



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

October 7, 2015

Mr. Scott Batson
Site Vice President
Oconee Nuclear Station
Duke Energy Carolinas, LLC
7800 Rochester Highway
Seneca, SC 29672-0752

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3 – STAFF EVALUATION RE:
REPORT PURSUANT TO 10 CFR 50.46 REQUIREMENTS RELATED TO
THERMAL CONDUCTIVITY DEGRADATION (CAC NOS. MF5572, MF5573,
AND MF5574)

Dear Mr. Batson:

By letter dated December 17, 2014, Duke Energy Carolinas, LLC (the licensee), submitted a report describing a significant error identified in the emergency core cooling system evaluation model, and an estimate of the effect of the error on the predicted peak cladding temperature for Oconee Nuclear Station, Units 1, 2 and 3. This report was submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 46 (10 CFR 50.46), paragraph (a)(3).

The U.S. Nuclear Regulatory Commission (NRC) staff has evaluated the report, along with its supplemental information submitted by letter dated March 31, 2015. Based on its evaluation, the NRC staff determined that the report, as supplemented, satisfies the reporting requirements of 10 CFR 50.46(a)(3). A staff evaluation describing the technical and regulatory basis for the NRC staff's conclusion is enclosed. This letter concludes the NRC staff's review associated with CAC Nos. MF5572, MF5573, and MF5574.

If you have any questions, please contact me at (301) 415-4090 or via e-mail at Jeffrey.Whited@nrc.gov.

Sincerely,

A handwritten signature in black ink that reads "Jeffrey A. Whited".

Jeffrey A. Whited, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-269, 50-270, and 50-287

Enclosure:
Staff Evaluation

cc w/encl: Distribution via ListServ



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

STAFF EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO REPORT PURSUANT TO 10 CFR 50.46

DUKE ENERGY CAROLINAS, LLC

OCONEE NUCLEAR STATION, UNITS 1, 2 AND 3

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

1.0 INTRODUCTION

By letter dated December 17, 2014,¹ as supplemented by letter dated March 31, 2015,² Duke Energy Carolinas, LLC, (Duke, the licensee), submitted a report describing a significant error identified in the emergency core cooling system (ECCS) evaluation model (EM) and an estimate of the effect of the error on the predicted peak cladding temperature (PCT) for the Oconee Nuclear Station, Units 1, 2 and 3 (ONS). This report was submitted pursuant to Section 50.46(a)(3) of Title 10 of the *Code of Federal Regulations* (10 CFR).

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of the submittals and determined, as discussed below, that Duke has satisfied the reporting requirements of 10 CFR 50.46(a)(3).

2.0 REGULATORY EVALUATION

2.1 Regulatory Requirements

Acceptance criteria for ECCS for light-water nuclear power reactors are found in 10 CFR 50.46. Among other things, 10 CFR 50.46(a)(1)(i) requires that ECCS cooling performance must be calculated in accordance with an acceptable evaluation model. Paragraph (b) of 10 CFR 50.46 provides the acceptance criteria for ECCS evaluation. In particular, 10 CFR 50.46(b)(1), "Peak Cladding Temperature," states, "The calculated maximum fuel element cladding temperature shall not exceed 2200 °F [degrees Fahrenheit]."

Paragraph (a)(3)(i) of 10 CFR 50.46 requires licensees to estimate the effect of any change to or error in an acceptable evaluation model, or in the application of such a model, to determine if

¹ Agencywide Documents Access and Management System (ADAMS) Accession No. ML14353A214.

² ADAMS Accession No. ML15090A303.

the change or error is significant. For the purpose of 10 CFR 50.46, a significant change or error is one which results in a calculated peak fuel cladding temperature difference of more than 50 °F from the temperature calculated for the limiting transient using the last acceptable model, or is a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than 50 °F. For each change to or error discovered in an acceptable EM, or in the application of such a model, 10 CFR 50.46(a)(3)(ii) requires the affected licensee to report the nature of the change or error and its estimated effect on the limiting ECCS analysis to the NRC at least annually. If the change or error is significant, the licensee is required to provide this report within 30 days and include with the report a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with 10 CFR 50.46 requirements.

2.2 Background

The AREVA Inc. (AREVA) proprietary topical report BAW-10192P-A, "BWNT (Babcock and Wilcox (B&W) Nuclear Technologies) Loss-of-Coolant Accident (LOCA) Evaluation Model (EM) for Once-Through Steam Generator Plants" (BWNT LOCA EM),³ is the acceptable EM used to evaluate ECCS cooling performance at ONS. In accordance with 10 CFR Part 21, "Reporting of Defects and Noncompliance," AREVA reported an error in its LOCA analysis for plants with a B&W design, including ONS, by letter to the NRC dated December 16, 2014.⁴

In its report, AREVA stated that the current fuel "thermal conductivity model does not adequately represent the change in conductivity with burnup for the fuel." This defect relates to the uranium fuel thermal conductivity models in the fuel thermal-mechanical codes TACO3⁵ and GDTACO,⁶ which are part of the BWNT LOCA EM. The defect resulted in an under-prediction of the large-break PCT at ONS. To compensate for the under-prediction of PCT, AREVA stated that each affected plant, including ONS, was advised to reduce fuel linear heat rate (LHR) by 2 kilowatts per foot (kW/ft).

Based on AREVA's notification, Duke submitted its December 17, 2014, letter to notify the NRC that the defect constituted an error in the ECCS EM for ONS. The licensee's letter provided: (1) a description of the nature of the error and its estimated effect on the PCT, (2) a summary of actions taken to ensure compliance with 10 CFR 50.46 requirements, including implementing the 2 kW/ft LHR reduction, and (3) a commitment that a large break LOCA (LBLOCA) reanalysis, accounting for the effects of thermal conductivity degradation (TCD) for the highest PCT case, would be performed for ONS by September 15, 2015. This commitment date was revised to 15 months after NRC approval of a supplement to BAW-10192P-A, by the supplemental letter dated March 31, 2015.

³ BAW-10192P-A describes the ECCS EM; however, the EM requires use of input from approved thermal-mechanical models. Plant-specific application is described in further detail in BAW-10179P-A, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses."

⁴ ADAMS Accession No. ML14351A308.

⁵ AREVA NP Licensing Topical Report BAW-10162P-A, "TACO3 – Fuel Pin Thermal Analysis Code."

⁶ AREVA NP Licensing Topical Report BAW-10184P-A, "GDTACO – Urania Gadolinia Fuel Pin Thermal Analysis Code."

The December 17, 2014, letter stated that the TCD-related defect was estimated to cause the PCT at ONS to increase 428 °F. The licensee's implementation of a 2 kW/ft LHR reduction was estimated to offset the TCD effect by a compensating amount. Therefore, the predicted PCT for ONS remains 1852 °F, which is less than the regulatory limit of 2200 °F.

3.0 TECHNICAL EVALUATION

3.1 Use of an Acceptable Evaluation Model for Reanalysis

The December 17, 2014, letter indicated Duke would complete a reanalysis incorporating the effects of TCD by September 17, 2015. Section 4.3.2.3 of the BWNT LOCA EM requires licensees to use NRC-approved fuel thermal-mechanical models to be consistent with the topical report. The fuel temperature uncertainty values used in TACO3 and GDTACO are specified in the NRC-approved fuel performance methodology documented in BAW-10162P-A and BAW-10184P-A. The AREVA report identified that these uncertainty values need to be modified in order to account for TCD.

In its March 31, 2015 letter, the licensee stated that AREVA will develop a supplement to its BWNT LOCA EM and submit it for NRC review and approval. The licensee stated the supplement will describe the modifications to the BWNT LOCA EM necessary to correct for the TCD issue. Based on this information, the NRC staff determined that the licensee has adequately described how it will ensure ECCS cooling performance is calculated using an acceptable EM. The March 31, 2015, letter also revised the fulfillment date of the reanalysis commitment to 15 months following receipt of NRC approval of the BWNT LOCA EM update.

3.2 Adequacy of Reanalysis Scope

As discussed above, the licensee stated that the TCD-related model changes will be incorporated as a supplement to the BWNT LOCA EM. The December 17, 2014, letter stated that the reanalysis would be performed for the highest PCT case at middle-of-life (MOL) conditions. Based on the magnitude of the estimated effect of a TCD correction on the ONS ECCS evaluation, the NRC staff determined that these model revisions would significantly change the predicted ECCS performance for ONS.

Regarding the evaluation of ECCS performance, 10 CFR 50.46(a)(1)(i) states, in part, that ECCS cooling performance "must be calculated for a number of postulated loss-of-coolant accidents of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated loss-of-coolant accidents are calculated." In its March 31, 2015, letter, the licensee stated, in part, that:

As part of the supplement to BAW-10192P-A, AREVA intends to confirm that the TCD error correction does not alter the conclusion of existing sensitivity studies [that confirm the limiting break size and location for ONS]. AREVA also intends to perform demonstration analyses to show how the revised evaluation model would be used in a licensing analysis. AREVA has indicated that the demonstration analysis to be included in the supplement to BAW-10192P-A will utilize the Oconee LBLOCA model.

For the Oconee TCD reanalysis effort, the middle-of-life (MOL) time in life is expected to remain limiting with respect to PCT, since TCD is not expected to affect the beginning-of-life (BOL) cases. For the Oconee reanalysis, the number of MOL cases to be analyzed, at particular axial core elevations, will be sufficient to ensure that the limiting break scenario has been calculated with an acceptable evaluation model, which includes the TCD error corrections to be described in the supplement to BAW-10192P-A. Also, an end-of-life (EOL) case at the 2.506 foot core elevation will be evaluated to ensure that EOL remains non-limiting with respect to PCT.

In the NRC staff experience, various issues associated with ECCS evaluation may be addressed using an evaluation of a spectrum of break sizes, locations, and other properties, and this evaluation may be performed on a more general, simplified basis. Once a set of generally limiting properties is identified, a more detailed, plant-specific analysis identifies the exact limiting properties and determines the results for comparison against the 10 CFR 50.46(b) acceptance criteria. The licensee's statement above is consistent with this practice, since the AREVA supplement to BAW-10192P-A will be based on sensitivity studies and demonstration calculations using the Oconee plant model.

Should, during the NRC staff review of the BAW-10192P-A supplement, issues be identified that indicate that the sensitivity studies and demonstration analyses are insufficient to ensure that the Oconee analysis continues to provide assurance that the most severe hypothetical LOCAs are calculated, conditions or limitations could be placed on the staff approval of the BAW-10192P-A supplement requiring further Oconee-specific analysis prior to implementation.

Based on the discussion above, the NRC staff determined that the licensee adequately described how it will provide assurance that the most severe postulated LOCAs are calculated.

3.3 Technical Specification (TS) Impacts

ONS TS 5.6.5, "Core Operating Limits Report," requires, in part, that:

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC [for use at ONS], specifically those described in the following documents: (6) BAW-10192P-A, BWNT LOCA-BWNT Loss of Coolant Accident Evaluation Model for Once-Through Steam Generator Plants.

In its letter dated March 31, 2015, Duke stated that the Oconee Large Break LOCA reanalysis would be performed incorporating a TCD error correction, once the NRC has approved a supplement to BAW-10192P-A. The licensee also stated that any subsequent Core Operating Limits Report (COLR) would provide a complete citation to the updated method, consistent with the ONS TS requirements for the COLR.

Based on the information provided by the licensee, the NRC staff determined that the reanalysis will be performed using NRC-approved methods, consistent with the ONS TS COLR requirements.

4.0 CONCLUSION

Based on its review, the NRC staff concluded that Duke's report, as supplemented, satisfies the reporting requirements of 10 CFR 50.46(a)(3). The report described the nature of the TCD-related error and provided its estimated effect on the PCT for the limiting ECCS evaluation. The report also indicated that the licensee took action to reduce LHR limits to compensate for the effect of TCD and showed that the predicted PCT would remain below 2200 °F. The report, as supplemented, included a proposed schedule for performing reanalysis and taking other actions, as needed, to comply with 10 CFR 50.46 requirements.

Principal Contributor: Benjamin Parks

Date: October 7, 2015

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Sincerely,
/RA/
Jeffrey A. Whited, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-269, 50-270, and 50-287

Enclosure:
Staff Evaluation

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