



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO.308 TO FACILITY OPERATING LICENSE DPR-38
AMENDMENT NO. 308 TO FACILITY OPERATING LICENSE DPR-47
AND AMENDMENT NO. 308 TO FACILITY OPERATING LICENSE DPR-55

DUKE ENERGY CORPORATION

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3

DOCKET NOS. 50-269, 50-270, AND 50-287

1.0 INTRODUCTION

By letter dated November 16, 1999, Duke Energy Corporation (the licensee) requested that the NRC exercise discretion not to enforce compliance with the actions required in Technical Specification (TS) 5.5.10, Section e.6 for the Oconee Nuclear Station, Units 1 and 3 (Unit 2 was shut down for a scheduled refueling outage at the time). TS 5.5.10 requires that steam generator tubes that exceed the repair limit shall be repaired by sleeving or rerolling or removed from service. The November 16, 1999, letter documented information previously discussed with the NRC in a telephone conversation on November 15, 1999. During the telephone conversation, the licensee stated that it had determined that a number of steam generator tube indications were not appropriately dispositioned. These indications had not been previously repaired as a result of an interpretation that indications located between the end of the steam generator tube ends and the outer, primary side of the steam generator tube sheet clad were outside the pressure boundary. As a consequence, the licensee did not either repair apparent defects during the prior refueling outages for Units 1 and 3 or submit a license amendment request to resolve the issue. The licensee stated that since Oconee Units 1 and 3 are not in compliance with TS 5.5.10, the units are required to be shutdown. The licensee requested that a Notice of Enforcement Discretion (NOED) be issued pursuant to the NRC's policy regarding exercise of discretion for an operating facility, set out in Section VII.c. of the "General Statement of Policy and Procedures for NRC Enforcement Actions" (Enforcement Policy), NUREG-1600, and be effective for the period until the license amendment request to be submitted on November 17, 1999, is approved by the staff.

By letter dated November 17, 1999, the staff documented its November 15, 1999, verbal approval of the licensee's request. In its November 17, 1999, letter, the staff stated that the enforcement discretion is for the period from 5:05 p.m. on November 15, 1999, until issuance of the license amendments that will address the issue. By letter dated November 17, 1999, the licensee submitted the license amendment request for Oconee Units 1, 2, and 3. The proposed change to TS 5.5.10, Section e.6 would modify the definition of repair limit by adding a provision to exclude certain steam generator tube defect indications.

2.0 BACKGROUND

In early May 1998, operating experience data based on events at another facility was received by the licensee. This information indicated that previous eddy current indications which were then classified as tube end anomalies (TEAs) had exhibited primary-to-secondary leakage at that facility, thus indicating they were within the pressure boundary. As a consequence, the licensee redefined TEAs and developed an analysis methodology and guidelines capable of distinguishing anomalies having indications extending below the outer surface of the upper tube sheet clad. These crack-like indications located between the primary face of the tube sheet clad and the tube sheet clad to carbon steel interface are now referred to as tube end cracks (TECs). These types of indications were identified in NRC Information Notice 98-27, "Steam Generator Tube End Cracking," dated July 24, 1998.

During the spring 1998 Oconee Unit 2 refueling outage, approximately 250 tubes with TEC indications were rerolled. Based on re-analysis of eddy current data, some TEA indications were confirmed to extend below the primary surface of the tube sheet clad and were in service at Oconee Units 1 and 3. These indications were re-classified as TEC indications for Oconee Units 1 and 3. In 1998, the licensee requested and the NRC staff approved a NOED and subsequent TS amendment to allow Oconee Units 1 and 3 to operate the remainder of their fuel cycles with TEC indications in service. The staff approved these requests based on a commitment that the TEC indications would be repaired or plugged during the next outage of sufficient duration (in its November 16, 1999, letter, the licensee stated that all known TEC indications at Oconee Units 1 and 3 have since been repaired).

After discussions with the NRC staff regarding its redefined analysis methodology and guidelines for indications extending below the outer surface of the upper tube sheet clad, the licensee incorrectly concluded that indications above the outer surface of the upper tube sheet clad (the licensee now refers to these indications as tube end anomalies - TEAs) were not part of the pressure boundary and could, therefore, be excluded from the TS inspection requirements. On September 7, 1999, the licensee submitted a letter to the staff that explained this interpretation.

On November 10, 1999, in a telephone conversation with the NRC staff, the staff suggested that the above position may be contrary to the requirements of the TS. Based on the definitions of repair and tube inspection in Oconee TS 5.5.10, the TS requires repair for defects in the tubing in the region of the tube end weld. Therefore, the staff indicated that the 40 percent repair criteria was applicable to the indications above the outer surface of the upper tube sheet clad such that operation with these indications was contrary to the TS. On November 15, 1999, as previously mentioned, the licensee determined that Oconee Units 1 and 3 were not in compliance with TS 5.5.10 and requested that the NRC exercise discretion not to enforce compliance with the actions required in TS 5.5.10 for Oconee Nuclear Station, Units 1 and 3.

3.0 EVALUATION

In its letter dated November 16, 1999, the licensee stated that the request for enforcement discretion, if granted, would have the effect of permitting continued operation of Oconee Units 1 and 3 without having to repair steam generator tubes with TEAs. The license amendment request would make this change permanent for all three units by modifying the definition of repair limit to add a provision to exclude certain steam generator tube defect indications.

Specifically, the definition of repair limit would state that axial tube imperfections of any depth observed between the primary side surface of the tube sheet clad and the end of the tube are excluded from this repair limit. The following is the staff's review of the licensee's safety evaluation.

3.1 Characteristics of Tube End Cracking and Tube End Anomalies

Based on the licensee's review of the eddy current data for tubes with TEC indications, the indications are typically characterized as crack-like and axially oriented. Circumferential indications have also been identified as well as a small number of volumetric indications. Multiple axial indications and combinations of axial and circumferential indications have also been identified. Based on this data, the licensee believes the TECs initiate on the inside surface of the steam generator tube. They are typically short, axially oriented, and located in the rolled portion of the tube near the heat affected zone created by the tube-to-tube sheet weld. While no laboratory examination data on TECs is available, these indications have been verified as through wall cracks based on bubble tests performed at other B&W plants. The rolling process and weld create residual stress that may make the material more susceptible to Primary Stress Corrosion Cracking (PWSCC). For this reason, it is believed that the TECs are PWSCC initiated.

Tube end anomalies (TEAs) are axial inner diameter indications located between the tube end and the primary face of the tube sheet clad. The rolling process and weld create residual stress that may make the material more susceptible to PWSCC. For this reason, it is believed that the TEAs are also PWSCC initiated. The licensee stated that the Oconee steam generators have been bubble tested during the last five refueling outages (for a total of ten tests) and leakage has not been identified from any TEA indication.

3.2 Safety Impact of Tube End Anomalies Indications

In its letters dated November 16 and 17, 1999, the licensee stated that the TEA indications are not predicted to contribute to primary-to-secondary leakage since the welds will remain functional and the TEAs do not extend into the clad. Therefore, until TEAs grow beyond the primary tube sheet face, a direct path from the primary side to the secondary side does not exist. The primary safety concern for primary-to-secondary leakage is during an accident condition. The axial loads and increased pressure differential during a postulated accident condition have the potential to increase the primary-to-secondary leakage, compared to the normal operating conditions. This can only occur if the TEAs that are left in service extend beyond the primary surface of the tube sheet clad.

The licensee reviewed more than 2500 TEAs in the three Oconee units for growth beyond the primary face of the tube sheet clad. The licensee stated that no TEA has been identified that grew into the cladding region of the tube sheet during one cycle of operation. Side-by-side comparisons of TEAs in successive outages indicate no apparent growth in length. Therefore, the licensee concluded that growth into the clad and completely through wall is not expected.

The licensee reviewed BAW-2346P, Rev. 0, "Alternate Repair Criteria for Tube End Cracking in the Tube-to-Tubesheet Roll Joint of Once Through Steam Generators," for comparable growth studies for TECs. If the TEAs are assumed to be due to PWSCC with the stress component being generated by the seal weld process, the licensee stated that it is reasonable to assume

that the growth rate of a TEA would be similar to that of a TEC. The growth rate indicated in the report is 0.0135 inches per 1.37 effective full power years (EFPY) in one steam generator and 0.0 growth in another steam generator. The licensee stated that the data is from another Babcock and Wilcox plant with a similar operating history. Since the apparent growth rate is small (on the order of 0.01 inches per EFPY based on the data presented) and no leakage has been observed during nitrogen pressure testing, the leakage from a TEA at main steam line break (MSLB) conditions is expected to be small even if some growth into the cladding is observed. To verify this conclusion, the licensee took the available information and used the Tubeworks computer code to assess TEAs for MSLB leakage.

The licensee stated that the leak rate calculations used in the Tubeworks Code are based on the EPRI leak rate equations, which are based on standard fracture mechanics calculations of crack opening areas. The leak rate equations that describe flow as a function of crack opening areas and crack lengths are used for both axial and circumferential cracks. The calculated leak rates are conservative since cracks are treated as occurring in the free span and the leakage restriction effect of the tube sheet roll is not modeled in the calculations. The presence of the tube sheet roll will decrease the actual leak rate through a flaw.

For comparison purposes, the licensee calculated the leak rate through a 0.5-inch-long crack using the EPRI methodologies and compared it to the leak test data in BAW-2346P, Rev. 0. Using the tolerance limit material properties at normal operating temperatures, the calculated leak rate for a 0.5-inch free span crack at 2640 pounds per square inch (psi) is 17 gallons per minute (gpm). In comparison, the maximum observed leakage through a 0.5 inch simulated tube sheet flaw was 0.00753 gpm, as reported in BAW-2346P, Rev. 0.

The licensee also calculated the leakage through flaws assuming a 0.0135-inch growth rate, that the TEAs are 100 percent through wall, and no leakage reduction due to the tube-to-tube sheet roll. The results of this calculation show an MSLB leak rate of 0.17 gpm for 10,000 indications 0.0135 inches long. Due to the reduction in leakage due to the tube sheet roll and considering the fact that no TEAs have exhibited growth into the clad, the licensee stated that the leakage from TEAs is expected to be zero during MSLB conditions.

The staff has not reviewed the Tubeworks computer code, but the results are believed to be conservative for application to TEAs based on the fact that the licensee assumed no leakage reduction for the tube-to-tube sheet roll. This assumption of no leakage reduction also serves to minimize the significance of growth rate uncertainties. Therefore, the staff finds the licensee's assessment reasonable and acceptable.

The licensee stated that primary-to-secondary leakage during normal operation is monitored according to the plant's TS to ensure that any leakage remains less than the acceptable limit. The licensee stated that total operational leakage from TEAs left in service has remained well within the acceptable limits of the TS and is zero. Further, the presence of the tube sheet precludes the possibility of burst for tubes with TEAs.

Lastly, the licensee stated that based on industry experience of Inconel 600 weld metal, it concluded that the tube-to-tube sheet weld (wire type 82T) is not likely to crack and that the weld would not be affected by the TEAs. If the tubing next to the seal weld is cracked due to PWSCC, the crack growth should slow as the remaining stresses from the weld process are relieved. The crack is not expected to penetrate into the weld material. The licensee,

therefore, concluded that there is no evidence of cracks in the welds and stated that this is further supported by bubble tests of steam generator tubes performed at various plants.

Based on the above, the staff concludes that the licensee's assessment of primary-to-secondary leakage during accident conditions is conservative and well within the licensee's MSLB leakage requirements for steam generator integrity. The staff also concluded that operational limits on the number of tubes with TEAs that may be left in service are not necessary given the bounding, conservative nature of the leak-rate calculations performed. Therefore, the staff finds that continued operation with TEAs left in service is acceptable.

3.3 TS Change

The proposed change to TS 5.5.10, Section e.6 would modify the definition of repair limit by adding a provision to exclude certain steam generator tube defect indications. Specifically, the definition of repair limit would state that axial tube imperfections of any depth observed between the primary side surface of the tube sheet clad and the end of the tube are excluded from this repair limit.

The licensee evaluated TEAs that are left in service for contribution to primary-to-secondary leakage during postulated worse-case accident conditions and stated that the contribution is expected to be zero. Therefore, the licensee concluded that operational limits on the number of tubes with TEAs, or a limit on leakage from tubes having TEAs, is unnecessary.

The staff has evaluated the TS change and, based on the above discussion, agrees that operational limits on the number of tubes with TEAs that may be left in service are not necessary given the bounding, conservative nature of the leak-rate calculations performed. Further, the licensee's present monitoring program will monitor the TEA indications and any future degradation will be assessed. Therefore, the staff finds the TS change acceptable.

3.4 Conclusion

The NRC staff has reviewed the licensee's request and finds that continued operation with TEAs left in service is acceptable. This is based on the staff's determination that the licensee's assessment of primary-to-secondary leakage during accident conditions is conservative and well within the licensee's MSLB leakage requirements for steam generator integrity. Further, the licensee's condition monitoring program will continue to monitor the TEA indications and any future degradation will be assessed.

4.0 EXIGENT CIRCUMSTANCES

The Commission regulations, 10 CFR 50.91, contain provisions for issuance of amendments when the usual 30-day public notice period cannot be met. One such type of situation is an exigency. An exigency is a case where the Commission and licensee need to act promptly and time does not permit the Commission to publish a *Federal Register* notice allowing 30 days for prior public comment, and it is determined that the amendment involves no significant hazards consideration.

Under such circumstances, the Commission notifies the public in one of two ways: by using a *Federal Register* notice providing an opportunity for hearing and allowing at least 2 weeks for

prior public comments, or by using the local media to provide reasonable notice to the public in the area surrounding the licensee's facility. In this case the Commission used the second approach.

The licensee submitted the request for amendments on November 17, 1999. A public notice regarding this request was placed in two local newspapers, the Greenville News of Greenville, South Carolina, and the Anderson Independent-Mail of Anderson, South Carolina, on November 24, 1999. In the notice the staff proposed a no significant hazards consideration determination.

On November 15, 1999, when the staff informed the licensee of its final conclusion that the licensee's interpretation of TS 5.5.10 was inaccurate, Oconee Units 1 and 3 were in non-compliance with the TS. As a result, the NOED was issued for Units 1 and 3, and the licensee requested that the related amendments be issued on an exigent basis in accordance with the staff policy for processing an amendment associated with a NOED. In addition, because Unit 2 was shut down for refueling, application of the NOED to that unit was not appropriate and it remained in non-compliance. Thus, the amendments must be processed prior to startup. Since startup is presently scheduled for December 7, 1999, the amendments must be processed on an exigent basis to prevent a delay of the startup.

These amendments complete the review process and implement the proposed TS changes for Oconee Units 1, 2, and 3, pursuant to the NRC's policy regarding the execution of enforcement discretion for an operating facility set out in Section VII.c of the "General Statement of Policy and Procedures for NRC Enforcement Actions" (Enforcement Policy), NUREG-1600, for processing NOEDs. The staff has determined that, because compliance with the steam generator inspection criteria for TEAs would necessitate either a plant shutdown or delayed startup, and in light of the NOED, issuance of these amendments is needed in less than the 30-day or 15-day comment periods allowed for processing amendments to the TSs. The licensee promptly submitted its application letter after being advised of the staff's interpretation of the testing criteria contained in the steam generator testing section of the TSs. Therefore, pursuant to 10 CFR 50.9(a)(6), the staff has determined that exigent circumstances exist and the amendments are being processed accordingly.

5.0 FINAL NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The Commission's regulations in 10 CFR 50.92 state that the Commission may make a final determination that license amendments involve no significant hazards consideration if operation of the facility, in accordance with the proposed amendments, would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously analyzed; or (3) involve a significant reduction in a margin of safety. As required by 10 CFR 50.91(a), the licensee has provided its analysis of the issue of no significant hazards consideration, which is presented below.

This [analysis] ensures that operation of the facility in accordance with the proposed amendments would not:

- (1) Involve a significant increase in the probability or consequences of an accident previously evaluated.

No. This evaluation addresses the potential effects of not applying the repair criteria to steam generator tubes. Tube End Anomalies (TEAs) are eddy current indications between the outer tubesheet cladding surface and the tube end. As described in the Technical Justification [of the submittal dated November 17, 1999, requesting the amendments], operating with some steam generator tubes with Tube End Anomalies (TEAs) in Units 1, 2 and 3 does not increase the probability of any accident evaluated in the Safety Analysis Report (SAR) because this condition is not an accident initiator. Operation with TEAs will not adversely affect the ability to mitigate any FSAR [Final Safety Analysis Report] described accident since it has been demonstrated that indications in areas defined as TEAs do not represent a risk of pressure boundary leakage. Therefore, the leakage requirements for steam generator integrity for the most limiting event, a Main Steam Line Break (MSLB), are satisfied with no compensatory actions required.

There is no physical change to the plant Structures, Systems or Components (SSCs) or operating procedures. Neither electrical power systems, nor important to safety mechanical SSCs will be adversely affected. The steam generators have been evaluated as operable for normal and accident conditions. There are no shutdown margin, reactivity management, or fuel integrity concerns. There is no increase in accident initiation likelihood, therefore analyzed accident scenarios are not impacted.

There is no adverse impact on containment integrity, radiological release pathways, fuel design, filtration systems, main steam relief valve setpoints, or radwaste systems.

There is no increase in accident initiation likelihood or consequences, therefore analyzed accident scenarios are not impacted.

- (2) Create the possibility of a new or different kind of accident from any kind of accident previously evaluated.

There is no increased risk of unit trip, or challenge to the reactor protection system or other safety systems. There is no physical effect on the plant, i.e., none on Reactor Coolant System (RCS) temperature, boron concentration, control rod manipulations, core configuration changes, and no impact on nuclear instrumentation. There is no increased risk of a reactivity excursion. No new failure modes or credible accident scenarios are postulated from this activity. The MSLB scenario has been evaluated and the potential for damage to the steam generator tubes is not increased.

- (3) Involve a significant reduction in a margin of safety

No function of any important-to-safety SSC will be adversely affected or degraded as a result of continued operation. No safety parameters, setpoints, or design limits are changed. There is no adverse impact to the nuclear fuel, cladding, RCS, or required

containment systems. Therefore, the margins of safety as defined in the bases to any Technical Specifications are not reduced as a result of this change.

Duke has concluded, based on the above, that there are no significant hazards considerations involved in this amendment request.

Based on the above considerations, the NRC staff concludes that the amendments meet the three criteria of 10 CFR 50.92. Therefore, the staff has made a final determination that the proposed amendments do not involve a significant hazards consideration.

6.0 STATE CONSULTATION

In accordance with its stated policy, on November 30, 1999, the staff consulted with the South Carolina State official, Mr. Virgil Autry, of the Division of Radiological Waste Management, Bureau of Land and Waste Management, Department of Health and Environmental Control, regarding the proposed action. The State official had no comments.

7.0 ENVIRONMENTAL CONSIDERATION

The amendments change surveillance requirements. 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 made a final finding that the amendments involve no significant hazards consideration. 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.

8.0 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.

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