



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

October 28, 2010

Mr. Michael J. Annacone, Vice President  
Brunswick Steam Electric Plant  
Carolina Power & Light Company  
Post Office Box 10429  
Southport, North Carolina 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 - REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUESTS FOR ADDITION OF ANALYTICAL METHODOLOGY TOPICAL REPORTS TO TS 5.6.5, CORE OPERATING LIMITS REPORT (TAC NOS. ME3856, ME3857, ME3858, AND ME3859)

Dear Mr. Annacone:

By application dated April 29, 2010, Carolina Power & Light Company, now doing business as Progress Energy Carolinas, Inc., requested changes to the Technical Specifications (TS) for the Brunswick Steam Electric Plant (BSEP), Units 1 and 2 (References 1 and 2).

The proposed changes would revise TS 5.6.5.b, "CORE OPERATING LIMITS REPORT (COLR)," to allow addition of two analytical methodology topical reports. Addition of Topical Report, ANP-10298PA, "ACE/ATRIUM 10XM Critical Power Correlation," Revision 0, dated March 2010, will enable Progress Energy to predict the minimum critical power ratio for BSEP Units 1 and 2 with the new ATRIUM 10XM fuel.

Addition of Topical Report BAW-10247PA, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," Revision 0, dated April 2008, will enable Progress Energy to determine reactor core linear heat generation rate limits using the RODEX-4 best estimate fuel performance code for BSEP Units 1 and 2 with ATRIUM 10XM fuel.

The NRC staff has determined that it needs additional information in order to complete its review of these amendments. Please respond to the enclosed requests by November 19, 2010, in order to facilitate a timely completion of the staff reviews.

Please contact me at 301-415-1447 if you have any questions on this issue, would like to participate in a conference call, or if you require additional time to submit your responses.

Sincerely,

*Farideh E. Saba*

Farideh E. Saba, Senior Project Manager  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-325 and 50-324

Enclosure: Request for Additional Information

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REQUEST FOR ADDITIONAL INFORMATION  
BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2  
LICENSE AMENDMENT REQUEST S FOR ADDITION OF ANALYTICAL METHODOLOGY  
TOPICAL REPORTS TO TS 5.6.5, CORE OPERATING LIMITS REPORT  
CAROLINA POWER & LIGHT COMPANY  
DOCKET NOS. 50-325 AND 50-324

By application dated April 29, 2010, Carolina Power & Light Company (CP&L, the licensee), now doing business as Progress Energy Carolinas, Inc., requested changes to the Technical Specifications (TSs) for the Brunswick Steam Electric Plant (BSEP), Units 1 and 2 (Refs. 1 & 2).

The proposed changes would revise TS 5.6.5.b, "CORE OPERATING LIMITS REPORT (COLR)," to allow addition of two analytical methodology topical reports. Addition of Topical Report, ANP-10298PA, "ACE/ATRIUM 10XM Critical Power Correlation," Revision 0, dated March 2010, will enable Progress Energy to predict the minimum critical power ratio (MCPR) for BSEP Units 1 and 2 with the new ATRIUM 10XM fuel.

Addition of Topical Report BAW-10247PA, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," Revision 0, dated April 2008, will enable Progress Energy to determine reactor core linear heat generation rate limits using the RODEX-4 best estimate fuel performance code for BSEP Units 1 and 2 with ATRIUM 10XM fuel.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's requests and determined that the following additional information is required in order to complete its review.

1. BSEP 10-0052, Page 5 of 12, Limitation and Condition 1

The licensee has indicated that "CP&L will not apply the ACE/A 10XM correlation to AREVA fuel other than the A10XM fuel design."

Please explain the procedure and methods that are in place at BSEP to support this statement, as well as how this restriction is implemented for transients and accident analyses for the BSEP Unit 1 and 2 cores containing different types of fuel.

2. BSEP 10-0052, Page 5 of 12, Limitation and Condition 2

Please explain how the restrictions on the range of conditions for mass flow rate, pressure, inlet subcooling, and design local peaking for the ACE/ATRIUM 10XM critical power ratio correlation are implemented in the AREVA engineering guidelines and in the BSEP core monitoring system.

Enclosure

3. ANP-2899, Part Length Rods (PLRs)

Given that the BSEP Unit 2 core will have three different types of fuel assemblies with PLRs of different lengths, please address the following:

- (a) What is the possibility of any of these PLRs being located in a limiting position?
- (b) Will any of these rods undergo boiling transition/dryout during normal operating conditions or during transients and accident conditions?
- (c) How are the PLRs treated during the critical power ratio (CPR) calculations?

4. BSEP 10-0052, Gadolinia Rods

Please explain how the gadolinia ( $\text{UO}_2\text{-Gd}_2\text{O}_3$ ) rods are treated during the application of the ACE/ATRIUM 10XM critical power correlation for MCPR calculations.

5. BSEP 10-0052, Page 4 of 12

The licensee stated that "the ANF-524(P)(A) methodology is modified slightly for use with the ACE correlation form due to the channel integration process used with the ACE correlation."

The detailed explanations and justification for these modifications were provided by AREVA in response to NRC Request for Additional Information (RAI) No.18 in ANP-10249(P)(A), "ACE ATRIUM-10 Critical Power Correlation," Revision 0.

The licensee further stated that "consistent with the approved methodology, CP&L's implementation of the analytical methods described in Topical Report ANP-10298(P)(A), Revision 0 (ACE/ATRIUM 10XM Critical Power Correlation), will include these modifications."

Please explain the potential impact of these modifications on the implementation of the ACE/ATRIUM 10XM critical power correlation for the ATRIUM10XM fuel at BSEP.

6. BSEP 10-0052, Page 4 of 12.

The licensee stated that "analyses to determine whether a change to the TS MCPR safety limit will be required, with the implementation of the ACE/ATRIUM 10XM correlation methodology, have not been completed. If analyses indicate that a change is required, the Technical Specification change will be separately requested."

Please confirm, with supporting analyses documents, whether or not a change to the TS MCPR limit is required for BSEP.

7. BSEP 10-0052, Page 7 of 12, ANP-2936(P)

- (a) Please provide a detailed calculation to show hydraulic compatibility as it relates to the performance of the three fuel designs in the BSEP Unit 2 core.

- (b) Considering the fact that the proposed BSEP Unit 2 core for the next few cycles will be a mixed core, please demonstrate, with supporting analyses, how the thermal-hydraulic design criteria per the Standard Review Plan (NUREG-0800), Section 4.4, and Table 3.1 of ANP-2936(P), are satisfied for the BSEP Unit 2 transition core configurations.

8. BSEP 10-0052, ANP-2936(P)

General Design Criterion (GDC) 10 of Appendix A to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, requires that the reactor core and associated coolant, control, and protection systems be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDL) are not exceeded during normal operation, including the effects of abnormal operational occurrences (AOOs).

In addition, acceptance criterion 1.b of the Standard Review Plan, Section 4.4, requires that at least 99.9 percent of the fuel rods in the core will not experience boiling transition during normal operation or AOOs.

Please describe, with supporting analyses, how the ACE/ATRIUM 10XM correlation is used to demonstrate that this requirement is met.

9. ANP-2936(P)

The proposed Cycle 19 BSEP Unit 2 core with AREVA ATRIUM-10, AREVA ATRIUM 10 XM, and GE14 fuel designs will constitute a "mixed core."

Please provide details of the potential impact of the mixed core on the CPR calculations, accounting for the differences in mechanical, thermal, and hydraulic characteristics of the three fuel designs in the transition core at BSEP Unit 2.

10. ANP-2936(P)

GDC 12 of 10 CFR Part 50, Appendix A, requires suppression of reactor power oscillations so that SAFDLs are not exceeded.

Please demonstrate, with supporting analyses and calculations, how thermal-hydraulic and neutronic stability of the mixed core will be maintained at BSEP throughout the upcoming and following cycles of operation.

11. BSEP 10-0057, ANP-2899(P), Section 3.2.2

Section 3.2.2 of ANP-2899(P) indicates that "AREVA evaluates fuel centerline temperature using RODEX4 for both normal operating conditions and AOOs. Fuel failure from the overheating of the fuel pellets is not allowed. The melting point of the fuel includes adjustments for gadolinia content."

Assuming degraded thermal conductivity, and with a lower melting point of the  $Gd_2O_3-UO_2$  mixture, please describe what adjustments are made in the Gadolinia rods to prevent failure of the Gadolinia rod from melting. In addition, address whether there is any restriction on the linear heat generation rate limit for the Gadolinia rods during normal operation and AOOs.

12. BSEP 10-0052 and BSEP 10-0057, Section 5.1

In Section 5.1, "No Significant Hazards Consideration," the licensee stated that "the change does not require any physical plant modifications, physically affect any plant components, or entail changes in plant operation. Since no individual precursors of an accident are affected, the proposed amendments do not increase the probability of a previously analyzed event."

Given the fact that the proposed amendments will ultimately enable BSEP Units 1 and 2 to transition to a new AREVA fuel, please justify or correct, if necessary, the statement that "the change does not require any plant modifications or physically affect any plant components."

13. BSEP 10-0052, ANP-2899(P)

Section 4.1.4, Rod Bow, of ANP-2899(P) states that "at higher exposures, a CPR penalty is determined as a function of exposure and fractional rod rod spacing closure."

Please explain how CPR penalties are evaluated at higher exposures for ATRIUM 10XM fuel.

14. ANP-2899(P)

Please provide supporting analyses and calculations for Tables 4.2 through 4.5 of ANP-2899(P).

15. ANP-2899(P), Section 5.0, *Nuclear Design Evaluation*

Nuclear fuel and core analyses for ATRIUM 10XM are performed using the NRC-approved XN-NF-80-19(P)(A) and EMF-2158(P)(A) methodology to assure that the new assembly and/or design features meet the nuclear design criteria established for the fuel and core.

ANP-2899(P), Section 5.0, states that the accuracy of the above methodology has been demonstrated for ATRIUM-10 fuel assembly design by comparison to measurements taken at operating reactors for many years at many reactors.

Accordingly, please address the following:

- (a) The ATRIUM 10XM fuel design involves changes in fuel density, part length rods, active fuel length, diameter and length of the fuel pellet, and cladding outer diameter from the ATRIUM-10 fuel design. Please explain how these changes are accounted for in the methodology and justify the statement that "these changes in fuel design have no impact on the applicability of the methodology."
- (b) Approval of EMF-2158(P), Revision 0, was subject to six conditions as stipulated in the safety evaluation (Section 6.0) attached to the letter from the NRC (Stephen Dembek) to the Siemens Power Corporation (James Mallay), dated October 18, 1999. Please describe how these six conditions are satisfied where the methodology of EMF-2158(P) is applied to the ATRIUM 10XM fuel design.

16. BSEP 10-0057, BAW-10247(P)(A)

NRC approval of topical report BAW-10247(P) was subject to compliance with five limitations and conditions that are listed in the safety evaluation for the topical report attached to the letter from the NRC (Ho Nieh) to AREVA Nuclear Power (Ronnie Gardner), dated February 12, 2008.

Accordingly, please address the following:

- (a) Provide documentation for how BSEP is planning to comply with Limitation Number 1 regarding the fission gas release (FGR) model in BAW-10247(P)(A).
- (b) In response to Limitation and Condition 3, the licensee indicated that the "BSEP core operating limits analyses performed with RODEX4 will not use the hydrogen pickup model within RODEX4." The NRC staff requests that the licensee explain the details of the model and its usage to assess the hydrogen pickup at BSEP.
- (c) In response to Limitation and Condition 4, the licensee indicated that the "BSEP core operating limits analyses performed with the BAW-10247(P)(A), Revision 0 methodology will use the specific values of the equation constants and tuning parameters derived in Topical Report BAW-10247(P), Revision 0 (as updated by RAI responses)." Justify the applicability of the validation process, the specific values of the equation constants, and the tuning parameters derived in BAW-10247(P) to the ATRIUM 10XM fuel design.
- (d) The licensee response to Limitation and Condition 5 of topical report BAW-10247(P) indicated that "where we have plant specific measurements indicating abnormal crud, our analyses for the plant will be based on the plant specific data" (Page 4 of 4 of the proprietary file "Initial RODEX4 Draft Comments.doc," attached to the email dated November 2, 2007, from J. Holm (AREVA) to Holly Cruz (NRC)). Provide the plant specific data for abnormal crud or corrosion layers BSEP.
- (e) Page 7 of 18 of BSEP 10-0057 indicates that the BSEP inspections of irradiated GE14 fuel were found to be clean with no evidence of tenacious crud. The licensee further stated that "low crud levels were similarly noted during recently completed inspections of irradiated ATRIUM-10 fuel operated in BSEP Unit 1, Cycle 17." Provide supporting documents to demonstrate that the ATRIUM fuel designs will not have design basis crud formation at BSEP.

17. BSEP 10-0057, EMF-2158(P)(A)

- (a) The licensee used topical report EMF-2158(P)(A) to calculate the radial and axial power distribution measurement uncertainties listed on Pages 3 and 4 of 18 of BSEP 10-0057, Enclosure 1. Please provide detailed analyses, calculations, and the database information used to establish the uncertainties listed in the two tables (unnumbered) on Page 4 of 18 of Enclosure 1 of BSEP 10-0057, and as illustrated in Figures 1, 2, and 3 on Pages 11 through 13 of Enclosure 1 of BSEP 10-0057.
- (b) Please discuss the applicability of the BSEP TIP measurement process and database to the ATRIUM 10XM fuel design.

18. ANP-2920(P), Brunswick Unit 2 Cycle 20 Fuel Cycle Design

In Section 2.0 of ANP-2920(P), the licensee stated that “beyond the full power capability, the cycle has been designed to achieve 38 gigawatt days additional energy via Constant Pressure Power Coastdown operation.”

Please briefly explain the process regarding constant pressure power coastdown operation.

19. ANP-2920(P), Brunswick Unit 2 Cycle 20 Fuel Cycle Design

Section 3.1 of ANP-2920(P) states that elevation views of the fresh reload fuel design axial enrichment and Gadolinia distributions are shown in Appendix B, Figures B.1 and B.2.

Please explain the naming convention that identifies the enrichment and Gadolinia distributions.

In addition, please provide the range of Gadolinia enrichments for each fuel design that will be used during the upcoming operating cycles for BSEP.

20. Impact on the Spent Fuel Pool

ATRIUM 10XM fuel has a larger outer diameter, slightly longer active fuel length, larger pellet diameter, higher pellet density, and higher uranium weight than those of resident fuel types at BSEP. Accordingly, please determine whether a spent fuel pool criticality analysis is necessary to accommodate the new fuel in the pool. Provide details of the analysis.

REFERENCES

1. Letter BSEP 10-0052 from Michael J. Annacone (Progress Energy) to NRC, “Request for License Amendments – Addition of Analytical Methodology Topical Report to Technical Specification 5.6.5, “CORE OPERATING LIMITS REPORT (COLR),” Progress Energy, April 29, 2010.
2. Letter BSEP 10-0057 from Michael J. Annacone (Progress Energy) to NRC, “Request for License Amendments – Addition of Analytical Methodology Topical Report to Technical Specification 5.6.5, “CORE OPERATING LIMITS REPORT (COLR),” Progress Energy, April 29, 2010

October 28, 2010

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\* by memo