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SUBJECT: Informs NRC of error in Oconee Units 1,2 & 3 LBLOCA ECCS analysis.Details of concern are provided in attachment.

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CATEGORY 1 DOCUMENT

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February 4, 1999

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001
Attention: Document Control Desk

Subject: Duke Energy Corporation

Oconee Nuclear Station, Units 1, 2 and 3
Docket Numbers 50-269, 50-270, and 50-287

Report Pursuant to 10CFR50.46, Error in LOCA Analysis

10CFR50.46 requires reporting of changes to or errors in ECCS Evaluation Models (EM) or in the application of such models that affects the temperature calculation. On January 6, 1999 Duke Energy Corporation received a preliminary report of safety concerns from Framatome Technologies, Inc. (FTI). This preliminary report indicated that an error might exist in the Oconee LBLOCA EM. The FTI report provides information regarding reactor coolant pump (RCP) modeling used in previous EM analyses. It was discovered that previous EM analyses might not have used the appropriate RCP type in the LBLOCA analyses.

The FTI preliminary concern has since been confirmed to affected nuclear utilities and also reported to the NRC by FTI letter dated February 4, 1999. Therefore, pursuant to 10CFR50.46(a)(3)(ii), Duke Energy Corporation is hereby reporting this error in the Oconee Units 1, 2, and 3 LBLOCA ECCS analysis. The details of this concern, as applicable to the Oconee units, are provided in the attachment to this letter. The Oconee units continue to be in compliance with the 2200°F peak cladding temperature limit required by 10CFR50.46(b)(1).

Please address any comments or questions regarding this matter to J. S. Warren at (704) 382-4986.

Very truly yours,

M. S. Tuckman

Attachments

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Attachment for Report Pursuant to 10CFR50.46
Error in LOCA Analysis
February 4, 1999

Framatome Technologies Incorporated (FTI) has determined that several B&W 177-FA LL plant large break loss of coolant accident (LBLOCA) analyses were performed with a reactor coolant pump (RCP) two-phase degradation model that did not produce the limiting peak cladding temperatures (PCTs). The LBLOCA analyses with the favorable RCP degradation model were performed in accordance with the RELAP5/MOD2-B&W-based evaluation model (EM) described in BAW-10192P-A. When reanalyzed with the minimum RCP two-phase pump degradation model, the beginning-of-life (BOL) PCTs increased by 55°F to 186°F, inclusive of all penalties and credits for the Mark-B10F fuel licensed in the Oconee Unit 1. The PCTs for Oconee Units 2 & 3 are also impacted, but are less than that for Oconee Unit 1. The PCT increase is most severe near the core inlet, and decreases at the upper core elevations. The maximum PCT of 2150°F for the 4-ft elevation remains below the 2200°F limit required by 10CFR50.46(b)(1). Pursuant to 10CFR50.46 Section (a)(3)(ii), Duke Energy Corporation is notifying the NRC of a significant change in the calculated PCT. No changes to the linear heat rates or core operating limits are required as a result of this reanalysis.

Background

FTI is in the process of developing LOCA input models for the Davis-Besse 177-FA raised loop plant. A RCP modeling question prompted a thorough review of the BAW-10192P-A RCP modeling requirements for LBLOCA. That review identified that some of the LOCA analyses of the 177-FA LL plants may not have been performed in accordance with Section 4.3.4.5 of Volume 1 of BAW-10192P-A. This section states that plant-specific pump performance tables (namely the pump rated parameters and pump homologous curves) should be used as input for the LOCA analyses. Some analyses were not done in accordance with this provision. Because of this deficiency, FTI initiated an RCP-type sensitivity study to show that the worst calculated consequences were not underpredicted.

The RCP-type sensitivity study revealed that a LBLOCA analysis using the Bingham pump homologous curves was less limiting (by roughly 60°F in PCT) than an identical analysis with the pumps replaced with the Westinghouse pump homologous curves. The difference in the homologous relationships on the HVN curve (the

dominant curve for CLPD breaks) was recognized as similar to a change in pump degradation. That is, the Westinghouse pump provided less resistance (appearing to be less degraded) than the Bingham pump. Since FTI was using the maximum RCP two-phase degradation model, it was realized that the PCT could be even higher when the minimum degradation model is used. Preliminary analyses confirmed this finding, and on January 6, 1999, FTI identified this problem to Duke Energy Corporation in a preliminary safety concern (PSC) reported as PSC 1-99. Subsequent to obtaining completed analyses, FTI and the B&W Owners Group identified this problem to the NRC during a February 1, 1999 telecon.

There are two sets of BAW-10192P-A LOCA linear heat rate (LHR) limits supporting current Oconee Nuclear Station operation affected by this concern. Oconee Units 1, 2, & 3 have Mark-B10F and Mark-B9 fuel LHR limits determined using the BAW-10192P-A Evaluation Model. FTI has also completed other LOCA analyses for future reference in core reload or FSAR applications that have non-conservative PCTs because of the RCP modeling. Those analyses must be replaced by cases with the correct RCP inputs. Some analyses will likely incur either a PCT increase or a LHR limit decrease, or both. When the revised analyses are completed, FTI will notify the affected plants and utilities of the corrected PCTs and LHR limits.

RCP Type and Degradation Sensitivity Studies

After identifying the PSC, FTI immediately began reanalysis efforts on the BOL Oconee Mark-B10F analyses. The first step was to quantify the worst pump two-phase degradation model. The two-phase head difference curves (single phase minus fully degraded two-phase curves) from the CRAFT2 Aerojet Nuclear Corporation fit to the Semiscale pump used in all 177-FA LL analyses to date, were replaced with the less resistive two-phase difference curves given in RELAP5/MOD2-B&W (BAW-10164PA Rev.3) for that same pump. This switch produced an estimated PCT increase of 70°F for the core midplane peak. Next, the void fraction dependent multiplier on the head difference curves was switched from the M1 maximum degradation curve to the M3 minimum degradation curve. This degradation change increased the PCT by an additional 30°F. The total increase from the head difference and void multiplier change for the Bingham pump is estimated at 100°F. This increase, when added to the existing Oconee 6-ft PCT of 1978°F, would push the temperature up to 2078°F (possibly higher due to the exponential metal-water reaction increase with temperature). Oconee Units 2 and 3 have Bingham pumps, but

Oconee Unit 1 has Westinghouse pumps. The PCT increase for Oconee Unit 1 must consider an additional 60°F due to the pump type. This implies that the Oconee Unit 1 PCT could increase to approximately 2140°F or higher when the metal-water reaction energy addition is considered.

The calculated changes in the PCT are related to lower negative core velocities and higher void fractions during the middle blowdown period. The RCP changes reduced the liquid inventory in the reactor vessel upper plenum region at the time of core flow reversal. With less liquid entering the top of the core, the boiling and flashing is reduced. This liquid deficit decreases the region of the core that has two-phase conditions, plus it reduces the steam velocities that are critical for core heat transfer in the lower portion of the core. This effect makes the PCT change elevation-dependent.

LOCA Reanalyses and PCT Rack Ups with Limiting RCP Inputs

Because of the estimated PCT increase, the BOL Mark-B10F fuel was reanalyzed with the new pump parameters. A slight conservatism was found in the rounding up of the TACO3 best-estimate fuel temperature uncertainty. The fuel temperature was increased by 12.0 percent, which is higher than the 11.51 percent required. When this conservatism removal was included in the reanalysis of Oconee Unit 1 with the worst pump type (Westinghouse) and pump degradation (RELAP5 Semiscale head difference with the M1 multiplier), the maximum PCT was calculated to be 2150°F. This overall temperature increase of +186°F was calculated for the BOL 4.264-ft axial peak for the Mark-B10F fuel. The 2.506-ft PCT was 2135°F (up by +135°F), and the 6.021-ft PCT was 2104°F (up by +126°F). The 9.536-ft PCT increased by 55°F to 2079°F. The 7.779-ft BOL case was not reanalyzed because the PCT increase should be bounded by the 6- and 10-ft cases. A PCT increase of 91°F was determined by linear interpolation between these two cases, yielding a PCT of 2082°F. The PCTs for Oconee Units 2 & 3 are less than that for Oconee Unit 1 by roughly 60°F because those two units have Bingham pumps.

Conclusions

FTI has identified significant PCT increases associated with both RCP type and pump two-phase degradation models used in current Oconee Nuclear Station RELAP5 based LOCA LHR licensing analyses. FTI reanalyzed the LHR limits expected to have the most significant PCT increase (BOL Mark-B10F fuel) and found

that the PCT could increase by 186°F, but the maximum PCT for this case was 2150°F. The PCT increases for all other LHR limits are expected to be bounded by this result. This maximum PCT value remains below the 2200°F limit required by 10CFR50.46 (b)(1). No changes to the linear heat rates or core operating limits are required as a result of this reanalysis.

FTI used PCT rack ups to show that the PCTs for all other LHR limits are less limiting. Because the PCT increases are significant, FTI has indicated that they will reanalyze a variety of additional LOCA LHR limit cases over the next several months to confirm that the rack ups are appropriate. The NRC will be notified should any of the calculated results exceed the 10CFR50.46 acceptance criteria.

FTI has indicated that the concern documented in PSC 1-99 does not affect the results of the break spectrum or break location sensitivity studies. FTI has also indicated that this concern will not significantly impact the small break LOCA PCT.