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LEGEND OR DESCRIPTION OF GROUPS

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1.0 SCOPE

This document is the ASME Code Section III Paragraph N-142 Stress Report for the Reactor Pressure Vessel. This analysis addresses the new loads applied to the vessel as a result of the installation of the shroud stabilizers which function to replace the horizontal girth welds H1 through H7 and weld H8 in the core shroud.

2.0 APPLICABLE DOCUMENTS

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

Subject	Document Number	
a. Code Design Specification	25A5689	Rev. 1
b. Shroud Repair Hardware Design Specification	25A5688	Rev. 2
c. GE Drawing-Reactor Vessel SH-4	885D660	Rev. 8
d. GE Drawing-Vessel Loading	885D910	Rev. 6
e. GE Drawing-Detail, Support Lower	112D6664	Rev. 0
f. GE Drawing-Detail, Contact Lower	112D6667	Rev. 0
g. GE Drawing-Detail, Contact Middle	112D6681	Rev. 1
h. GE Drawing-Detail, Contact Upper	112D6666	Rev. 0
i. GE Drawing-Reactor Thermal Cycles	921D265	Rev. 1
j. GE File-Shroud Support Dresden 2	VPF # 1248-114-4	
k. GE File-RPV Stress Report for Dresden 2	VPF # 1248-436-1	
1) Report # 8 Rev. 5-Support Skirt Analysis		
2) Report # 10 Rev. 6-Brackets		
3) Report # 11 Rev. 4-Shroud Support System Analysis		
4) Report # 20-Rev. 3-Shell Analysis		
l. GE Shroud Mechanical Repairs Program Dresden 2 & 3- Seismic Analysis	GENE-771-84-1194	Rev 2
m. GE File-Shroud Support Dresden 3	VPF # 2252-131-3	
n. GE File-RPV Stress Report for Dresden 3	VPF # 2252-181-1	
1) Report # 8 Rev. 5-Support Skirt Analysis		
2) Report # 10 Rev. 6-Brackets		
3) Report # 11 Rev. 4-Shroud Support System Analysis		
4) Report # 20-Rev. 3-Shell Analysis		

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, 1963 Edition and Addenda through Summer 1964 (Dresden 2)

b. Section III, 1965 Edition and Addenda through Summer 1965 (Dresden 3)

2.2.2 Other Documents

a. "Roark's Formulas For Stress & Strain", by W. C. Young, 6th Edition
b. "Theory of Plates and Shells", by S. Timoshenko, 2nd Edition

3.0 GENERAL DESCRIPTION

3.1 Purpose

The purpose of the shroud stabilizers is to structurally replace all of the horizontal girth welds in the core shroud and and weld betweeen the shroud cylinder and the shroud support plate. These welds provide support for the cylindrical plate sections, and the shroud head, and prevent core bypass flow from exiting to the downcomer region. The core top guide and core support plate horizontally support the fuel assemblies and maintain the correct fuel channel spacing permitting control rod insertion.

3.2 Design Requirements

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.b). The second document addressed those requirements that were under the jurisdiction of the ASME Code (Paragraph 2.1.a).

3.3 Acceptability

This Stress Report documents the acceptability of the structural integrity requirements of the Code Design Specification defined in Paragraph 2.1.a. The original B & W stress report for Dresden 2 (2.1.k) and for Dresden 3 (2.1.n) are indentical except their VPF numbers. Therefore, any reference to 2.1.k implies reference to 2.1.n also. Where data for Dresden 2 (2.1.j) differs from Dresden 3 data (2.1.m), the most conservative of the two values are used in the calculations and are specifically indicated.

4.0 ANALYSIS

4.1 General

The Design Specification (2.1.a) defines four 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 approximately equal to 70" (See Figure 1) and therefore, can be treated as separate forces. Each of F1, F2, F3 and F4 are addressed in sections 4.2 through 4.6.

4.2 Evaluation for load F1

The force F1 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 Design Basis earthquake (DBE). At this elevation the RPV shell is 6.125 inches thick minimum (page B-2-2 of 2.1.k.4).

4.2.1 Compute stresses induced in RPV due to F1 applied radially to RPV shell at approximately 72 inches above the support plate during DBE:

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

R_i=125.5" Inside radius of RPV

h = 6.125" Thickness of RPV shell exclusive of cladding

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

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

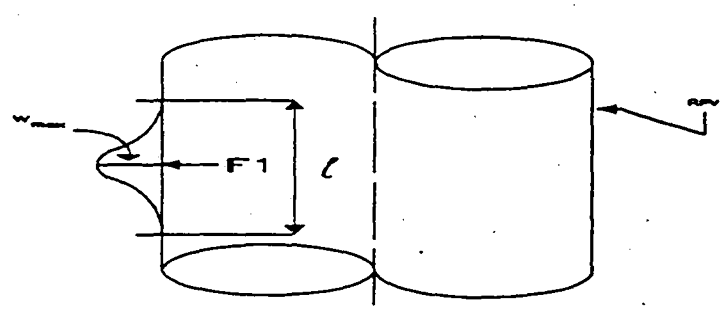
ν = 0.30 Poisson's ratio (2.1.k.4)

β = 0.046

M_{Max} = P/4β and P = F1/2l

where l is contact width of upper contact plate, 5" for F1 & 2" for F2 & 4" for F3 (2.1.f through 2.1.h).

M_{MAX} =0.543F1 or 1.358F2 & 0.679F3 k-in/in.



From paragraph 2.2.2.b page 474 deflection under load is

W_{MAX}= (Pα^2 β)/(2Eh)= 0.00021F1 or 0.00052F2 or 0.00026F3 in. since E = 29.4 x 10^3 ksi. (2.1.k.4)

And l/2 = (3xΠ) / (4xβ) is the length over which deflection due to radial load become zero on either side of the point of the application of the load.

l/2 = (3xΠ) / (4x0.046) = 51.22 in.

$\sigma_1 = \sigma_l$ = Longitudinal Stress

$\sigma_2 = \sigma_t$ = Tangential Stress

Pm = Primary membrane stress intensity

Pl = Primary local membrane stress intensity

Pb = Primary bending stress intensity
$\sigma_2 = \sigma_1 = 6M_{MAX}/h^2 = 0.087$ F1 or 0.218 F2 or 0.109 F3 ksi
$\sigma_2 = \sigma_t = 6\,\nu\,M_{MAX}/h^2 + E\,W_{max}/\alpha = 0.074$ F1 or 0.186 F2 or 0.093 F3 ksi

4.2.2 For Faulted condition F1 = 190 kips. the maximum value of Pl stress intensity due to this load is negligible and the maximum value of Pb stress intensity due to this load is = 0.087 x 190 =16.53 ksi. These stress intensities occur directly under the point of load application.

4.2.3 The existing primary local membrane stress intensities in the shell per the original Stress Report (Paragraph 2.1.k.4, Page B-19-2) are 12.8 ksi (Pl) and also (Pl + Pb).

4.2.4 The new value of Pl is same as original value of 12.8 ksi. The new value of (Pl + Pb) can be conservatively calculated as 12.8 + 16.53 = 29.33 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 (Pl) plus primary bending (Pl + Pb) stress intensity is 1.5Sm, which equals 40 ksi. (paragraph 2.1.k.4).

4.2.6 The Emergency load F1 is almost same as (only 4 kips. less) Faulted load F1 and thus the new value of (Pl + Pb) is 28.98 ksi. which is below the allowable of 1.5Sm = 40 ksi. per 2.1.k.4.

4.2.7 Primary stress intensity (Pb) for normal / upset condition F1 = 93 kips = 0.087 x 93 = 8.09 ksi. and the primary local stress intensity (Pl) is negligible. The existing Pl and (Pl + Pb) are 12.8 ksi. The new Pl = 12.8 ksi while new (Pl + Pb) = 12.8 + 8.09 = 20.89 ksi. < 40 ksi (1.5Sm).

4.3. <u>Evaluation for load F2</u>

Stresses in RPV due to Faulted condition F2 = 24 kips applied at approximately 188 inches above the shroud support plate can be obtained by scaling from values obtained for F1 = 190 kips. and using the lower contact plate width of 2 inches as value of "ℓ".
σ_1 = 5.23 ksi. And σ_2 = 4.46 ksi.

4.3.1 The maximum value of Pl stress intensity due to this load is negligible and the maximum value of Pb is 5.23 ksi. These stress intensities occur directly under the point of load application.

4.3.2 The existing primary local membrane stress intensities in the shell per the original Stress Report (Page B-19-2 of 2.1.k.4) is 12.8 ksi. for (Pl) and (Pl +Pb).

4.3.3 The new value of Pl is conservatively same as existing value of 12.8 ksi. The new value of Pl + Pb can be conservatively calculated as 12.8 + 5.23 = 18.03 ksi.

4.3.4 The faulted allowable value of primary membrane stress intensity is Sm, which equals 26.7 ksi. and the allowable value of primary local (Pl) and the primary plus bending (Pl + Pb) stress intensity is 1.5Sm, which equals 40 ksi. per 2.1.k.4.

4.3.5 The Emergency load F2 is same as Faulted load F2 and thus the new value of (Pl + Pb) is 18.03 ksi. which is below the allowable of 1.5Sm = 40 ksi. per 2.1.k.4.

4.3.6 Since the faulted stress intensities (Pl) and (Pl + Pb) are below the upset conditions allowable of 40 ksi., the primary stress intensity for normal / upset condition F2 = 12 kips. is satisfied by inspection as the F2 in upset conditions is lower than F2 of the DBE condition.

4.4 Evaluation for load F3

Stresses in RPV due to Faulted condition F3 = 140 kips applied at approximately 244 inches above the shroud support plate, can be obtained by scaling from values obtained for F1 = 190 kips. and using the lower contact plate width of 4 inches as value of "l".
σ_1 = 15.26 ksi. and σ_2 = 12.97 ksi.

4.4.1 The maximum value of Pl Stress intensity due to this load is negligible and the maximum value of Pb is 15.26 ksi. These stress intensities occur directly under the point of load application.

4.4.2 The existing primary membrane stress intensities in the shell per the original Stress Report (Page B-19-2 of 2.1.k.4) is 12.8 ksi., for (Pl) and (Pl + Pb).

4.4.3 The new value of Pl is conservatively same as existing value of 12.8 ksi. The new value of (Pl + Pb) can be conservatively calculated as 12.8 +15.26 = 28.06 ksi.

4.4.4 The faulted allowable value of primary membrane stress intensity is Sm, which equals 26.7 ksi. and the allowable value of primary local (Pl) and the primary plus bending (Pl + Pb) stress intensity is 1.5Sm, which equals 40 ksi. per 2.1.k.4.

4.4.5 The Emergency load F3 is almost same as Faulted load F3 (only 6 kips less) and thus the new value of (Pl + Pb) is 26.79 ksi. which is below the allowable of 1.5Sm = 40 ksi. per 2.1.k.4.

4.4.6 Since the faulted stress intensities (Pl) and (Pl + Pb) are below the upset conditions allowable of 40 ksi., the primary stress intensity for normal / upset condition F3 = 67 kips. is satisfied by inspection as the F3 in upset conditions is lower than F3 of the faulted condition.

4.5 Evaluation of load F4 For RPV Shell

The force F4 is applied to vertical plate at 4.25 inches (2.1.e) from the inside surface of the RPV shell (this results in moment arm of 4.25 + 6.125 / 2 = 7.31" at RPV shell center line). The value of F4 is 339 kips. for Faulted and Emergency, and 123 kips. for Normal / Upset conditions, all without thermal preload, for primary stress evaluation. Additionally Normal / Upset condition is also evaluated for primary plus secondary stress intensities ranges along with fatigue using F4 of 194 kips per 2.1.a.

4.5.1 Formulas for Stress Intensity for F4 @ Shell

Apply F4 as vertical load and it will transfer as axial load V = F4 kips and moment of 7.31 F4 k-in. This load V = F4 kips. and moment 7.31F4 k-in. will be assumed to be resisted by the width of RPV shell equal to the width (b = 13.5"), of the lower support plate (paragraph 2.1.e).

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:

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

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

where

m_o = End moment = 7.31 F4/13.5 k-in/in;

t = Thickness of shell = 6.125";

P = F4/13.5 kips/in;

E = Young's Modulus = 29.4×10^3 ksi.;

R_m = Vessel Mean Radius = 128.563 in.;

ν = Poisson's ratio = 0.30;

W_o = Deflection at edge (calculated below).

Using para. I-232(2) of 2.2.1.a, the limiting value of $W_o = m_o / 2\beta^2 D$, where

$D = Et^3/12(1-\nu^2)$, $\beta = \sqrt[4]{\dfrac{3(1-\nu^2)}{R_m^2 t^2}}$ and substituting values of D, β in terms of E, t,

R_m, the expression for σ_t can be simplified as $\sigma_t = \dfrac{6 m_o}{t^2}\left(\nu + \sqrt{\dfrac{1-\nu^2}{3}}\right)$. And with

$\nu = 0.30$ $\sigma_t = \dfrac{6 m_o}{t^2}(0.85)$.

Further, since t = 6.125", the final σ_ℓ = 0.099F4 ksi., σ_t = 0.074F4 ksi.

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

4.5.2 Evaluation For Faulted Condition

Primary local membrane plus bending (Pl + Pb) stress intensity for faulted condition F4 = 339 kips. are as follows:

$\sigma_\ell = \sigma_1 = 0.099 \times 339 = 33.56$ ksi. And $\sigma_t = \sigma_2 = 0.074 \times 339 = 25.09$ ksi.
Thus the maximum primary stress intensity (Pl + Pb) = 33.56 ksi
From page B-19-3 of original stress report (2.1.k.4) the existing maximum primary local membrane (Pl) & also (Pl + Pb) stress in tangential direction is 12.8 ksi. and 6.4 ksi. in longitudinal direction. And as the major stresses due to F4 are Pb, i.e.; while Pl = 0.012F4 = 4.07 ksi., Pb is 0.087F4 = 29.49 ksi. out of a total (Pl + Pb) of 33.56 ksi. And the new values will be as follows:

Pl = 6.4 + 4.07 = 10.47 ksi. OR 12.8 ksi.
Pl + Pb = 6.4 + 33.56 = 39.96 ksi. OR 12.8 + 25.09 = 37.89 ksi.

The allowable Pl and Pl + Pb stress intensity is 1.5Sm = 40 ksi. in the original stress report (2.1.k.4).

4.5.3 Evaluation For Emergency Condition

Primary local membrane plus bending stress intensity (Pl + Pb) and primary local membrane stress intensity (Pl) for emergency conditions and the allowable of the original stress report is same in both conditions.

4.5.4 Evaluation For Normal / Upset Conditions

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

4.5.4.1 Primary stress intensity evaluation is required for F4 = 123 kips. which will give Pl + Pb = 0.099 x 123 = 12.18 ksi. and Pl = 0.012 x 123 = 1.47 ksi.
The existing primary stress intensity at this location for operating condition is Pl = 12.8 ksi. and Pl + Pb = 12.8 ksi. (page B-19-3 of 2.1.k.4). Thus the new value of Pl + Pb at this location is

Pl + Pb = 12.8 + 12.18 = 24.98 ksi < $1.5S_m$ = 40 ksi. and Pl = 12.8 + 1.47 = 14.27 ksi. < Sm = 26.7 ksi.

4.5.4.2 The primary plus secondary stress intensity for upset condition load F4 = 194 kips is performed for all 120 cycles including the blow down transient as follows (at RPV shell):
Conservatively the primary plus secondary intensity stress range for 120 cycles is Sn = 0.099 x 194 = 19.21 ksi. The existing value of same primary plus secondary stress intensity range is 20.4 ksi. (page B-16-1 of 2.1.k.4). Thus the new value of S_n = 20.4 + 19.21 = 39.61 ksi. < $3S_m$ = 80 ksi.

4.5.4.3 Fatigue, i.e., peak stress intensity range, evaluation for 120 cycles F4 is as follows:

$S_a = K_e x \frac{S_n}{2}$ Since $S_n < 3 S_m$, $K_e = 1.0$

And there is no stress concentration factor per page B-14-1 of 2.1.k.4

S_a = 22.55 (existing S_a, page B-18-2 of 2.1.k.4) + 19.21 / 2 = 32.15 ksi.

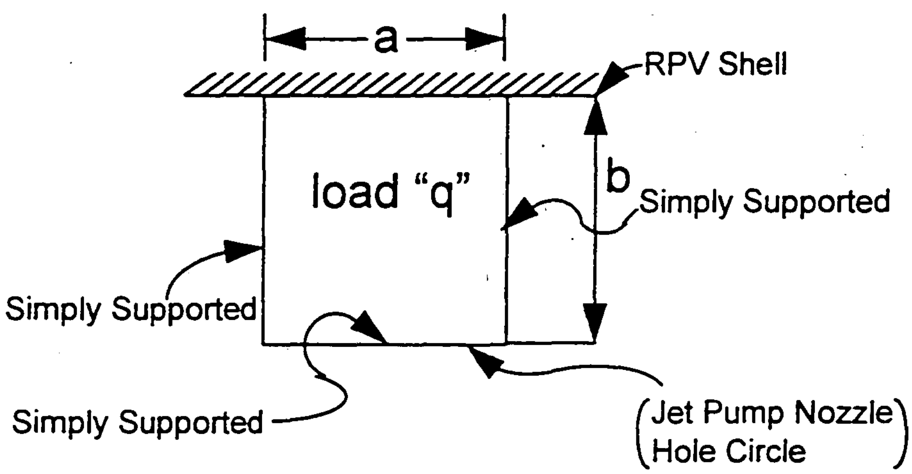
N_{all} = 20000 (Figure N-415(A) of 2.2.1.a)

Usage Factor = UF = 120 / 20000 = 0.006 < 1.0

4.6 Evaluation of RPV Shell and Baffle Plate Junction for F4 Load

4.6.1 <u>Evaluation for Weld H8 Uncracked condition</u>

Due to the support afforded by jet pump nozzles to the baffle plate, the load F4 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 below:



where

a = Width of horizontal lower support plate (2.1.e) = 13.5";

b = Distance (radial) between shell inside radius (=125.5") and jet pump nozzle hole circle radius = 226 / 2 = 113" (per 2.1.j and 2.1.m) = 12.5";

q = Distributed load = F4 / 13.5 x 12.5 = 0.006F4 ksi.

Using formulas for middle of fixed edge moments (for uniformly loaded plate with one edge fixed, other three edges simple supported) from Timoshenko (2.2.2.b, page 241), the moment $\bar{M}y = d_2 q l^2$ (symbols per 2.2.2.b). Further, since b / a = 0.907 d_2 = 0.0916 from Table 52 of 2.2.2.b. And since l = 12.5" (smaller of a = 13.5" or b = 12.5"),

$\bar{M}y = 0.0916 \times 0.006F4 \times (12.5)^2 = 0.0859F4$ in-kips/in.

Further the bending stress $\sigma_b = 6\ \bar{M}y / t^2$ and with t = 2.063" (thickness of baffle plate per 2.1.j), the bending stress value is

$\sigma_b = 0.0859F4 x\ 6 / (2.063)^2 = 0.1211F4$ ksi

And shear stress τ = F4 /Area = (F4 / (Perimeter x 't'))

$\tau = \{F4 / [(2) \times (12.5 + 13.5) \times (2.063)]\} = 0.0093F4$ ksi.

Principal stress $\sigma_1 = 0.1211F4 / 2 + \{(0.1211F4 / 2)^2 + (\tau)^2\}^{1/2} = 0.1218F4$ ksi.

$\sigma_2 = 0.1211F4 / 2 - \{(0.1211F4 / 2)^2 + (\tau)^2\}^{1/2} = -0.0007F4$ ksi.

The maximum stress intensity = $(\sigma_1 - \sigma_2)$ = 0.1225F4 ksi.

4.6.1.1 Evaluation for Faulted Condition

Primary local membrane plus bending (Pl + Pb) stress intensity for faulted conditions F4 = 339 kips. are as follows:
Thus the maximum primary stress intensity (Pl + Pb) = 0.1225 x 339 = 41.5 ksi
The maximum primary membrane plus bending stress intensity at this location from the existing stress analysis (2.1.k.3 page B-16-7) is 0.5 ksi. Therefore, the new maximum primary membrane plus bending (Pl + Pb) stress intensity is = 0.5 + 41.5 = 42 ksi. which is less than faulted allowable of 3Sm = 80 ksi for carbon steel (vessel material) and also less than the 3Sm = 70 ksi for Inconel (baffle plate material).

4.6.1.2 Evaluation for Emergency Condition

Primary local membrane plus bending stress intensity (Pl + Pb) for the Emergency condition F4 = 339 kips. is equal to 0.1225 x 339 = 41.5 ksi. Thus new Pl + Pb = 0.5 + 41.5 = 42 ksi. which is less than emergency condition allowable of 2.25Sm = 60 ksi for carbon steel (vessel material) and also less than the 2.25Sm = 52.5 ksi for Inconel (baffle plate material).

4.6.1.3 Evaluation for Normal / Upset Conditions

4.6.1.3.1 Evaluation for Primary Stress Intensity

Primary stress intensity evaluation for upset conditions is required for F4 = 123 kips. which will give Pl + Pb value of 0.1225 x 123 = 15.06 ksi.
The existing primary stress intensity for operating conditions is 9.6 ksi (page B-16-7 of 2.1.k.3). Thus the new value of Pl + Pb at this location is
Pl + Pb = 9.6 + 15.06
= 24.66 ksi. < 1.5Sm = 40 ksi for cabon steel, the vessel material
< 1.5Sm = 35 ksi for Inconel, the baffle plate material

4.6.1.3.2 Evaluation for Primary plus Secondary Stress Intensity

The primary plus secondary stress intensity range for upset condition F4 = 194 kips is performed for all 281 loading cycles including the blow-down transient as follows (at junction of baffle plate and RPV shell):

Conservatively the highest primary plus secondary stress intensity range is for 10 cycles of loss of feed water pump transient and is equal to Sn = 0.1225 x 194 = 23.77 ksi The existing value of the same primary plus secondary stress intensity range is 67.2 ksi. (page C-16-7 of 2.1.k.3). Thus the new value of Sn

= 67.2 + 23.77 = 90.97 ksi. > 3Sm = 70 ksi. (conservatively, for Inconel, the baffle plate material)

4.6.1.3.3 Evaluation for Fatigue

Fatigue, i.e., peak stress intensity range, for these 10 cycles is Sp = 88.8 (Existing) + 1.64 x 23.77 = 127.78 ksi. where 1.64 is the bending stress concentration factor as used in the original stress report, pg. B-17-2.
Sa = Ke x Sp / 2. and since Sn > 3 Sm,
Ke = 1.0 + [(1/n - 1) / (m - 1)] { (Sn / 3Sm) - 1} = 1.6
Sa = 102.22 ksi.
Na = 550 (Figure N-415(A) of 2.2.1.a)
Usage Factor = UF = 10 / 550 = 0.018
Similarly calculating the usage factor for remaining 271 cycles, the cumulative usage factor is 0.141 << 1.0, and thus is well below the code limit.

4.6.2 Evaluation for Weld H8 Cracked condition

A finite element model using computer program ANSYS was analyzed for this condition. The results are summarized in this subsection.

4.6.2.1 Evaluation for Faulted Condition

Primary local membrane plus bending (Pl + Pb) stress intensity for faulted conditions F4 = 339 kips is 59.17 ksi. which is less than faulted allowable of 3Sm = 70 ksi. for Inconel (baffle plate material) as well as 3Sm = 80 ksi. for carbon steel (RPV shell material).

4.6.2.2 Evaluation for Emergency Condition

Primary local membrane plus bending stress intensity (Pl + Pb) for the Emergency condition F4 = 339 kips is 38.27 ksi which is less than 2.25Sm = 52.5 ksi. for Inconel (baffle plate material).as well as 2.25Sm = 60 ksi. for carbon steel (RPV shell material).

4.6.2.3 Evaluation for Normal / Upset Conditions

4.6.2.3.1 Evaluation for Primary Stress Intensity

Primary local membrane plus bending stress intensity (Pl + Pb) for the Emergency condition F4 = 123 kips is 22.43 ksi which is less than 1.5Sm = 35 ksi. for Inconel (baffle plate material).as well as 1.5Sm = 40 ksi. for carbon steel (RPV shell material).

4.6.2.3.2 Evaluation for Primary plus Secondary Stress Intensity

The primary plus secondary stress intensity range for upset condition F4 = 194 kips is performed for all 281 loading cycles including the blow-down transient at junction of baffle plate and RPV shell.

Conservatively the highest primary plus secondary stress intensity range is for all 281 cycles is Sn = 44.36 ksi < 3Sm = 70 ksi (conservatively, for baffle plate material).

4.6.2.3.3 Evaluation for Fatigue

Fatigue, i.e., peak stress intensity range, for all 281 cycles is Sp = 1.64 x 44.36 = 72.76 ksi where 1.64 is the bending stress concentration factor as used in the original stress report, pg. B-17-2.
Sa = Ke x Sp / 2. and since Sn < 3 Sm, Ke = 1.0
Sa = 36.38 ksi
Na = 11000 (Figure N-415(A) of 2.2.1.a)
Usage Factor = UF = 281 / 11000 = 0.026 < 1.0

4.7 Summary

Evaluation for Dresden Unit 2 & 3 for F1, F2, F3, F4 and their effects on all Code requirements are satisfied as documented in sections 4.1 through 4.6. All of the stress intensities due to the new design mechanical loads F1, F2, F3, and F4 satisfy the allowable stress intensities of the original Code of Construction (Paragraph 2.2.1.a for Dresden 2 and Paragraph 2.2.1.b for Dresden 3).

4.8 Evaluation of RPV Stabilizer Brackets

The new seismic load on the RPV stabilizer bracket location (F7) is 1120 kips. in DBE and 550 kips. in OBE. These when conservatively converted into individual bracket loads result in individual bracket loads of 275 kips. in OBE and 560 kips. in DBE. These loads are greater than the RPV stabilizer bracket seismic loading of 246 kips per document 2.1.d. Thus the effect of F7 (as a result of shroud stabilizer modification) on RPV is reevaluated using the existing analysis (2.1.k.2). The results of these re-evaluations (GENE-771-77-1194) show that the stress intensities at shell junction as well as the maximum stresses in the bracket legs are below their respective allowable. The highest stress intensity (including local stresses) in the shell junction is 42.83 ksi. which is below the allowable of 80 ksi.

4.9 Evaluation of RPV Skirt

The new seismic shear and overturning moment on the base of RPV skirt are F5 and M5. The maximum of these values are F5 = 1100 kips and M5 = 25220 kip-ft in Upset conditions while in Faulted conditions they are F5 = 2220 kips. & M5 = 50870 kip-ft (Emergency condition values are slightly lower than Faulted condition values). These values are not the same as the seismic values of H = 870.72 kips and M = 25,200 kip-ft used in the original skirt stress analysis report (page B-19-3 of 2.1.k.1).

The bending moments in the original analysis & the present analysis are of the same nature, but have different numerical values. The original bending moments were calculated based on the seismic horizontal design acceleration coefficient of 0.4g and taking the summation of the moments of the horizontal seismic loads located at the center of gravity (C. G.'s) of each load causing the overturning moments. This was given in Table G of GE drawing 885D910 (2.1.d) for the original analysis. In the present analysis the bending moments are taken directly from the dynamic analysis of the seismic model. The details are available in GENE-771-84-1194 (2.1.l). This analysis was performed using time-history methodology.

The original seismic axial load was based on a vertical acceleration coefficient (= 0.08g OBE) multiplied by the total downward load. This axial load has not been changed in the present analysis even though the vertical acceleration coefficient is 0.067g in OBE per Dresden UFSAR The present analysis(GENE-771-77-1194) also documents the qualification of RPV skirt for DBE seismic while original analysis was performed for only OBE earthquake.

Therefore, the RPV skirt stresses are re-evaluated using the analysis of the existing stress report # 8. The results of these re-evaluations (GENE-771-77-1194) show that the maximum stresses in the skirt are below their respective allowable. The highest direct and shear stress in the skirt are 26.87 ksi. & 13.53 ksi. which are below the allowable of 40 ksi. and 16 ksi. respectively.

4.10 Evaluation of Shroud Support System

The new seismic shears and overturning moments on the base of shroud support are F6 and M6. The maximum (envelope of cracked and uncracked shroud) of these values are F6 = 520 kips and M6 = 10820 kip-ft in Upset conditions while in Emergency and Faulted conditions they are F6 = 1090 kips and M6 = 23080 kip-ft. These values are not the same as the seismic values of H = 945 kips and M = 6000 kip-ft used in the original stress analysis report (page B-11-1 of 2.1.k.3). Additionally there is an axial load on the support legs due to tie-rod attachment at the top of the shroud. Therefore, the stresses in shroud support system are re-evaluated using the analysis of the existing stress report # 11. The results of these re evaluations (GENE-771-77-1194) show that the maximum stresses in the shroud support system are below their respective allowable. The highest primary stress intensity is 32.53 ksi which is below the allowable of 52.5 ksi. The highest usage factor is (at the junction of support leg and RPV shell) 0.07 < 1.0. Thus the shroud support system meets all code allowable.

The shroud support legs were checked for buckling in the original stress report for dead weight plus OBE loads (2.1.k.3) with factor of safety of 1.97 against yield stress. In the present analysis, the load on support legs is same in both weld H8 uncracked and cracked. Therefore, only one check for buckling is performed in the present analysis. This check for buckling is performed (GENE-771-77-1194) under vertical & horizontal seismic loadings. The factors of safety for buckling under various conditions ranges from a low value of 1.2 based on short column theory & 4.2 based on long column theory (Faulted and Emergency condition) to a high value of 13.8 based on short column theory & 82.3 based on long column theory (Normal condition). Thus the support legs are adequetely supported against buckling failure.

5.0 Certification

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, 1963 Edition with Addenda through Summer 1964 (Dresden 2) & 1965 Edition with Addenda through Summer 1965 (Dresden 3) and Design Specification listed in Paragraph 2.1.a. This certification is provided as required by Paragraph N-142 of said Section III.

Signature: ____________ Date: 5/12/95

License Number: C23562 State: California

Table 1 - ADDITIONAL DESIGN MECHANICAL LOADS

Force	Normal/Upset	Emergency	Faulted	Remarks
F1	93 kips	186 kips	190 kips	Primary Stress Only
F2	12 kips	23 kips	24 kips	Primary Stress Only
F3	67 kips	134 kips	140 kips	Primary Stress Only
F4	123 kips	339 kips	339 kips	Primary Stress Only(Note 3)
	194 Kips	-	-	Pl+Pb+Q+F Stresses Only
F7	550 kips	1100 kips	1120 kips	RPV Stabilizer Bracket Seismic load
F5	1100 kips	2210 kips	2220 kips	Seismic Shear @ RPV skirt
M5	25220 K-ft	50440 K-ft	50870 K-ft	Seismic Moment @ RPV skirt
M6	10820 K-ft	23080 K-ft	23080 K-ft	Seismic Moment @ Shroud Support
F6	520 kips	1090 kips	1090 kips	Seismic Shear @ Shroud Support

NOTES

1)F1, F2, F3 are discrete loads applied over a small area. At any one point in time, F1, F2, F3 are each applied to one location. At any one point in time, F4 is applied to 4 tie rod locations locations 90° apart for the installation of four shroud stabilizer assemblies. The load F4 shown is maximum and applies to one of any two tie rods 180 degrees apart, while the remaining three tie rods have loads lower than F4 values shown above.

2)The stress intensities shall meet the stress allowable of the ASME Code, Section III, for the load combinations defined by the Dresden UFSAR. Faulted and Emergency load combinations shall meet the stress allowable as defined by the Dresden UFSAR for the reactor pressure vessel.

3) Loads F1, F2, F3, F4 to be used in the primary stress evaluation are from document 2.1.a. Loads F5, F6, F7, M5 & M6 are taken from 2.1.l.

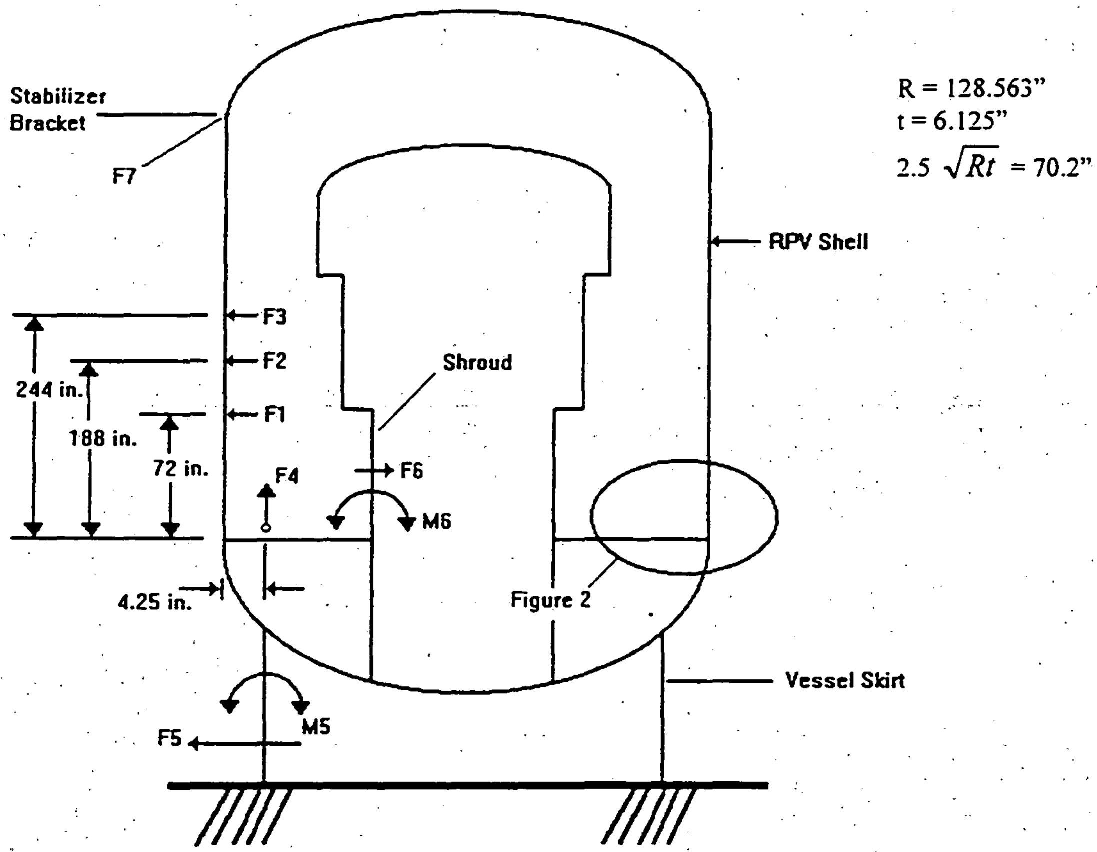


FIGURE 1. APPLICATION OF DESIGN MECHANICAL LOADS

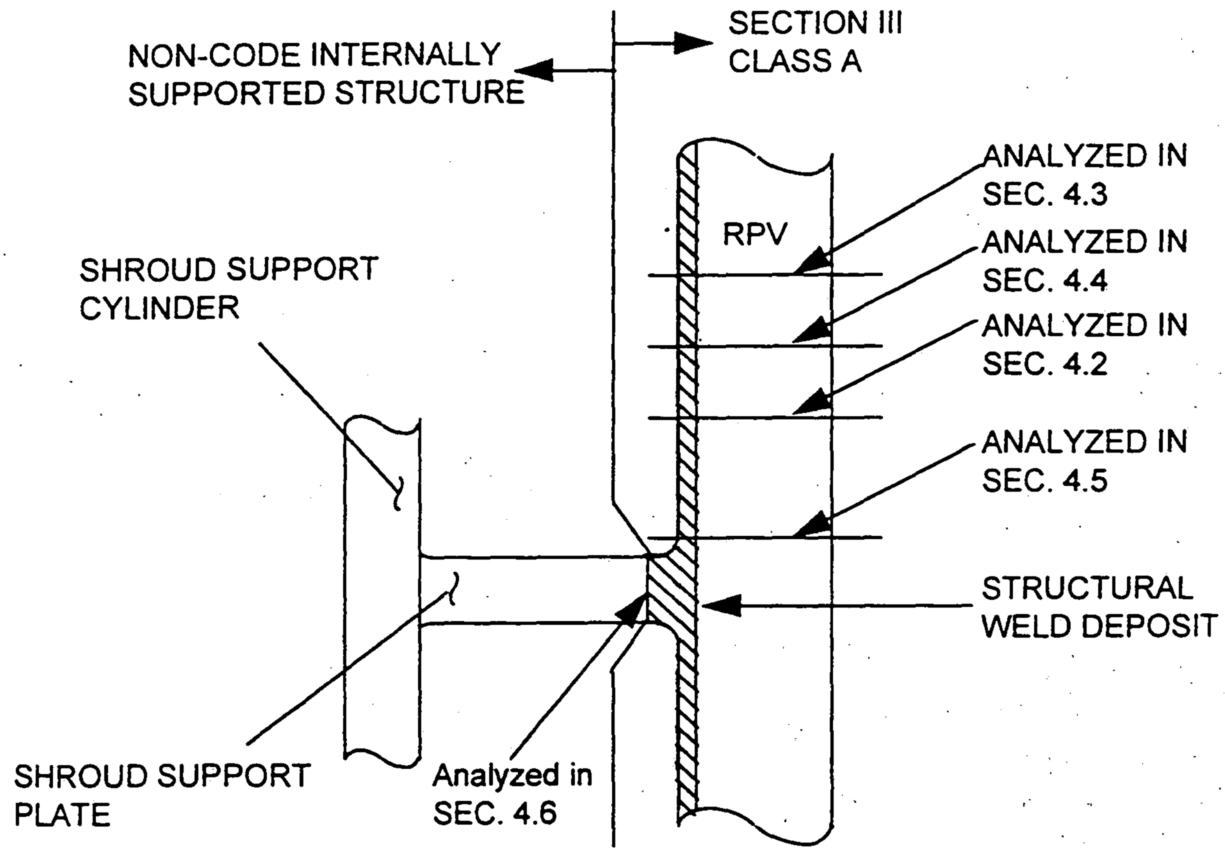


FIGURE 2. BOUNDARY OF ASME CODE JURISDICTION

Enclosure 11

GENE Stress Report, 25A5691, Revision 2

Pressure Vessel - Dresden Units 2 & 3