February 5, 2004

Mr. Ronald A. Jones
Vice President, Oconee Site
Duke Energy Corporation
7800 Rochester Highway
Seneca, SC 29672

SUBJECT: OCONEE NUCLEAR STATION, UNIT 2 RE: ISSUANCE OF AMENDMENTS (TAC NO. MC1174)

Dear Mr. Jones:

The Nuclear Regulatory Commission has issued the enclosed Amendment No. 338 to Renewed Facility Operating License DPR-47 for the Oconee Nuclear Station, Unit 2. The amendment consists of changes to the Updated Final Safety Analysis Report (UFSAR) in response to your application dated October 28, 2003.

The amendment revises the licensing basis in the UFSAR to support installation of a passive low-pressure injection (LPI) cross connect inside containment. The changes to the UFSAR revise the licensing basis for selected portions of the core flood and LPI/Decay Heat Removal piping to allow exclusion of the dynamic effects associated with postulated pipe rupture of that piping by application of leak-before-break technology. A similar revision to the licensing basis for Unit 1 was approved by Amendment No. 335, issued September 29, 2003.

A copy of the related Safety Evaluation is also enclosed. A Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA/

Leonard N. Olshan, Senior Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-270

Enclosures:
1. Amendment No. 338 to DPR-47
2. Safety Evaluation

cc w/encls: See next page

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DUKE ENERGY CORPORATION

DOCKET NO. 50-270

OCONEE NUCLEAR STATION, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 338
Renewed License No. DPR-47

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment to the Oconee Nuclear Station, Unit 2 (the facility) Renewed Facility Operating License No. DPR-47 filed by the Duke Energy Corporation (the licensee) dated October 28, 2003, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, changes to the Oconee Unit 2 Updated Final Safety Analysis Report (UFSAR) to revise the licensing basis for selected portions of the core flood and LPI/Decay Heat Removal piping to allow exclusion of the dynamic effects associated with postulated pipe rupture of that piping by application of leak-before-break technology, as set forth in the application for amendment dated October 28, 2003.

3. This license amendment is effective as of its date of issuance and shall be implemented during the Spring 2004 refueling outage.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

John A. Nakoski, Chief, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: February 5, 2004

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO

AMENDMENT NO. 338 TO RENEWED FACILITY OPERATING LICENSE DPR-47

DUKE ENERGY CORPORATION

OCONEE NUCLEAR STATION, UNIT 2

DOCKET NO. 50-270

1.0 INTRODUCTION

By letter dated October 28, 2003, Duke Energy Corporation (the licensee) submitted a request for changes to the licensing basis in the Oconee Nuclear Station, Unit 2 (Oconee 2) Updated Final Safety Analysis Report (UFSAR). These changes would support installation of a passive low-pressure injection (LPI) cross connect inside containment. The changes would revise the licensing basis for selected portions of the core flood (CF) and LPI/Decay Heat Removal (DHR) piping to allow the exclusion of the dynamic effects associated with a postulated rupture of that piping by application of leak-before-break (LBB) technology.

By letter dated September 29, 2003, the NRC staff issued Amendments 335, 335, and 336 for Oconee Nuclear Station, Units 1, 2, and 3, to support the installation of a passive LPI cross connect inside containment. These amendments approved for all three units (1) the use of Standard Review Plan Section 3.6.2 Branch Technical Position MEB 3-1, (2) the leakage detection capability, (3) the reanalysis of the loss-of-coolant accident, and (4) the changes to the Technical Specifications. These amendments approved the revisions to the UFSAR for the use of LBB technology only for Oconee, Unit 1. The following Safety Evaluation (SE) approves for Oconee 2 revisions to the UFSAR for the use of LBB technology; it is similar to the SE issued September 29, 2003, for Oconee, Unit 1.

2.0 REGULATORY EVALUATION

Requirements regarding exclusion of the dynamic effects of pipe rupture from the licensing basis of a nuclear power plant are addressed in Title 10 of the *Code of Federal Regulations* Part 50, Appendix A, General Design Criteria (GDC) 4:

> Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from

> events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

The licensee's submittal contains the LBB analysis mentioned in GDC 4 to support the exclusion of the dynamic effects of pipe rupture from the Oconee 2 licensing basis for segments of the CF and LPI/DHR piping system. The NRC staff used draft Standard Review Plan (SRP) 3.6.3, "Leak-Before-Break Evaluation Procedures," (August 28, 1987), and NUREG-1061, Volume 3, "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee, Evaluation of Potential for Pipe Breaks," (November 1984) to conduct the LBB review. LBB evaluations also rely in part on the capability of a facility's reactor coolant system (RCS) leakage detection system. NRC Regulatory Guide (RG) 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," (1973), provides NRC staff guidance on the design and evaluation of RCS leakage detection systems.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Evaluation

This section of the SE describes: (1) the scope (i.e., piping segments evaluated) of the licensee's LBB evaluations, (2) the analysis methodology used by the licensee in its LBB evaluation, and (3) the results of the licensee's analysis and its conclusions regarding the application of LBB to the subject piping segments.

3.1.1 Scope of the Licensee's LBB Evaluation

In the submittal, the licensee clearly defined the scope of the high energy piping within the Oconee 2 CF and LPI/DHR piping system for which it sought to apply LBB. The piping includes a 14-inch CF line connecting the CF tank with the reactor pressure vessel (RPV) and two 10-inch LPI/DHR lines that connect two new check valves, 2LP-176 and 2LP-177, to two 90-degree tee-fittings of the CF line. The other side of the check valves is moderate energy piping that is connected to the added passive LPI cross connect and is not pressurized under normal operations. Consequently, the added passive LPI cross connect piping and the moderate energy piping that separate the cross connect from the proposed high energy LBB piping are outside the scope of LBB application. Further, the Alloy 82/182 weld between the RPV CF nozzle and the safe-end, which is at an operating temperature of 557 °F, is excluded from the LBB application due to the concern of primary water stress corrosion cracking (PWSCC). However, the Alloy 82/182 welds at the two CF tanks are included, since PWSCC is of no concern at these locations due to the low operating temperature of 125 °F.

The 14-inch CF line was constructed from wrought austenitic A-358, Type 304 (schedule 30), A-376, Type 304 (schedule 140), and A-376, Type 316 (schedule 140) stainless steel. The corresponding wall thicknesses for the piping are 0.375 inch, 1.25-inch, and 1.25-inch. The 10-inch LPI/DHR line was constructed from wrought austenitic A-376, Type 304 (schedule 140), and the corresponding wall thicknesses for the piping is 1.0-inch. The piping welds were fabricated using a gas tungsten arc welding (GTAW) process and a shielded metal arc welding (SMAW) process. No cast austenitic stainless steel (CASS) was used to construct the analyzed piping segments. However, Inconel Alloy 82/182 material was used in the fabrication of piping welds at both CF tanks, which is at a low operating temperature of 125 °F. These welds are included in the analyzed piping segments.

3.1.2 Licensee's LBB Evaluation Methodology

The licensee's LBB evaluation methodology is summarized in the report prepared by Framatome Advance Nuclear Power (Framatome) entitled, "Evaluation of the Core Flood and Low Pressure Injection/Decay Heat Removal Piping Systems for Oconee Unit 2" (Framatome report). The following description briefly addresses general aspects of the licensee's methodology which are consistent with draft SRP 3.6.3 and NUREG-1061, Volume 3. Specific aspects of the licensee's methodology, which are not specified in draft SRP 3.6.3 and NUREG-1061, Volume 3, are discussed in additional detail.

Consistent with the guidance provided in draft SRP 3.6.3 and NUREG-1061, Volume 3, the licensee first established that no active degradation mechanisms (flow accelerated corrosion, stress corrosion cracking, fatigue) were expected in the subject piping segments. Further, the licensee established that no unanalyzable loading events (water hammer) would be expected to occur in the subject piping segments. The evaluation of these topics was provided in Section 2.2 of the Framatome report.

Next, the licensee established material property parameters, operating conditions, and piping moments and membrane stresses for use in its LBB analyses. The material property parameters used in the licensee's analysis were given in Section 3.3 of the Framatome report, where both the tensile and fracture toughness (J-R) properties of the base metals and GTAW and SMAW welds were addressed. Based on consideration of the highest stress locations coincident with the worst material properties, the licensee identified two locations for LBB analysis: the CF piping adjacent to the CF tank nozzle and the RPV CF nozzle safe end to the CF piping. Materials applicable to these locations are Type 304 stainless steel and GTAW welds for the CF piping adjacent to the CF tank nozzle and Type 316 stainless steel and SMAW welds for the RPV CF nozzle safe end to the CF piping. The tensile and J-R properties for materials at these critical locations were from the experimental work documented in the Electric Power Research Institute (EPRI) Report NP-4768, "Toughness of Austenitic Stainless Steel Pipe Welds." These properties are summarized in the Framatome report in Tables 3-5 and 3-6, with corresponding J-R curves shown in Figures 3-2 to 3-6.

The LBB analysis consists of a leakage flaw size calculation using loading associated with normal operating conditions and a critical flaw size calculation using loading associated with faulted conditions. The pipe loading associated with normal operating conditions are axial forces and moments due to pressure, dead weight, and thermal expansion; and the pipe loading associated with faulted conditions are axial forces and moments of normal operating conditions in conjunction with safe shutdown earthquake and seismic anchor motion loads. In the licensee's critical flaw size calculation, the absolute sum method was used to add the individual axial forces and moments into the combined axial forces and moments.

Based on the material property, operating condition, and loading information noted above, the licensee implemented its LBB evaluation. This process first required determination of the leakage flaw size (i.e., the length of a through-wall circumferential flaw at the two critical locations in the analyzed piping segments that would generate a leakage rate of 10 gallons per minute (gpm), 10 times the leakage detection capability of 1 gpm at Oconee 2). This determination was based on the normal operating moments and stresses and the crack morphology parameters (surface roughness and number of turns) associated with fatigue type of cracks. The licensee then determined the critical flaw sizes for the critical locations that would be predicted to lead to piping failure under the faulted loading conditions. These critical flaw size calculations were performed using elastic-plastic fracture mechanics (EPFM) technique. The last step in the licensee's evaluation process was the calculation of ratios (margins) between the critical flaw size and the leakage flaw size for the two critical locations. This relationship between the critical flaw size and leakage flaw size results from the guidance in draft SRP 3.6.3 and NUREG-1061, Volume 3, that specifies that a margin of two should be maintained for an acceptable LBB evaluation. A similar process was repeated for assumed axial flaws.

The licensee addressed several additional concerns regarding the impact of recent generic material information on the licensee's EPFM results and the assessment of a stress corrosion cracking (SCC) type of degradation on LBB due to the implication of the V. C. Summer PWSCC event. These concerns are (a) the variability of strain hardening parameters, (b) the thermal aging of stainless steel weld materials, (c) the exclusion of fatigue crack growth analysis, (d) the validity of the J-estimation scheme, and (e) the assessment of the implication of PWSCC by performing a sensitivity study using the crack morphology parameters characteristic of transgranular SCC.

The licensee addressed the issue of variability of strain hardening parameters by performing a sensitivity study using a wide range of strain hardening parameters (the Ramberg-Osgood parameters) in the LBB analysis to determine the effects. The results indicate that the variability of strain hardening parameters has only minor effect on the flaw-size margins. Nevertheless, the licensee revised its results using the Ramberg-Osgood parameters that produce the most conservative results. The licensee addressed the issue of thermal aging of stainless steel weld materials by using the lower-bound, unaged J-R curve for SMAW, submerged arc welds (SAW), and GTAW welds from NUREG/CR-6428, "Effects of Thermal Aging on Fracture Toughness and Charpy-Impact Strength of Stainless Steel Pipe Welds," in its revised analysis, and it also showed a minor impact. The licensee addressed the exclusion of fatigue crack growth analysis by conducting a review of the detailed stress analysis to determine the effects of the transients at the critical location close to RPV. The stress analysis showed that this location experiences negligible pressure and thermal transient stresses due to the only significant transient, the check valve test transients (240 cooldown cycles). Therefore, an explicit fatigue crack growth analysis is not necessary. The licensee addressed the issue of the validity of the J-estimation scheme by performing a comparative study using the original General Electric (GE)/EPRI J-integral estimation scheme in the flaw stability analysis. The results indicate that using the original GE/EPRI J-integral estimation scheme moderately decreases the flaw-size margins. Finally, the licensee addressed the implication of PWSCC by performing a sensitivity study using a wide range of crack morphology parameters characteristic of transgranular SCC based on information in NUREG/CR-6443, "Deterministic and Probabilistic Evaluations for Uncertainty in Pipe Fracture Parameters in Leak-Before-Break and In-Service Flaw Evaluations." In the analysis, the licensee maintained a margin of ten for the leakage estimation and studied the reduction of flaw size margins for the assumed cases where crack morphology parameters characteristic of transgranular SCC were used.

3.1.3 Results/Conclusions from the Licensee's LBB Analysis

For circumferential flaws, the results of the licensee's LBB analysis for all critical locations in the 14-inch CF line and the two 10-inch LPI/DHR lines indicate that using the unaged lower-bound J-R curve for welds from NUREG/CR-6428 reduced the flaw-size margin for SMAW welds from 2.8 to 2.7, and using the original GE/EPRI J-integral estimation scheme in the flaw stability analysis further reduced the flaw-size margin from 2.7 to 2.4. Given the way in which the licensee's analysis was conducted (as noted in Section 3.1.2 of this SE), an acceptable LBB analysis result would be achieved if, for each critical location, the flaw size margin is greater than two. The flaw size margins listed in Table 7-1 of the Framatome report indicate that the flaw size margin is greater than two for all materials at the two critical locations. The corresponding results of the licensee's LBB analysis for axial flaws are listed in Table 7-2 of the Framatome report.

The licensee presented the results of its leakage rate sensitivity study. For the sensitivity analysis, the licensee focused on the limiting SMAW weld. As noted in Section 3.1.2 above, the licensee developed a number of cases using different combinations of flaw morphology parameters consistent with both intergranular and transgranular SCC and determined the flaw size margins for them. In this study, the margins for the leakage rate calculations were kept at ten for all cases. Based on the range of flaw morphology parameters, the licensee concluded that by maintaining this factor of ten for the leakage rate as required by the draft SRP 3.6.3 and NUREG-1061, Volume 3, there is still flaw size margin left for all cases.

3.2 NRC Staff Evaluation

3.2.1 Scope of the Licensee's LBB Evaluation

The NRC staff reviewed the scope of the licensee's LBB evaluation and concluded that the licensee adequately defined the analyzable segments of the piping system (as given in Section 3.1.1 of this SE) for which LBB approval was sought. The licensee addressed the effects of PWSCC in three different ways depending on the degree of involvement of PWSCC. For Alloy 82/182 weld between the RPV CF nozzle and the safe end, which sees an operating temperature of 557 °F, the licensee excluded the weld from the LBB application. For Alloy 82/182 welds at the two CF tanks, which sees an operating temperature of 125 °F, the licensee determined that the effects of PWSCC are insignificant. For any implication of PWSCC to other welds, the licensee performed a sensitivity study to address the reduced flaw size margin. The NRC staff considers the exclusion of Alloy 82/182 weld under direct influence of PWSCC a key step in making the proposed lines acceptable candidates for LBB approval at this time. The NRC staff also agrees with the licensee that inclusion of Alloy 82/182 welds at the two CF tanks in the LBB application poses no concern because PWSCC is inactive at the operating temperature of 125 °F. This conclusion is based on the test data reported in EPRI report, "Crack growth of Alloy 182 Weld Metal in PWR Environments (PWRMRP-21)."

Since no CASS piping, elbows, or safe ends were present in the subject piping segments for LBB application, the NRC staff agrees with the licensee's conclusion that the selected materials being analyzed at the critical locations would be limiting. In addition, the NRC staff reviewed the tensile and fracture toughness material property parameters provided in the licensee's analysis for aged SMAW welds. The NRC staff concludes that the material property parameters used by the licensee were consistent with those used by the NRC staff for independent analyses in other recent LBB applications.

3.2.2 Licensee's LBB Evaluation Methodology

The NRC staff has reviewed the licensee's LBB evaluation methodology summarized in the Framatome report and has determined that the licensee's LBB methodology is in accordance with draft SRP 3.6.3 and NUREG-1061, Volume 3. The qualitative evaluation of potential degradation mechanisms (corrosion, water hammer, thermal stratification, erosion, and creep) is consistent with plant-specific and industry service data and is acceptable to the NRC staff. The leakage flaw size and the critical flaw size calculations are based on (a) EPFM, which reflects the fracture phenomenon of the ductile materials for the piping, (b) loadings with adequate summation method, and (c) a factor of ten for the leakage estimation and two for the flaw-size margin. Therefore, the NRC staff considers the leakage flaw size and critical size calculations appropriate.

The NRC staff has also reviewed the licensee's discussion regarding recent generic material information related to the EPFM analysis and the potential for SCC type of degradation. The tensile and J-R properties for materials at the critical locations are from the experimental work documented in EPRI Report NP-4768. Due to the lack of actual plant-specific test data for these materials, the NRC staff considers the use of the EPRI material properties in the licensee's LBB analysis to be appropriate only if the resulting flaw size margins are large enough to account for uncertainties in these properties. The licensee performed a sensitivity study using a wide range of Ramberg-Osgood parameters in its LBB analysis, and the results indicate that the variability of Ramberg-Osgood parameters has only minor effect on the flaw size margins. Based on these results, the NRC staff determined that the use of generic tensile properties is appropriate. For the J-R curve, the NRC staff has been using the lower-bound, unaged curve for SMAW, SAW, and GTAW welds from NUREG/CR-6428 as a proper reference toughness property in recent LBB applications. The licensee's revised LBB analysis using this J-R curve showed that the flaw size margin for the limiting SMAW weld only decreased from 2.8 to 2.7, which indicates that the J-R curve used in the licensee's LBB analysis for the SMAW weld was close to the lower-bound, unaged curve that is acceptable to the NRC staff. Further, the qualitative argument for excluding the fatigue crack growth analysis from the LBB evaluation is based on a review of the piping stress analysis considering the most probable transients. The NRC staff accepts this approach because the licensee's review indicates that the stresses at the critical locations are too low to justify a need for a quantitative fatigue crack growth analysis. The revised flaw size margin using the original GE/EPRI J-integral estimation scheme as suggested by the NRC staff is also acceptable because the margin meets the draft SRP requirement of two. Finally, the NRC staff's concern with the sensitivity study using crack morphology parameters characteristic of transgranular SCC was fully addressed by the licensee based on information in NUREG/CR-6443, and the results indicate that although the LBB margins of draft SRP 3.6.3 can not be maintained, a margin of ten for leakage estimation and a flaw size margin of at least 1.25 exist for all cases being studied.

3.2.3 Licensee's Results/Conclusions

The NRC staff confirms the licensee's conclusion that the subject piping segments can be shown to exhibit LBB behavior consistent with the guidance in draft SRP 3.6.3 and

NUREG -1061, Volume 3. This conclusion is based on the licensee's flaw size margins, which are greater than two; a margin of ten between the estimated leakage rate and the detected leakage rate; and the sensitivity of the licensee's RCS leakage detection system. Based upon this information, the NRC staff concludes that LBB behavior has been demonstrated for the subject piping segments.

The NRC staff also evaluated the information provided by the licensee regarding the sensitivity of its LBB analysis to changing flaw morphology parameters. The changes in leakage identified in the licensee's analysis when going from a fatigue flaw morphology to a SCC flaw morphology were consistent with NRC staff expectations. The NRC staff concludes that, although the licensee's analysis did not demonstrate that the standard flaw size margin of two would be met if a SCC-type flaw were assumed, the licensee's analysis did confirm that the factor of ten is maintained for the estimated leakage rate while a lesser flaw size margin is also maintained for the ratio of the critical flaw size to the leakage flaw size.

Considering the types of material from which the subject piping segments were constructed and their operating environment, no operating experience exists that would indicate the presence of active SCC mechanisms in these piping segments. Based on this experience, the NRC staff concludes that there is a lower likelihood of SCC in these piping segments when compared to traditional fatigue or corrosion-fatigue cracking mechanisms, such that the NRC staff can accept that the lesser flaw size margins demonstrated by the licensee's analysis are sufficient to confirm that LBB approval may still be granted on the segments of the piping system for which it was requested.

The NRC staff concludes that LBB behavior has been demonstrated for the segments of the Oconee 2 CF and LPI/DHR piping system defined in Section 3.1.1 of this SE. Therefore, consistent with 10 CFR Part 50, Appendix A, GDC 4, the licensee shall be permitted to exclude consideration of the dynamic effects associated with the postulated rupture of the analyzed segments of the subject piping system from the Oconee 2 design and licensing basis.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the South Carolina State official was notified of the proposed issuance of the amendments. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change requirements with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (68 FR 68661). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: L. Olshan

Date: February 5, 2004

Oconee Nuclear Station

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