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A Duke Energy Company

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

Subject: Oconee Nuclear Site
Docket Nos. 50-269, -270, -287
Final Response to NRC Bulletin 88-08

In a letter dated March 10, 1989, Duke Energy Corporation (Duke) submitted the original response to NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to the Reactor Coolant System." On April 21, 1997, Oconee Unit 2 experienced a leak in the 2A1 High Pressure Injection Normal Makeup (HPI/NMU) line. As a follow-up action stemming from the investigation of this leak, Duke committed in a letter to the NRC dated July 28, 1997 to update its response to NRC Bulletin 88-08 by March 1, 1998. The updated response (Supplement 1) was provided on February 26, 1998, in which Duke committed to do the following actions:

1. A computational fluid dynamics (CFD) analysis of the HPI/NMU nozzles on the Reactor Coolant System (RCS) will be performed by Framatome Technologies.

2. Thermal monitoring of the HPI/NMU and HPI Emergency Injection (HPI/EI) lines will continue until 1EOC18 (Spring 1999), 2EOC17 (Fall 1999), and 3EOC18 (Spring 2000).

3. A final supplement to NRC Bulletin 88-08 will be provided after completion of the monitoring effort and related activities.

A Request for Additional Information (RAI) related to Supplement 1 was issued by the staff on February 22, 1999. Duke met with members of the Office of Nuclear Regulation on April 29, 1999 to discuss the RAI and responded to the RAI on July 14, 1999.

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The current status of these commitments is that the CFD analysis was completed as scheduled, monitoring and analysis of thermal data is now complete on all three units, and this letter serves as the final supplement to NRC Bulletin 88-08.

The recent completion of the analysis of the thermal monitoring data revealed no abnormal thermal transients. The data analysis results, along with the CFD analysis, continue to support our conclusions regarding the root cause of the 2A1 HPI weld leak. This root cause is as follows:

> The cause of the weld failure was high cycle thermally induced fatigue. Turbulent penetration of hot RCS fluid up into the thermal sleeve, and cross flow of RCS fluid during uneven RCP operation (1 RCP on in a loop, 1 RCP off in a loop) with leaking boundary check valves, eventually caused the loss of pre-stress in the connection between the thermal sleeve and the nozzle safe end. With the loss of pre-stress, gaps formed in the interface, allowing hot RCS fluid to be drawn through the gaps, intermingling with cold HPI injection fluids. This caused an unstable flow field resulting in high cycle thermal transients centered on the pipe to safe end weld. These high cycle thermal transients caused the initiation of a crack and ultimately drove the crack through wall, resulting in the leak.

As noted in the RAI response dated July 14, 1999, Duke has completed the following measures or initiated programs to reduce or eliminate the thermal phenomena that caused the failure:

- Replacement of the combination RCS/HPI boundary stop/check valves with separate stop and check valves. The check valves are more sensitive to flow changes. This sensitivity is expected to prevent "cross flow."
- Changes in operational procedures to provide maximum warming line flow during plant heat-ups and cool-downs to prevent "cross flow."
- Management of thermal sleeve degradation by periodic non-destructive examinations of the thermal sleeve/safe end interface, and periodic visual examination of the thermal sleeve cantilever end.

With the initiation of these actions and the completion of all analyses associated with the failure, this letter serves as the final response to NRC Bulletin 88-08.

If there are any questions regarding this submittal, please contact R.P. Todd at (864) 885-3418.

Very truly yours

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