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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Edwin I. Hatch Nuclear Plant
Response to Request for Additional Information on
Technical Specification Revision Request:
Pressure-Temperature Limits

Gentlemen:

Enclosed you will find our response to a request for additional information on a Technical Specification revision request dealing with reactor pressure vessel pressure and temperature limits. The original submittal was transmitted to you on September 19, 1996. The request for additional information was made during a telephone conference between GPC and NRC representatives on Friday January 10, 1997.

The three NRC questions are paraphrased, followed by our response.

Please contact this office if you have further questions.

Sincerely,

J. D. Woodard

OCV/eb

A001/1

Enclosure: Response to Request for Additional Information on
Technical Specification Revision Request: Pressure-Temperature Limits

cc: (See next page.)

cc: *Georgia Power Company*
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NORMS

U.S. Nuclear Regulatory Commission, Washington, D.C.
Mr. K. Jabbour, Licensing Project Manager - Hatch

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Enclosure

Edwin I. Hatch Nuclear Plant
Response to Request for Additional Information on
Technical Specification Revision Request:
Pressure-Temperature Limits

NRC Question A:

Please provide the details of the calculation of ART and Shift for the limiting beltline (Weld 101-842) for Hatch Unit 2.

GPC Response:

The impact on adjusted reference temperature (ART) due to irradiation in the beltline materials is determined according to the methods in Reg. Guide 1.99, Rev. 2, as a function of neutron fluence and the element contents of copper (Cu) and nickel (Ni). The specific relationship from Reg. Guide 1.99, Rev. 2 is:

$$\text{ART} = \text{Initial } RT_{NDT} + \Delta RT_{NDT} + \text{Margin}$$
$$\text{Shift} = \Delta RT_{NDT} + \text{Margin}$$

where:

$$\Delta RT_{NDT} = [CF] * f^{(0.28 - 0.10 \log f)}$$
$$\text{Margin} = 2 * (\sigma_I^2 + \sigma_\Delta^2)^{1/2}$$

CF = chemistry factor from Tables 1 or 2 of Reg. Guide 1.99, Rev. 2,
f = 1/4 T fluence (n/cm^2) divided by 10^{19},
σ_I = standard deviation on initial RT_{NDT},
σ_Δ = standard deviation on ΔRT_{NDT}, 28°F for welds and 17°F for base material, except that σ_Δ need not exceed 0.50 times the ΔRT_{NDT} value.

For the limiting beltline weld 101-842

CF = 154.5 with %Cu = 0.23 and % Ni = 0.5
f = 1.050e18/1e19 for the lower long. shell with thickness of 6.38 inches,
σ_I = 0°F,
σ_Δ = 28°F

Therefore,

ART at 32 EFPY = -50 + 65.9 + 56.0 = 71.9°F
Shift at 32 EFPY = 65.9 + 56.0 = 121.9°F

where:

Initial RT_{NDT} = -50°F
$\Delta RT_{NDT} = [154.5]*0.105^{(0.28 - 0.10 \log(0.105))} = 154.5*0.427 = 65.9°F$
Margin = $2*(0^2 + 28^2)^{1/2}$ = 56°F

NRC Question B:

Please explain why in the P-T curves for Hatch Unit 2 a shift of 116.6°F was used for the A' curve and 121.9°F for the B' curve.

GPC Response:

The reason for the difference in shift used for Curve A' as opposed to Curves B' and C' is the relationship of thickness and shift to the temperatures determined. The smaller thickness (5.38" min and 5.59" max) and shift of 116.6°F produces a more conservative A' curve. The larger thickness (6.38" min and 6.59" max) and shift of 121.9°F produces a more conservative B' and C' curve. See the following example calculations for 1000 psig.

The methods used for the pressure test and heatup/cooldown curves are briefly described below. The core critical operation curve is simply the heatup/cooldown curve plus 40°F, as required in 10CFR50 Appendix G, so the methods for the heatup/cooldown curves (Curve B') apply to the core critical curves (Curve C') as well.

B.1 Pressure Test

Pressure test K_{IR} is the calculated value K_{Im} multiplied by a safety factor of 1.5. The relationship between K_{IR} and temperature relative to reference temperature (T - RT_{NDT}), is:

$$K_{IR} - 26.78 = 1.223\, e\, [0.0145\, (T - RT_{NDT} + 160)] \qquad \text{(B-1)}$$

B.2 Heatup/Cooldown

The beltline curves for heatup/cooldown conditions are influenced by pressure stresses and thermal stresses:

$$K_{IR} = 2.0\ K_{Im} + K_{It}, \qquad \text{(B-2)}$$

where:

K_{Im} is primary membrane K due to pressure and
K_{It} is radial thermal gradient K due to heatup/cooldown.

The pressure stress intensity factor K_{Im} is calculated by the method described in section B.1, the only difference being that a safety factor of 2.0 is applied in the B-2 equation, while a safety factor of 1.5 is used in the B-1 equation.

B.3 Example Calculation - 32 EFPY Pressure Test at 1000 PSIG

The following inputs were used in the beltline limit calculations:

ART	-50 + 116.6 = 66.6°F
Vessel Height	825.2 inch
Bottom of Active Fuel Height	208.6 inch
Vessel Radius	110.38 inch
Vessel Thickness Minimum	5.38 inch
Vessel Thickness Maximum	5.59 inch
Beltline Material S_y	73.9 ksi

Pressure was calculated to include hydrostatic pressure for a full vessel:

$$P = 1000 \text{ psi} + (825.2\text{-}208.6) \text{ inch} * 0.0361 \text{ psi/inch} = \underline{1022 \text{ psig}}$$

Pressure stress:

$$\sigma = PR/t = 1022 \text{ psig} * 110.38 \text{ inch} / 5.38 \text{ inch} = 21{,}000\ \underline{\text{psi}}$$

The factor M_m depends on (σ/S_y) and $\sqrt{t}$:

$$\sigma/S_y = 21{,}000 / 73{,}900 = 0.284 \text{ (use } \sigma/S_y = 0.5)$$
$$\sqrt{t} = (5.38)^{1/2} = 2.32$$

$$M_m = \underline{2.23}$$

The stress intensity factor, K_{Im} is $M_m * \sigma$:

$$K_{Im} = 2.23 * 21{,}000 = 46{,}800 \text{ psi}\sqrt{in} = \underline{46.8 \text{ ksi}\sqrt{in}}$$

T - RT_{NDT}:

$$(T - RT_{NDT}) = \ln[(1.5*46.8 - 26.78)/1.223]/0.0145 - 160$$
$$(T - RT_{NDT}) = \underline{86°F}$$

Adding the adjusted RT_{NDT} for 32 EFPY of 67°F:

$$\underline{T = 153°F}$$

B.4 Example Calculation - 32 EFPY Heatup/Cooldown Curve at 1000 PSIG

The following inputs were used in the beltline limit calculations:

ART	-50 + 122 = 72°F
Vessel Height	825.2 inch
Bottom of Active Fuel Height	208.6 inch
Vessel Radius	110.38 inch
Vessel Thickness Minimum	6.38 inch
Vessel Thickness Maximum	6.59 inch
Beltline Material S_y	73.9 ksi

The heatup/cooldown curve at 1000 psig uses the same K_{Im} as the pressure test curve, but with a safety factor of 2.0 instead of 1.5.

Pressure was calculated to include hydrostatic pressure for a full vessel:

$$P = 1000 \text{ psi} + (825.2-208.6) \text{ inch} * 0.0361 \text{ psi/inch} = \underline{1022 \text{ psig}}$$

Pressure stress:

$$\sigma = PR/t = 1022 \text{ psig} * 110.38 \text{ inch} / 6.38 \text{ inch} = 17{,}700 \underline{\text{ psi}}$$

The factor M_m depends on (σ/S_y) and $\sqrt{t}$:

$$\sigma/S_y = 17{,}700 / 73{,}900 = 0.24 \text{ (use } \sigma/S_y = 0.5)$$
$$\sqrt{t} = (6.38)^{1/2} = 2.53$$

$$M_m = \underline{2.43}$$

The stress intensity factor, K_{Im}, is $M_m * \sigma$:

$$K_{Im} = 2.43 * 17{,}700 = 43{,}000 \text{ psi}\sqrt{\text{in}} = \underline{43.0 \text{ ksi}\sqrt{in}}$$

In addition, there is a K_{It} term for the thermal stress. The additional inputs used to calculate K_{It} are:

$G = 100°F/hr$
$C = 6.59$ inches, including clad thickness
$\beta = 0.354$ ft^2/hr at 550°F (most conservative value)

The absolute value of ΔT for heatup or cooldown can be calculated from:

$$\Delta T = GC^2/2\beta$$

For the values above, $\Delta T = \underline{43°F}$

The corresponding value of M_t is

$$M_t = \underline{0.30}$$

Thus, the thermal stress intensity factor, $K_{It} = M_t * \Delta T$, is calculated to be

$$K_{It} = \underline{12.9 \text{ ksi}\sqrt{in}}$$

$T - RT_{NDT}$:

$$(T - RT_{NDT}) = \ln[((2.0*43.0 + 12.9) - 26.78)/1.223]/0.0145 - 160$$
$$(T - RT_{NDT}) = \underline{121°F}$$

Adding the adjusted RT_{NDT} for 32 EFPY of 72°F:

$$T = 193°F$$

NRC Question C:

Please provide the correct Initial RT_{NDT} temperature shift for Hatch 1 weld 1-313 heat numbers 90099 and 33A277.

GPC Response:

The correct initial RT_{NDT} temperature shifts for the weld 1-313, heat numbers 90099 and 33A277 were provided in the BWRVIP topical report "Bounding assessment of BWR/2-6 Reactor Pressure Vessel Integrity Issues." They are, for heat number 90099, -10°F and for heat number 33A277, -50°F. GPC referenced this report in a November 16, 1995 letter to the NRC.

These initial RT_{NDT} values were provided to you in our response to Generic Letter 88-11, dated November 22, 1988. However, by letter dated June 3, 1994 you requested us to verify that certain information was accurately entered in the Reactor Vessel Integrity database (RVID) for Hatch Units 1 and 2. In that letter, an erroneous value of -10°F was entered for Hatch 1 weld 1-313, heat number 33A277. Unfortunately, we failed to notify you in our subsequent letter of July 1, 1994 that the value was incorrect.

Therefore, as listed in the above referenced BWRVIP report and in our response to GL 88-11, the correct initial RT_{NDT} value for Hatch 1 weld 1-313, heat number 33A277 is -50°F.