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SUBJECT: Forwards responses to remaining questions re HPI nozzle components.Responses provide justification for continued operation of Oconee Unit 1 as result of Unit 2 HPI line leak.

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June 5, 1997

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Justification for Continued Operation of
Oconee Unit 1 as a Result of Oconee Unit 2
HPI Line Leak
Supplemental Information
NRC TAC No. M98454

In a meeting dated May 14, 1997, and per follow-up discussions with the NRC staff, Duke committed to provide the NRC with answers to eleven additional questions regarding HPI nozzle components. In correspondence since May 14, 1997, Duke has responded to all but questions 5 through 11. Please find the response to these remaining questions in Attachment 1.

Please address any questions to D. A. Nix at (864) 885-3634.

Very Truly Yours,

J. W. Hampton

J. W. Hampton
Site Vice President

Attachment

1/1

A001

160055

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Attachment
Response to HPI Nozzle Component Questions

Question 5:

Explain the differences between a radiograph that shows a gap and those that do not show a gap in single and double sleeve radiographs.

Response:

Any gaps appear the same for both types of sleeves. A gap is indicated by a dark line at the interface between the sleeve and the safe end or between the sleeves for Unit 1. This line is due to the low density of air (or water) when compared to the surrounding metal. When no gap is present, the dark line does not appear, indicating continuity of the material at the interface.

Question 6:

Based on the RT results, is there an estimate of how long it will take to form a gap in a single contact thermal sleeve installation and the dual contact thermal sleeve installation? Provide the estimate and the bases.

Response:

Experience has shown that at least several operating cycles have occurred between indication of gaps via radiographs and a failure of the thermal sleeve significant enough to result in cracking of the safe end and associated welds. The 2A1 thermal sleeve developed a significant gap between 1989 and 1996, and the safe end to pipe weld cracked in 1997. The 3A1 thermal sleeve developed a significant gap in 1985 and by 1996 the gap had grown to 100%. Some cracking was noted in the safe end to pipe weld and the base material of the pipe and safe end, however, the cracks were not through wall. To date, we have no indication of cracking or thermal sleeve loosening in dual sleeve installations.

Question 7:

What is the value of the rover video inspection performed in 1991 on Oconee-1 HPI/MU lines in determining whether there was or was not a gap between the thermal sleeve and the safe end?

Response:

The videos completed in 1991 were part of the 10 year ISI of the Reactor Vessel and did not provide the detail necessary to determine thermal sleeve conditions. Therefore, they provide minimal information relative to the thermal sleeve condition. No credit is being taken for the 1991 inspections for the Unit 1 JCO.

Question 8:

Explain the thermal/mechanical benefits of the dual contact thermal sleeve relative to the single thermal sleeve. Why do these benefits prevent a gap forming in the dual contact thermal sleeves while gaps form in the single thermal sleeve? Explain how contact rolling is performed on a single and dual sleeve.

Response:

- The contact expansion of the inner sleeve improves the contact between the outer sleeve and safe end. This prevents cold water from leaking past the rolled joint and contacting the hot nozzle. In addition, the improved contact makes the sleeve stiffer and thus increases its natural frequency. This produces additional margin by increasing the separation between the thermal sleeve natural frequency and the flow induced forcing function frequency.
- The thermal resistance of the two sleeve design is greater than that for the single sleeve design. This reduces thermal stresses in the nozzle. In addition, the temperature differential across the inner sleeve of the two sleeve design will be less than across the single sleeve design resulting in increased life of the inner sleeve.

- The thermal shock imposed on the inner sleeve must fail that sleeve before the outer sleeve would be exposed to this type of thermal load. Thus, the nozzle would be protected longer (by the life of the inner sleeve) by using two sleeves rather than one.
- The double sleeve results in a nominal inside diameter of 1.235 inches compared to the 1.5 inch inside diameter for the single sleeves on Units 2 and 3. The reduced diameter of the double sleeve results in a reduction in the flow area. For the same makeup flow rate, this correlates to a flow velocity in the double sleeve design that is 48% greater than in the single sleeve design. The higher flow velocity would tend to prevent migration of the turbulent mixing zone into the nozzle.
- The inner sleeve has an interlocking flange which contains 4 axial notches in the flanged region. Weld buttons, attached to the safe end, were placed within these notches to provide additional anti-rotation protection. These flanges are not present in the original single sleeve design.

Question 8(b): When were the thermal sleeves in Units 1, 2, and 3 installed and when were they last rolled?

Response: The chart given in the answer to question 4 in the May 22nd submittal, on pages 5 through 7 of Attachment 1, provides a tabulation of the Units 1, 2, and 3 original thermal sleeve installation and subsequent repair/replacement/re-rolling history.

Question 8(c): Explain how rolling is performed on a "hard roll". What criteria were used during contact rolling and hard rolling to ensure there is no gap during installation?

Response

In a hard roll, the thermal sleeve is mechanically expanded to the inside diameter of the safe end until a 5% sleeve wall reduction is achieved. In a contact roll, the thermal sleeve is mechanically expanded until contact is achieved between the outside diameter of the thermal sleeve and the inside diameter of the safe end. There is no documented acceptance criterion for the original contact roll installation. The acceptance criterion for hard rolling the new design thermal sleeves (installed both in 1982 and in 1997) was the measured internal diameter of the sleeve versus the acceptable value. The acceptable value was based on achieving the desired 5% wall reduction. This value was calculated as follows:

New Thermal Sleeve I.D. (after rolling) = [Safe End Bore (rolled area) - Initial Thermal Sleeve O.D.] + Initial Thermal Sleeve I.D. + .024″

The Safe End Bore in the rolled area equals 2.063″
Initial Thermal Sleeve O.D. equals 2.0″
Initial Thermal Sleeve I.D. equals 1.5″

So, the New Thermal Sleeve I.D. = (2.063″ - 2.0″) + 1.5″ + .024″ = 1.587″
Based on this result, the new thickness of the thermal sleeve after rolling would be:

(2.063″ - 1.587″) / 2 = .238″ or 95% of .25″

Question 9:

Based on the current findings relative to gap information, and crack propagation by thermal cycling, explain why inspection may be deferred to 5 cycle intervals?

Response:

Based on the information gathered during this investigation, Oconee believes a five cycle frequency is not appropriate for our units. Oconee is in the process of determining the proper inspection interval and has committed to provide the inspection criteria and frequency thirty days prior to the next Unit 1 Refueling Outage (Unit 1 RFO currently scheduled for September 1997).

Question 10:

LBB-type analyses have normally been used for large diameter piping. In the light of the uncertainty regarding possible cracks of indeterminate size in Oconee Unit 1, provide justification for use of this type of analyses on HPI/MU piping and explain why it is appropriate.

Response:

It is not Oconee's intent to qualify HPI/MU piping using LBB methods. The LBB discussion was provided to show that margin exists between a crack size exhibiting 10 gpm leakage and the critical flaw size. This margin was also shown in the fracture mechanics analysis for the geometry of the Unit 2 cracked pipe which showed that ASME Section XI structural margins existed for normal + Operating Basis Earthquake conditions. See the answers to questions 4(e) & (f) provided in Dukes May 22, 1997, submittal.

Question 11:

Provide the largest fatigue cumulative usage factors (CUF's) for the HPI and the MU/HPI lines. Show the CUF's at the pipe-to-safe end weld.

Response:

See Chart below:

OCONEE UNITS 1, 2, AND 3
CUF'S FOR HPI/MU PIPING AND NOZZLES

UNIT	COMPONENT	CASE	MAX CUF	COMMENTS
1	PIPING	PRE-VALVE CHANGEOUT	N/A	PIPING NOT QUALIFIED TO CLASS 1 RULES.
1	NORMAL MU NOZZLE	PRE-VALVE CHANGEOUT: ORIGINAL FTI NOZZLE LOADS, NO INCLUSION OF THERMOCOUPLE DATA	0.045	

1'	EMERGENCY MU NOZZLE	PRE-VALVE CHANGE OUT: ORIGINAL FTI NOZZLE LOADS, NO INCLUSION OF THERMOCOUPLE DATA	0.74	
2 & 3	PIPING	INTERIM ANALYSIS FOR VALVE CHANGEOUT	0.01	FATIGUE USAGE THROUGH 1999
2 & 3	NORMAL MU NOZZLE	POST VALVE CHANGE OUT; INCLUDES 1989 THERMOCOUPLE STRATIFICATION	N/A	BOUNDED BY EMERGENCY NOZZLE
2 & 3	EMERGENCY MU NOZZLE	POST VALVE CHANGE OUT; INCLUDES 1989 THERMOCOUPLE STRATIFICATION	0.88	

Note: The CUF's shown include all design basis loads, however, they do not include any postulated thermal transients associated with the Unit 2 normal make-up safe end to pipe weld failure.