = 36.01 ksi.

4.2.5 The allowable value of primary membrane Pm stress intensity is Sm, which equals 26.7 ksi and the allowable value of primary local (P_l) plus primary bending (P_l + Pb) stress intensity is 3 Sm, which equals 80.0 ksi.

4.2.6 Primary stress intensity (Pb) for normal/upset condition F_1 = 33.4 kips = 33.4/89.6 x 7.81 = 2.91 ksi. and primary local stress intensity (P_l) is negligible.

4.2.6.1 The existing P_l = 26.8 ksi. and (P_l + Pb) = 28.2 ksi. The new P_l = 26.8 ksi while new (P_l + Pb) = 28.2 + 2.91 = 31.11 ksi. < 40 ksi (1.5Sm).

4.3 The force F_2 is applied to the reactor pressure vessel (RPV) shell 244 inches above the shroud support plate. It is a local force applied in the radial direction by the shroud repair during a MCE. At this elevation the RPV shell is 6.125 inches thick minimum (Paragraph 2.2.2.c(1).

4.3.1 Stresses in RPV due to F_2 = 31.2 kips applied at approximately 244 inches above the shroud support plate during MCE, can be obtained by scaling from values obtained for F_1 = 89.6 kips.

σ_1 = 3.40 ksi

σ_2 = 0.99 ksi

4.3.2 The maximum value of P_ℓ Stress intensity due to this load is negligible and the maximum value of Pb is 3.40 ksi. These stress intensities occur directly under the point of load application.

4.3.3 The existing primary membrane stress intensities in the shell per the original Stress Report (Page B-9-20 of 2.2.2.c(1)) is 26.8 ksi, (P_ℓ) and 28.2 ksi ($P_\ell + P_b$).

4.3.4 The new value of $P\ell$ is conservatively same as existing value of 26.8 ksi. The new value of Pl + Pb can be conservatively calculated as 3.40 + 28.2 = 31.60 ksi.

4.3.5 The faulted allowable value of primary membrane stress intensity is Sm, which equals 26.7 ksi and the allowable value of primary local (P_ℓ) and the primary plus bending ($P_\ell + P_b$) stress intensity is 3 Sm, which equals 80.0 ksi.

4.3.6 Since the faulted stress intensities (P_ℓ) and ($P_\ell + P_b$) are below upset condition allowable of 40 ksi., the primary stress intensity for normal/upset condition F_2 = 16,800 lbs is satisfied by inspection as the F_2 is lower than F_2 of MCE condition.

4.4 The force F_3 is applied to vertical plate at 4.25 (2.2.2.g) inches from the inside surface of the RPV shell (This results in moment arm of 4.25 + 6.125/2 = 7.3 at RPV shell center line). The value of F3 is 448,770 pounds for maximum MCE, and 321,933 pounds for emergency and 168,600 pounds for DBE conditions. The effects of F_3 on shell are addressed in 4.4.1 thru 4.4.5 and on baffle plate junction with shell in Section 4.4.6.

4.4.1 Apply F_3 in any condition as vertical load and it will transfer as axial load V = F_3 lbs and moment of 7.31 F_3 k-in. This load V=F_3 kips. and moment 7.31 F_3 k-in. will be assumed to be resisted by the width of RPV shell equal to the width (b = 13.5"), of the horizontal plate of stabilizer lower support (paragraph 2.2.2.g).

4.4.2 Using analysis methods for edge loads for m_o (para. I-233 of 2.2.1.a) and direct membrane stress as P/t, the stresses in shell are as follows:

$$\sigma_l = 6\, m_o / t^2 + P / t;$$

$$\sigma_t = \frac{EW_o}{R_m} + 6\nu\frac{m_o}{t^2}$$

where

m_o = End moment = 7.31 F_3/13.5 k-in/in;

t = Thickness of shell = 6.125";

P = V/13.5 kips/in;

E = Young's Modulus = 28.7 x 10^3 ksi;

R_m = Vessel Mean Radius = 128.5625 in.;

ν = Poisson's ratio = 0.29;

W_o = Deflection at edge (calculated below).

Using para. I-232(2) of 2.2.2.1.a, the limiting value of $W_o = m_o/2\beta^2 D$, where $D = E\,t^3/12\,(1-\nu^2)$, $\beta = 4\sqrt{\frac{3(1-\nu^2)}{R_m^2 t^2}}$ and substituting values of D, β in terms of E, t, R_m, the expression for σ_t can be simplified as $\sigma_t = \frac{6m_o}{t^2}\left(\nu + \sqrt{\frac{1-\nu^2}{3}}\right)$. And with $\nu = 0.29$ $\sigma_t = \frac{6m_o}{t^2}(0.84)$.

Further, since t = 6.125", the final $\sigma_\ell = 0.094\,F_3$ ksi, $\sigma_t = 0.073\,F_3$ ksi.

These σ_ℓ,σ_t stresses will be used to calculate the stress intensity by principle stress difference formulas. Since shear stress is zero, the principle stresses are $\sigma_1 = \sigma_\ell$; $\sigma_2 = \sigma_t$. Primary stress intensity is maximum of σ_1, σ_2 or $\sigma_1 - \sigma_2$.

4.4.3 Primary local membrane plus bending ($P_\ell + P_b$) stress intensity for <u>faulted conditions</u> F_3 = 448.77 kips are as follows:

4.4.3.1 $\sigma_\ell = \sigma_1 = 0.094 \times 448.77 = 42.18$ ksi

$\sigma_t = \sigma_2 = 0.073 \times 448.77 = 32.65$ ksi

Thus the maximum primary stress intensity (P_ℓ + Pb) = 42.18 ksi

4.4.3.2 From page B-9-20 of original stress report (2.2.2.c(1)) the existing maximum primary local membrane stress intensity is 26.8 ksi and ($P\ell + P_b$) is 28.2 ksi. And as the major stresses due to F_3

are P_b, i.e; while $P_\ell = 0.007\ F_3 = 3.14$ ksi, P_b is $0.087\ F_3 = 39.0$ ksi out of a total $P\ell + P_b$ of 42.18 ksi. And conservatively the new values will be

$$P_\ell = 26.8 + 3.14 = 29.14 \text{ ksi}$$

and $$P_\ell + Pb = 28.2 + 42.18 = 70.38 \text{ ksi}$$

However, the maximum P_ℓ , $P_\ell + P_b$ values from page B-9-20 of the existing stress report at location of F_3 (i.e. elem. #20 of Seal Shell model on page B-2-1 of 2.2.2.c(1)), are 17.86 ksi and 19.81 ksi. Thus these values could be used if required.

The allowable P_ℓ and $P_\ell + P_b$ stress intensity is $1.5S_m = 40$ ksi in the original stress report. However, this is a faulted event and per 2.2.1.a the allowable for faulted conditions is $3S_m = 80$ ksi.

4.4.4 Primary stress i sity ($P_\ell + P_b$) and (P_ℓ) for emergency conditions $F_3 = 321{,}933$ lbs are as follows:

4.4.4.1 The primary stress intensity value from 4.4.3.2 for $F_3 = 448{,}770$ lbs can be used to get the σ_1 as follows:

$$\sigma_1 = \frac{321933}{448770} \times 42.18 \quad \text{and} \quad \sigma_\ell = \frac{321933}{448770} \times 3.14$$

$$= 30.26 \text{ ksi } (P_\ell + P_b) \qquad = 2.25 \text{ ksi } (P_\ell)$$

4.4.4.2 Using same existing maximum primary stress intensity of 4.4.3.2 (for faulted condition) of P_ℓ = 26.8 ksi and $P_\ell + P_b$ =28.2, ksi., the new values are:

$$P_\ell + P_b = 28.2 + 30.26 \quad \text{and} \quad P_\ell = 26.8 + 2.25$$

$$= 58.46 \text{ ksi} < 60 \text{ ksi (2.1.1.a)} \qquad = 29.05 \text{ ksi} < 2.25\ S_m = 60 \text{ ksi. (2.1.1.a)}$$

4.4.5 Normal/upset conditions evaluations required for primary, primary plus secondary, and peak stress intensities per 2.2.1.a are shown in this section.

4.4.5.1 Primary stress intensity evaluation is required for $F_3 = 168{,}600$ pounds which will give P_b value of $\frac{168{,}600}{448{,}770} \times 42.18 = 15.85\ ksi$. and $P_\ell = \frac{168{,}600}{448{,}770} \times 3.14 = 1.18\ ksi$

4.4.5.2 The existing primary stress intensity at this location for operating condition is $Pl = 17.86$ ksi. and $P_\ell + P_b = 19.81$ ksi. (page B-9-1 of 2.2.2.c(1)). Thus the new value of $P_\ell + P_b$ at this location is

$$P_\ell + P_b = 19.81 + 15.85 \quad \text{and} \quad P_\ell = 17.86 + 1.18$$

$$= 35.66 \text{ ksi} < 1.5\ S_m = 40 \text{ ksi} \qquad = 19.04 \text{ ksi} < 1.0S_m = 26.7 \text{ ksi}$$

4.4.5.3 The primary plus secondary stress intensity for upset condition load F_3 is required for two (2) sets of loading cycles as follows (at RPV shell):

F_3 = 177,000 lbs for 120 cycles excluding loss of feedwater pump transient

and

F_3 = 240,400 lbs for 10 cycles of loss of feedwater pump transient

4.4.5.4 Primary plus secondary stress range for 120 cycles is $S_n = \frac{177{,}000}{448{,}700} \times 42.18 = 16.64$ ksi. The existing value of same primary plus secondary stress intensity range is 35.0 ksi (page C-9-21 of 2.2.2.c(1)). Thus the new value of $S_n = 35.0 + 16.64 = 51.64$ ksi $< 3\,S_m = 80$ ksi.

4.4.5.5 Primary plus secondary stress intensity range for 10 cycles (of Loss of Feedwater Pump Transient) is $S_n = \frac{240{,}400}{448{,}770} \times 42.18 = 22.60$ ksi. The existing value of the same primary plus secondary stress intensity range is 35.0 ksi (page C-9-21 of 2.2.2c(1)). Thus the new value of $S_n = 35.0 + 22.60 = 57.60$ ksi $< 3\,S_m = 80$ ksi..

4.4.5.6 Fatigue, i.e., peak stress intensity range, evaluation for 120 plus 10 cycles together F_3 is as follows:

$S_a = K_e \bullet \frac{S_n}{2} \bullet$ Since $S_n < 3\,S_m$, $K_e = 1.0$ for both sets. (i.e., 120 cycles & 10 cycles)

And there is no stress concentration factor per section C-8 of 2.2.2.c(1)

S_a = 27.0 (existing S_a, page C-10-1 of 2.2.2.c (1)) + 22.60/2 = 38.3 ksi.

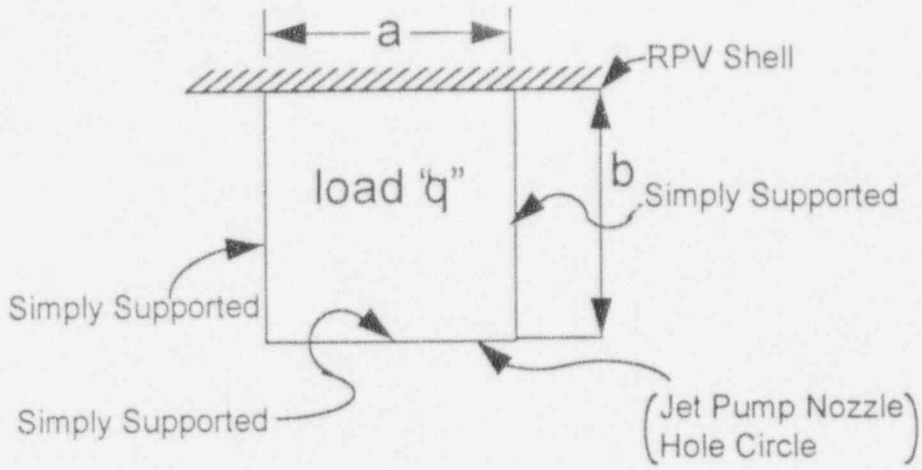
N_{all} = 8500 (Figure N-415(A) of 2.2.1.a)

Usage Factor = UF = 262/8500 = 0.03 < 1.0 since 262 are total cycles in original report.

4.4.6 Evaluation of RPV Shell and Baffle Plate Junction

4.4.6.1 For Faulted Condition F_3

Due to the support afforded by jet pump nozzles to the baffle plate, the load F_3 will be essentially distributed over a rectangular plate between RPV shell and jet pump nozzle hole circle with the width equal to the width of the lower support plate as shown on the next page.



where

a = Width of horizontal lower support plate (2.2.2.g) = 13.5";

b = Distance (radial) between shell inside radius (=125.5") and jet pump nozzle hole circle radius = 226.5/2 = 113.25" (per 2.2.2.k) = 12.25";

q = Distributed load = F3/13.5 x 12.5 = 448.77/12.25 x 13.5 = 2.713 ksi;

Using formulas for <u>middle of fixed edge moments</u> (for uniformally loaded plate with one edge fixed, other three edges simple supported) from Timoshenko (2.2.2.e, page 241), the moment $\bar{M}y = d_2ql^2$ (symbols per 2.2.2.3). Further, since b/a = 0.907 d_2 = 0.0914 from Table 52 of 2.2.2.e. And since l = 12.25" (smaller of a = 13.5" or b = 12.25"),

$$\bar{M}y = 0.0914 * 2.713 * (12.25)^2$$

$$= 37.2 \text{ in-kips/in.}$$

Further the bending stress $\sigma_b = 6\ \bar{M}y/t^2$ and with t = 2.0625" (thickness of baffle plate), the bending stress value is

$$\sigma_b = 37.2 * 6/(2.0625)^2$$

$$= 52.5 \text{ ksi}$$

And shear stress $\tau = F_3$ /Area = F_3/Perimeter * 't'

$$\tau = 448.77/2\ (12.25 + 13.5)(2.0625)$$

$$= 4.22 \text{ ksi}$$

Principal stress $\sigma_1 = 52.5/2 + \sqrt{\left(\frac{52.5}{2}\right)^2 + (4.22)^2} = 52.84$ ksi

$\sigma_2 = -0.34$ ksi

The maximum stress intensity = $\sigma_1 - \sigma_2 = 52.84 - (-0.34) = 53.18$ ksi

The maximum primary membrane plus bending stress intensity at this location from the existing stress analysis (paragraph 2.2.2.c(2), page B-16-6) is 16.7 ksi. Therefore, the new maximum primary membrane plus bending ($P_\ell + P_b$) stress intensity is = 16.7 + 53.18 = 69.88 ksi which is less than faulted allowable of 3 Sm = 80 ksi (pages B-17-1, B-17-5 of 2.2.2.c(2)). However, this is very conservative since F_3 = 448.77 kips includes new MCE loads which are lower than the original MCE loads included in the 16.7 ksi stress intensity. (This is proven by fact that new MCE load transferred by shroud support M_6 is only 123.9 k-ft while the original stress report used loads much greater than 4885 k-ft for DBE and large portion of 11724 k-ft. moment for max. seismic plus jet load as given in document 2.2.2.b, Table 10. This is stated on page B-11-A of 2.2.2.c(2) document.) Thus the actual additional load F_3 to be addressed in faulted condition is only tie-rod pressure load equal to 321.93 kips. Thus the revised primary membrane plus bending stress intensity in faulted condition is $P_\ell + P_b$ = 16.7 + 321.93/448.77 x 53.18 = 54.85 ksi which is less than 3 S_m = 80 ksi.

4.4.6.2 Primary local membrane plus bending stress intensity (Pl + Pb) for the Emergency condition F3 = 321.933 kips is same as for the Faulted condition (pressure load only) case. Thus new value is Pl+Pb = 54.85 ksi which is less than 2.25 Sm = 60 ksi for this condition. (paragraph 2.1.1.a)

4.4.6.3 Primary stress intensity evalution for upset conditions is required for F3 = 168,600 pounds which will give Pb value of 168,600/448,770 x 53.18 = 19.98 ksi.

The existing primary stress intensity for operating conditions is 11.5 ksi (page B-16-8 of 2.2.c(2)). Thus the new value of Pl+Pb at this location is

Pl+Pb = 11.5 + 19.98

= 31.48 ksi < 1.5 Sm = 40 ksi

4.4.6.4 The primary plus secondary stress intensity range for upset condition F3 is required for two (2) sets of loading cycles as follows (at junction of baffle plate and shell):

F3 = 177,000 lbs for 120 cycles excluding loss of feedwater pump transient

and

F3 = 240,400 lbs for 10 cycles of loss of feedwater pump transient

4.4.6.5 The primary plus secondary stress intensity range for 120 cycles is Sn = 177,000/448,700 x 53.18 = 20.98 ksi. The existing value of the same primary plus secondary stress intensity range is 51.6 kis (page B-16-15 of 2.2.2.c(2) range of all cases except case VI See Table 2 for details). Thus the new value of Sn = 51.6 + 20.98 = 72.58 ksi < 3 Sm = 80 ksi.

4.4.6.6 The primary plus secondary stress intensity range for 10 cycles (Loss of Feedwater Pump Transient) is Sn = 240,400/448,770 x 53.18 = 28.49 ksi. The existing value of the same primary plus secondary stress intensity range is 72.0 ksi (per B-7-1 of 2.2.c(2)only cases III and VI are part of this transient, Table 4 for details). Thus the new value of Sm= 72.0 + 28.49 = 100.48 ksi. which is greater than 3Sm = 80 ksi. Thus simplified elastic-plastic analysis will be required.

4.4.6.7 Fatigue, i.e., peak stress intensity existing range, for 120 cycles is 66.3 ksi (Table 3 for details). Thus the new Sp = 66.3 + (20.98)(1.64) = 100.70 ksi where 1.64 is the bending stress concentration factor, pg. B-17-2.

Sa = Ke . Sp/2. Since Sn < 3 Sm, Ke = 1.0

Sa = 100.7/2 = 50.35 ksi

Nall = 4200 (Figure N-415(A) of 2.2.1.a)

Usage Factor = UF1 = 120/4200 = 0.029

4.4.6.8 The peak stress intensity evaluation for 10 cycles F3 is as follows: Sn = 100.48 ksi which exceeds 3 Sm = 80 ksi. And with material parameters of m = 2, n= 0.2 (per page B-17-5 of 2.2.2c(2) Sm < Sn < m 3 S_m. Thus

Ke = 1.0 + [(1-n)/(m-1)n] [S_n/3 S_m - 1] (per 2.2.1.a)

= 1.0 + 0.8/1x0.2 [100.48/80 - 1] = 2.02

4.4.6.9 Fatigue evalution for these 10 cycles is as follows: The existing peak stress intensity per page B-17-3 of 2.2.c(2) is 146.8 ksi (Table 5 for details). The extra peak stress intensity for this F3 load is (28.48) (Bending stress concentration factor of 1.64 per page B-17-2 of 2.2.2.c(2)) = 46.71 ksi.

The new (total) peak stress intensity Sp = 146.8 + 46.71 = 193.51 ksi. And with Ke = 2.02, the alternating stress Sa = 2.02/2 x 193.51 = 195.5 ksi. The allowable cycles at this Sa level per Figure N-415(A) of 2.2.1.a are 95. Thus usage factor UF2 = 10/95 = 0.11

4.4.6.10 The cumulative usage factor (revised) is as follows:

UF = UF1 + UF2 + UF3 [For (260-130) cycles at Sa of 31.3/2 = 15.7 ksi (page B-17-5 of 2.2.2c(2)]

UF3 = 130/400,000 ≅ 0 [400,000 are allowable cycles Sa = 15.7 ksi]

The cumulative UF = 0.029 + 0.11 +0 = 0.14 < 1.0 below limits of 2.2.1.a

The usage factor being less than 0.50 (either for shell or junction of shell and baffle plate) no power rerate evalution will be required per 2.2.2.h.

4.5 Evaluation for Peach Bottom Unit 2 for F_1, F_2, F_3 and their effects on all code requirements is satisfied as documented in sections 4.1 through 4.4. The original stress report for Peach Bottom Unit 3 (2.2.2.d) states that stress reports 20 (2.2.2.d(1)) and stress report 11 (2.2.2.d(2)) for Unit 3 are exact duplicates of same reports for Unit 2. Hence F_1, F_2, F_3 assessments for Unit 3 is same as shown above for Unit 2 and thus meets all the code (2.2.1.a) requirements. It should be noted that seismic shears and overturning moments for shroud support used in the analysis (page B-11-A of 2.2.2.c(2)) are higher than those required by G.E. Drawing Design (2.2.2.b).

4.6 In accordance with power rerate analysis/reconciliation documentation (2.2.2.h) and fatigue evaluation of Peach Bottom II and III Reactor Vessels for power rerate (2.2.2.i), there are no changes required to the original stress analysis (2.2.2.c and 2.2.2.d) in the regions affected by loads F_1, F_2, and F_3. Thus power rerate analysis is still valid.

4.7 All of the stress intensities due to the new design mechanical loads F1, F2, and F3 satisfy the allowable stress intensities of the original Code of Construction (Paragraph 2.2.1.a).

4.8 The new seismic loads on the stabilizer bracket location (F_4) is 334,000 lbs for MCE. These when conservatively converted into individual bracket loads (i.e., taken two bracket only in any one directional earthquake) result in individual bracket loads of 167 kips (for MCE). This load is less than the stabilizer bracket seismic loadings of 300 kips (conservatively DBE only) per document 2.2.2.b, Table 9. Thus the effect of F_4 (as a result of shroud stabilizer modification) on RPV is enveloped by the existing analysis (2.2.2.c(3)) since page 12 of 2.2.2.c(3) states that it is using seismic loads from 2.2.2.b. Power rerate analysis (2.2.2.h and 2.2.2.i) have no effect on the stabilizer bracket evaluations.

4.9 The new seismic forces and moments on the base of RPV skirt are F5 and M5. The max. of these values (MCE values) are F5 = 280 kips and M5 = 6611 kip-ft. These values are less than the seismic values of H_B = 1083 kips and M_B = 40,138 kip-ft (2.2.2.b) which are used in the original skirt stress analysis reports (page B-15-4 of 2.2.2.c(4) and 2.2.2.d(4)) for Peach Bottom Units 2 and 3 respectively. Thus original stress analysis of RPV skirt is still valid. These loads are only primary loads and do not affect fatigue evaluation. The power rerate analysis documentation (2.2.2.h and 2.2.2.i) reevaluates support skirt but since seismic loading used in power rerate is the same as the original loading (2.2.2.b), the power rerate documentation is unaffected by these stabilizer modification forces and moments F5 and M5.

4.10 The new seismic overturning moments and shears at the shroud support location are M_6 = 123.9 k-ft, F_6 = 136.78 kips in MCE. These loads are lower than the seismic moment of 4885 k-ft and 238 kips(conservatively DBE only) per Table 10 of 2.2.2.b. Thus effects of M6/V6 (new) on RPV is enveloped by the existing analysis since page B-11-A of 2.2.2.c(2) states that it is using seismic loads

higher than those given in GE drawing (2.2.2.b). Power rerate reconciliations (2.2.2.h and 2.2.2.i) are not affected by this shroud support evaluations.

5.0 Based on the best of my knowledge and belief, it is hereby certified that the analysis documented in this Stress Report satisfies the requirements of ASME Boiler and Pressure Vessel Code Section III, 1965 Edition with Addenda through Winter 1965 and Design Specification listed in Paragraph 2.1.1.a. This certification is provided as required by Paragraph N-142 of said Section III.

Signature: Asherlekar Date: 9/24/94

License Number: C23562 State: California

Table 1 - ADDITIONAL DESIGN MECHANICAL LOADS

Force	(Normal/Upset) DBE + Normal Pressure	Emergency	(Faulted) MCE + LOCA	Remarks
F_1	33,400 lbs	-	89,600 lbs	Primary Stress
F_2	16,800 lbs	-	31,200 lbs	Primary Stress
F_3	168,600 lbs	321,933 lbs	448,770 lbs	Primary Stress
	177,000 lbs	-	-	Pri plus Sec. S.I Range (120 cycles) and fatigue
	240,400 lbs	-	-	Pri plus Sec. S.I Range (10 cycles) and fatigue
F_4	-	-	334,000 lbs	Seismic (Total) Tangential Load @ stabilizer Bracket
F_5	-	-	280,000 lbs	Seismic Shear Only @RPV skirt
M_5	-	-	6,611,000 ft-lbs	Seismic Moment @RPV skirt
M_6	-	-	123,900 ft-lb	Seismic Moment @Shroud Support
F_6	-	-	136,780 ft-lb	Seismic Shear @ Shroud Support

NOTES

1) F_1, F_2, F_3 and F_4 are discrete loads applied over a small area. At any one point in time, F_1 , F_2 , F_3 are each applied to one location. At any one point in time, F_3 is applied to 4 locations 90° apart for the installation of four shroud stabilizer assemblies. DBE is a Design Basis Earthquake (OBE). MCE is a Maximum Credible Earthquake (SSE).

2) The stress intensities shall meet the stress allowables of the ASME Code, Section III, for the load combinations defined by the Peach Bottom UFSAR. The original Code of Construction did not include Faulted load combinations. Faulted and Emergency load combinations shall meet the stress allowables as defined by the Peach Bottom UFSAR for the reactor pressure vessel

3) Loads F_1, F_2, F_3 to be used in the primary stress evaluation are from document 2.1.1.a. The load F_3 for upset conditions evaluation for cyclic loading are those required in document GENE-771-58-0994, Rev. 0. Loads F_4, F_5, M_5, M_6 and F_6 are thos for cracked condition as documented in GENE-771-60-0994, Rev. 0.

Table 2

Maximum primary plus secondary stress intensities (P + Q), ksi, for 120 cycles case is range of all cases on page B-16-15 excluding case VI since it is L.O.F.W.P transistion case.

Case	TOP			BOTTOM			2.2.2.c(2)
	H-L	L-R	R-H	H-L	L-R	R-H	Page #
Max. Primary	+6.6	+2.2	+2.4	+1.8	+9.3	+0.3	B-16-15 Case (1)
Min. Primary	-1.2	-8.8	-1.0	-6.0	-2.1	-3.3	B-16-15 Case (2)
Max./Min of cases	+21.0	+9.3	+9.4	+26.2	+0	+11.2	B-16-15
III,IV,V	-6.9	-31.3	-9.2	-8.3	-37.4	-6.3	B-16-15
Total +	+28.5	+11.5	+11.8	+28.0	+9.3	+11.4	Max.
Total -	-8.1	-40.1	-10.2	-14.3	-39.5	-9.9	Min.
Existing Revised Range	+36.6	+51.6	+22.0	+42.3	+48.8	+21.3	(Max-Min)
Absolute Max. Range	-	+51.6	-	-	-	-	Existing Revised
Contribution From F_3	-	+20.98	-	-	-	-	177.0/448.77*53.18
Revised Value	-	72.58	-	-	-	-	Max = S_n

Table 3

Maximum primary plus secondary plus peak (P+Q+F) stress intensity in ksi for 120 cycles case is range of all cases on page B-17-3 except case VI since it is L.0.F.W.P. transient case

Case	TOP			BOTTOM	2.2.2.c(2)
	H-L	L-R	R-H		Page #
Case (1) Max. Primary	+11.6	+2.8	+4.1	Since "BOP" envelopes "BOTTOM" only "TOP" is evaluated for peak stress intensities to be consistant with original stress report.	Max. (+), B-17-3
Case (2) Min. Primary	-1.4	-15.6	-1.5		Max (-), B-17-3
Max./min of cases III,IV,V	+21.9	+16.6	+9.4		Max (+), B-17-3
	-6.9	-31.3	-10.1		Min (-), B-17-3
Max. (+) Min. (-)	+33.5 -8.3	+19.4 -46.9	+13.5 -11.6		
Range	+41.8	+66.3	+25.1		(Max-Min)
Absolute Max	-	+66.3	-		Existing for 120 cycles
Contribution of F_3	-	34.40	-		1.64*20.98
Sp Revised	-	100.7	-		Existing + Contri. of F_3

Table 4

Primary Plus Secondary Stress Intensity Range (P + Q)

Existing stress report page B-7-1 of 2.2.2.c(2) states that Case VI (which is L.0.F.W.P) is broken into two parts for down ramp i.e. VI iter 32 and VI iter 960 while up ramp is same as Case III. Thus maximum primary plus secondary stress intensities range (ksi) of original analysis for L.0.F.W.P. transient is as follows.

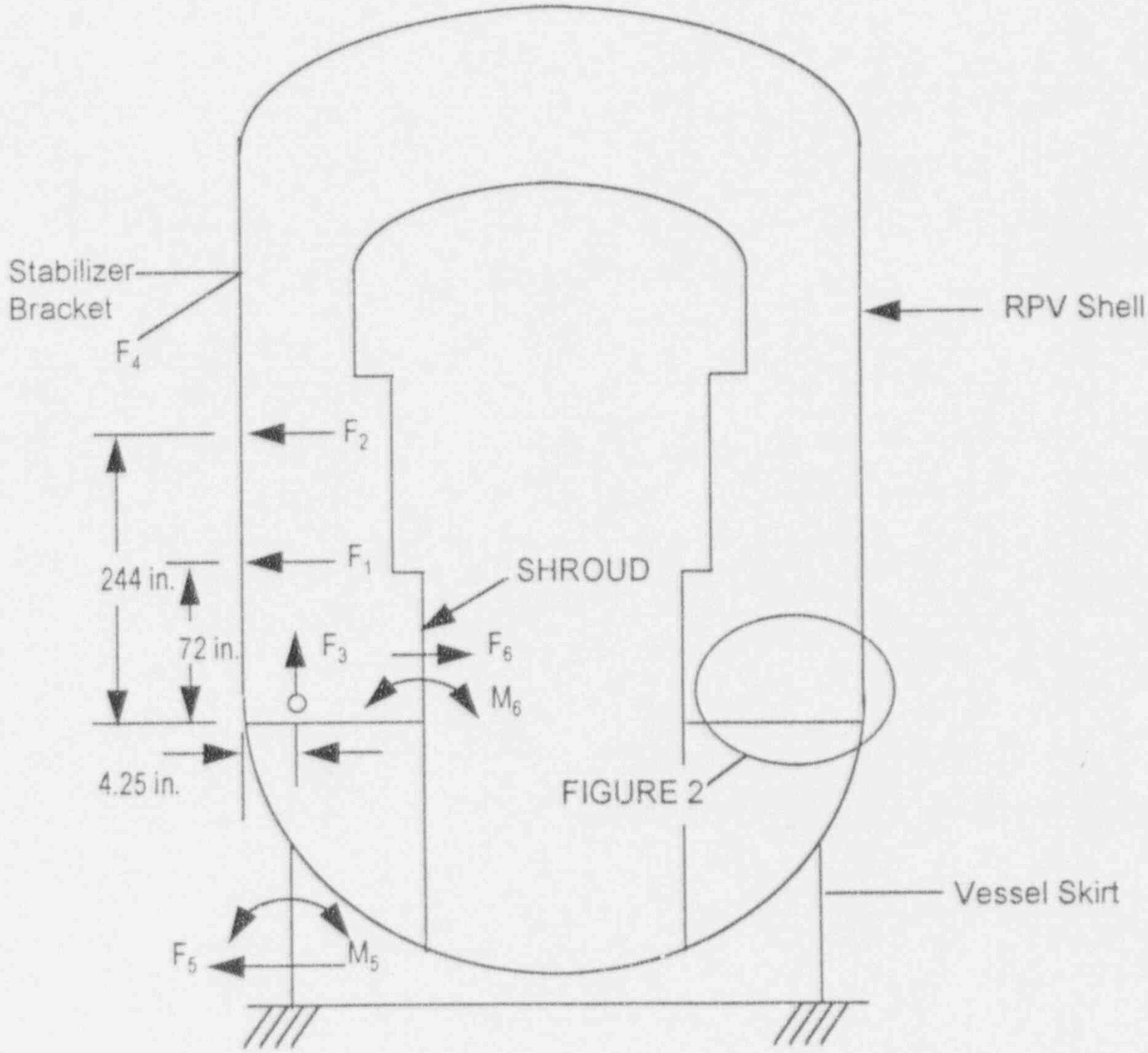
Case	TOP			BOTTOM			2.2.2.c(2)
	H-L	L-R	R-H	H-L	L-R	R-H	Page #
Case III (up)	-6.9	-2.1	9.0	-8.3	0	8.3	B-16-3
Case VI (max)	-	69.9	-	22.1	11.4	11.2	B-16-3
(min.)	-19.0	-	-50.9	-	-22.2	-33.5	B-16-3
Range (Case VI-Case III)	-12.1	72.0	-59.9	30.4	-22.2	-41.8	-
Absolute Max Range	-	+72.0	-	-	-		Existing Revised
Contribution of F_3	-	28.48	-	-	-	-	240400/448 770*53.18
Revised Value	-	100.48	-	-	-	-	Max S_n

Table 5

Peak Stress Intensity (P + Q + F)

This revised maximum primary plus secondary stress intensity for 10 cycles of this transient is 94.46 ksi which is greater than 3Sm = 80 ksi. Thus simplified elastic-plastic approach will be used for fatigue evaluation. Based on similar statement used for (P + Q) stress intensities, revised (P + Q + F) stress intensities (ksi) are as follows:

Case	TOP			Doc. 2.2.2.c(2)	Remark
	H-L	L-R	R-H	Page #	
Case III (up) Case IV Max. Case IV Min.	-6.9 - -68.5	-2.1 +144.7 0	9.0 +12.2 -76.2	B-17-3 B-17-3 B-17-3	• Original Report evaluated only "TOP" since it enveloped "BOTTOM" as shown on P + Q evaluation. This is also true for new values as seen on previous page.
Range	-61.6	+146.8	-85.2	Existing Revised	
Absolute Max. Range	-	146.8	-	-	
Contribution of F3	-	46.71	-	(1.64) (28.49)	• Using stress concentration factor for bending = 1.64 page B-17-2 of 2.2.2.c(2)
Revised Sp	-	193.51	-		



All other dimensions per 2.2.2.a

FIGURE 1. APPLICATION OF DESIGN MECHANICAL LOADS

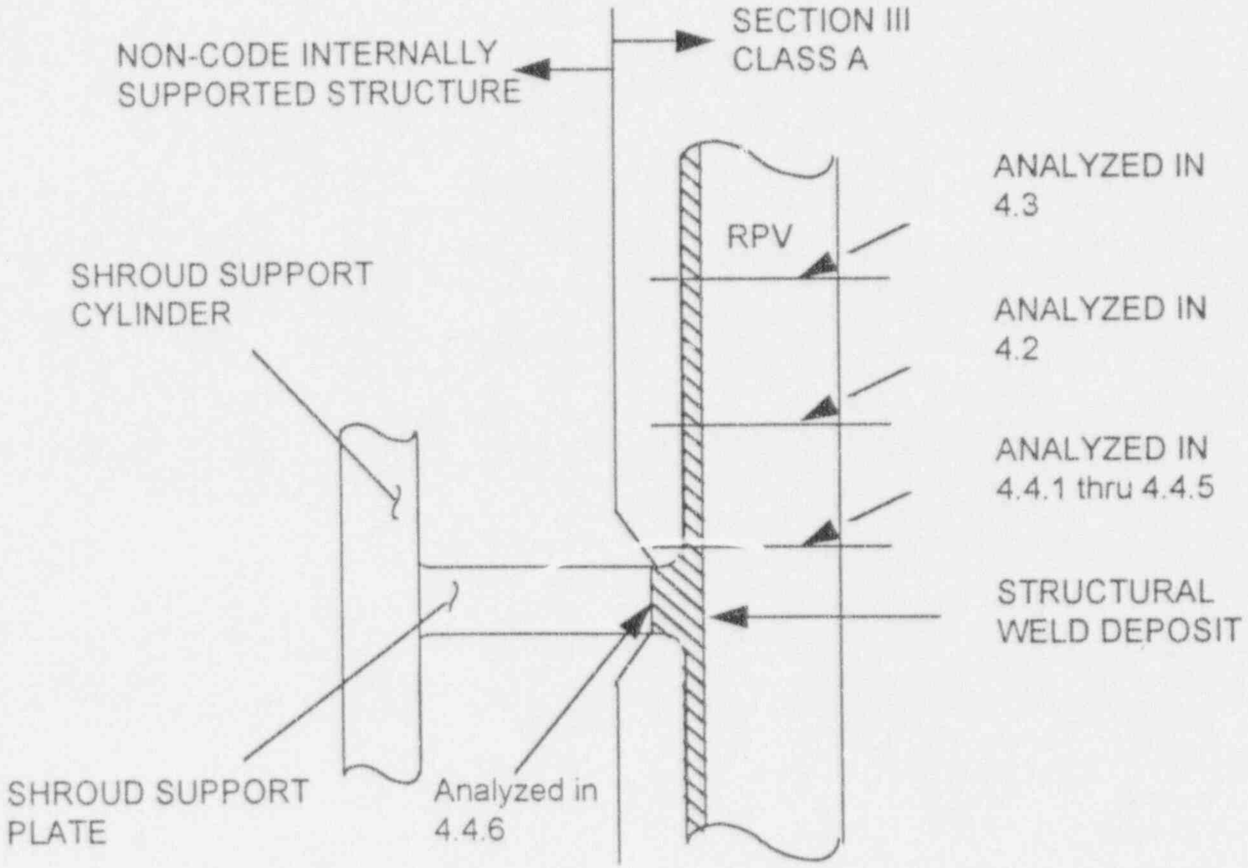


FIGURE 2. BOUNDARY OF ASME CODE JURISDICTION