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NUCLEAR POWER

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U. S. Nuclear Regulatory Commission
Division of Operating Reactors
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. David M. Verrelli
Operating Reactors Branch 3

Gentlemen:

SUBJECT: TAB STRESS ANALYSIS FOR PEACH BOTTOM III ALTERNATE ABSORBER MATERIAL CONTROL BLADE TEST PROGRAM

Reference: NEDO-24213, "Proposed Peach Bottom Atomic Power Station Unit 3 Alternate Absorber Control Blade Test Program," August 1979

The time required to obtain material performance data in the BWR environment is extremely long. Since the control blade is not designed to be disassembled once it is fabricated, no interim data can be obtained without destructive examination of the control rod. To avoid destructive examination and still obtain some data as soon as possible, the structural design of the control blade has been modified to allow the removal of the edge absorber rod in each wing. The design of the removeable rod feature was required to meet the following criteria:

(a) The design shall maintain structural integrity for all normal and abnormal events anticipated over the design life of the test blade.

(b) The design shall not require major redesign of the existing control blade structural components (minor modification of existing hardware is allowed provided form, fit and function are not impacted).

(c) The design shall be capable of allowing the removal of the absorber rod by remote means under 12 to 20 feet of water.

(d) The design shall have a high probability of allowing successful removal of the absorber rod and provide a mechanism for capturing a replacement rod.

(e) The design shall be easy to fabricate.

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Within the constraints of the above design criteria, the design selected incorporates a tab which allows the removal of the edge absorber tube. The modifications to the control blade required to backfit this design are minimal and do not impact the structural integrity of the existing control blade components. The tab, in its assembled position, maintains the edge absorber rod in position during all phases of operation. The tab allows easy removal of the edge absorber rod which is longer than the other absorber rods so that a sufficient length of rod is available to attach a tool for removal of the rod. Once the absorber rod has been removed, a new rod (slightly shorter in length) will be inserted in the edge rod position and the structure below the tab will be modified to hold the new rod in place.

The design provides that with the reactor at power, there are no loads on the tab, and that during manufacturing the tab is bent and then annealed. Thus, there is no applied or residual stress in the tab. The tab is loaded only during scram and occurs when there is a scram and the buffer in the control rod drive fails to slow the drive before reaching the mechanical limit. Under these conditions, and assuming the control rod structure does not dissipate any of the load, the stress on the tab is .67 (Appendix I) of the ASME, Section III, allowable (the control rod is not a code component, but code limits were used as a conservative approach). The fatigue limits were also calculated. Under the worst case loading the code allows about 700 failed buffer scrams. Forty-five (45) is a conservative estimate of the number of scrams in a three year period that would cover the life of the tab. Therefore, the tab is considered adequate to place in Peach Bottom 3 core for a single cycle of operation.

Very truly yours,

R. O. Brugge, Manager
Services Licensing
Safety and Licensing Operation

ROB:gmm/519-520

cc: L. S. Gifford (GE-Bethesda)

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APPENDIX I

TAB EVALUATION

A. LIMITING CASE

Assumptions:

1. The most limiting event is a failed buffer. A failed buffer scram is only a problem when the reactor is not pressurized. At pressures of 500 lbs/in^2 and higher the failed buffer scram imparts less load than a normal cold scram.

   NOTE: A failed buffer scram is extremely unlikely because: (a) no GE operating reactor has ever had such an event; (b) the design of the Peach Bottom 3 control rod drive requires extensive breakage of the buffer seals to reach a postulated failed buffer condition.

2. The short duration of the tab life (one 18 month fuel cycle), the probability of the event occurring and the short time duration of the event, if it does occur, places this event in the same category as the SSE event. Therefore, the ASME Section III rules for the SSE event may be applied (i.e., stress allowable = 2.4 Sm)

3. Loading of the tab is directly proportional to the loading of the control blade. No credit is taken for friction, hydrodynamic effects, or energy absorption in the materials.

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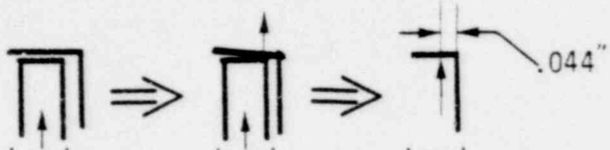
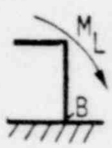
APPENDIX I - continued

ANALYSIS:



Moment = Load x .044" = M_L



MAX. STRESS IS AT POINT "B"

$S_B = \frac{M_L \, y}{I}$ $\quad$ $y = \frac{t}{2}$ $\quad$ $t = .056'' \pm .003$ $\quad$ $t_{min} = .053''$

$M_L = \frac{S_B I}{\frac{t}{2}}$ $\quad$ $I = \frac{t^3 w}{12}$ $\quad$ $w = .200'' \pm .020$

$w_{min} = .180''$

$$M_L = \frac{2S_B \; t^3 w}{12t} = \frac{S_B t^2 w}{6}$$

$S_{B_{Allowable}} = 2.4 \times 30{,}000 = 72{,}000 \text{ lb/in}^2$

$M_{L_{Allowable}} = \frac{72{,}000 \times .053^2 \times .18''}{6} = 6.06 \text{ in.lb.}$

$\text{Load}_{Allowable} = L_A = \frac{M_{L_A}}{.044} = \frac{6.06}{.044''} = \underline{137.7 \text{ lb.}}$

Failed Buffer Load = 10,000 lb. at coupling

Hafnium Rod Wt. $= V_{Hf} \; \rho_{Hf} = \left(\frac{.188'' \pm .002}{2}\right)^2 \pi \times 145.5'' \times .481 \text{ lbm/in}^3$

$= 1.99 \text{ lb}_{max}$ or about $\underline{2 \text{ lb.}}$

Control Rod Wt. = 218 lb. (218 used because 10,000 lbs. is based on 218. Not wt. of test C.R.)

APPENDIX I - continued

ANALYSIS: (continued)

$$\frac{2}{218} \times 10{,}000 = 91.7 \text{ lb.} = \text{Max. Load Applied}$$

$$\frac{\text{Load Applied}}{\text{Load Allowed}} = \frac{91.7}{137.7} = \underline{\underline{.67}}$$

Based on the assumptions listed on Sheet 1, the tab will withstand a failed buffer load.

B. Normal Conditions

The terminal scram velocities under normal conditions are:

Cold: 6 - 8 in/sec

Hot : <6 in/sec

The small amount of energy, about .16 in-lb, will be absorbed within the sheath and the tab will see no load.