Letter Enclosures Contain Proprietary Information
Withhold in Accordance with 10 CFR 2.390

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10 CFR 50.4

September 21, 2012
Serial: BSEP 12-0104

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Docket Nos. 50-325, 50-324
Response to Request for Additional Information Regarding License Amendment Request for Addition of Analytical Methodology Topical Report to Technical Specification 5.6.5, "CORE OPERATING LIMITS REPORT (COLR)," and Revision to Technical Specification 2.1.1.2 Minimum Critical Power Ratio Safety Limit

References:

1. Letter from Michael J. Annacone to the U.S. Nuclear Regulatory Commission (Serial: BSEP 12-0031), "Request for License Amendments – Addition of Analytical Methodology Topical Report to Technical Specification 5.6.5, 'CORE OPERATING LIMITS REPORT (COLR),' and Revision to Technical Specification 2.1.1.2 Minimum Critical Power Ratio Safety Limit," dated March 6, 2012, ADAMS Accession Number ML12076A062
2. Letter from Michael J. Annacone to the U.S. Nuclear Regulatory Commission (Serial: BSEP 12-0098), "Response to Request for Additional Information Regarding License Amendment Request for Addition of Analytical Methodology Topical Report to Technical Specification 5.6.5, 'CORE OPERATING LIMITS REPORT (COLR),' and Revision to Technical Specification 2.1.1.2 Minimum Critical Power Ratio Safety Limit," dated August 29, 2012, ADAMS Accession Number ML12251A142

By letter dated March 6, 2012 (i.e., Reference 1), as supplemented by letter dated August 29, 2012 (i.e., Reference 2), Carolina Power & Light Company (CP&L) requested license amendments to revise the Technical Specifications (TS) for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The proposed license amendments: (1) revise TS 5.6.5.b by replacing AREVA Topical Report ANF-524(P)(A), *ANF Critical Power Methodology for Boiling Water Reactors* with AREVA Topical Report ANP-10307PA, Revision 0, *AREVA MCPR Safety Limit Methodology for Boiling Water Reactors*, June 2011, in the list of analytical methods that have been reviewed and approved by the NRC for determining core operating limits, (2) revise TS 2.1.1, "Reactor Core SLs," by incorporating revised Safety Limit Minimum Critical Power Ratio (SLMCPR) values, and (3) revise the license condition in Appendix B, "Additional Conditions," of the operating licenses regarding an alternate method for evaluating SLMCPR values.

On August 9, 2012, by electronic mail (i.e., ADAMS Accession Number ML12223A196), the NRC provided a request for additional information concerning the referenced license amendment requests. The response to this NRC request for additional information is enclosed.

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NRR

This letter contains no regulatory commitments.

Please refer any questions regarding this submittal to Mr. Lee Grzeck, Manager – Regulatory Affairs, at (910) 457-2487.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on September 21, 2012.

Sincerely,

Michael J. Annacone

WRM/wrm

Enclosures:

1. Response to Request for Additional Information **(Proprietary Information – Withhold from Public Disclosure in Accordance With 10 CFR 2.390)**
2. AREVA Affidavit Regarding Withholding Information from Public Disclosure
3. Response to Request for Additional Information (Nonproprietary Version)

cc (with all enclosures):

U. S. Nuclear Regulatory Commission, Region II
ATTN: Mr. Victor M. McCree, Regional Administrator
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Rockville, MD 20852-2738

cc (with Enclosures 2 and 3 only):

Chair - North Carolina Utilities Commission
P.O. Box 29510
Raleigh, NC 27626-0510

Mr. W. Lee Cox, III, Section Chief
Radiation Protection Section
North Carolina Department of Environment and Natural Resources
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AREVA Affidavit
Regarding Withholding Information
from Public Disclosure

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for AREVA NP Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA NP to determine whether certain AREVA NP information is proprietary. I am familiar with the policies established by AREVA NP to ensure the proper application of these criteria.

3. I am familiar with the AREVA NP information contained in the Enclosure 1 to Duke Energy (Carolina Power & Light Company) letter BSEP 12-0104, from Michael J. Annacone to the U. S. Nuclear Regulatory Commission, "Response to Request for Additional Information Regarding License Amendment Request for Addition of Analytical Methodology Topical Report to Technical Specification 5.6.5, "CORE OPERATING LIMITS REPORT (COLR)," and Revision to Technical Specification 2.1.1.2, Minimum Critical Power Ratio Safety Limit," and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA NP and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by AREVA NP to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA NP's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA NP.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA NP in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA NP, would be helpful to competitors to AREVA NP, and would likely cause substantial harm to the competitive position of AREVA NP.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

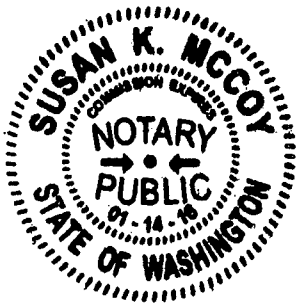
7. In accordance with AREVA NP's policies governing the protection and control of information, proprietary information contained in this Document have been made available,

on a limited basis, to others outside AREVA NP only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA NP policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

SUBSCRIBED before me this 14th day of September, 2012.



Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2016

Response to Request for Additional Information (Nonproprietary Version)

By letter dated March 6, 2012 (i.e., Reference 1), as supplemented by letter dated August 29, 2012, Carolina Power & Light Company (CP&L) requested license amendments to revise the Technical Specifications (TS) for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The proposed license amendments: (1) revise TS 5.6.5.b by replacing AREVA Topical Report ANF-524(P)(A), *ANF Critical Power Methodology for Boiling Water Reactors* with AREVA Topical Report ANP-10307PA, Revision 0, *AREVA MCPR Safety Limit Methodology for Boiling Water Reactors*, June 2011, in the list of analytical methods that have been reviewed and approved by the NRC for determining core operating limits, (2) revise TS 2.1.1, "Reactor Core SLs," by incorporating revised Safety Limit Minimum Critical Power Ratio (SLMCPR) values, and (3) revise the license condition in Appendix B, "Additional Conditions," of the operating licenses regarding an alternate method for evaluating SLMCPR values. On August 9, 2012 (i.e., ADAMS Accession Number ML12223A196), by electronic mail, the NRC provided a request for additional information concerning the license amendment requests. Responses to the NRC questions are provided below.

NRC Question 1

Page 6 of the Enclosure 1 states that "The method described in AREVA Operability Assessment CR 2011-2274, Revision 1, to assess SLMCPR values determined using the ANF-524(P)(A) methodology may not always remain appropriate to assess SLMCPR values determined using the ANP-10307PA methodology." Describe briefly the reasons why ANF-524(P)(A) is inappropriate to assess the SLMCPR values determined using ANP-1037PA.

Response to NRC Question 1

The amendments requested by CP&L's letter dated March 6, 2012 (i.e., Serial: BSEP 12-0031), do not propose to use either SLMCPR methodology to assess values determined by the other. It is the methods described in AREVA Operability Assessment CR 2011-2274, Revision 1, currently used to evaluate SLMCPR values determined using the ANF-524(P)(A) methodology, that may not always remain appropriate to assess SLMCPR values determined using the ANP-10307PA methodology. The reason for this is briefly described below.

The methods described in AREVA Operability Assessment CR 2011-2274, Revision 1, require use of a **[** **]** to calculate CPR margin on a fuel assembly basis. This method is specified for setpoint and operating limit evaluation, but it is not applicable to SLMCPR evaluation.

SLMCPR calculations count the number of individual fuel rods expected to experience boiling transition. This requires the K-factor and CPR calculations be associated with individual fuel rods. **[**

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CP&L's letter dated March 6, 2012 requests a license amendment to replace the ANF-524(P)(A) SAFLIM2 methodology with the ANP-10307PA SAFLIM3D methodology. SAFLIM2 [ ] As a result, the [ ] SLMCPR evaluation methodology specified by Operability Assessment CR 2011-2274, Revision 1 is applicable to SAFLIM2 analyses. SAFLIM3D [

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A [ ] methodology to evaluate the impact of the ACE K-Factor issue on SLMCPR has been developed since the Operability Assessment CR 2011-2274, Revision 1 methodology was specified. This new methodology is described in ANP-3086(P). The ANP-3086(P) methodology is applicable to SAFLIM3D analyses, [ ] Therefore, the license condition change requested by CP&L's letter dated March 6, 2012, [ ] Operability Assessment CR 2011-2274, Revision 1 SLMCPR evaluation method with the [ ] SLMCPR evaluation methodology described in the proposed licensing condition is justified.

NRC Question 2

Appendices A and B of ANP-10249PA provide details of the development of ACE/ATRIUM-10 correlation and the K-Factor examples, respectively. Provide a summary of the changes in the modified K-factor methodology that was implemented in response to deficiencies found in the axial averaging process. The Staff would like to have the licensee's response similar to what is presented in the Appendices A and B, i.e., changes in analytical treatment.

Response to NRC Question 2

The changes to Appendices A and B of ANP-10249PA to correct the deficiencies in the model are minimal.

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NRC Question 3

Section 3.0, "Revised Correlation" of ANP-3086(P) indicates that the assumption that the K-factor (k(z)) appearing in equation 3.1 could be replaced by a single axially averaged K-factor value. This assumption was stated to be found inappropriate because of the two reasons, i.e., (1) it allows downstream conditions above the location of dryout to non-physically influence the critical power and (2) it provides equal weighting to all axial locations. Both these assumptions were found to be capable of influencing the predicted results in a non-conservative manner. Describe how the non-conservatism is removed in the modified methodology, by providing a typical analytical treatment and a calculation.

Response to NRC Question 3

For the purpose of discussion, consider the following ATRIUM™ 10XM[2] example in which 24 equal sized nodes are used for the limiting rod heated length. The k_j value calculated for each node is shown below. These nodal k_j values are used in both the original method and the revised method. In the original method they are used to calculate an average K-factor, as shown in the table below.

[2] ATRIUM is a trademark of AREVA NP.

In the original ANP-10298PA method, each nodal k had the same weight as every other nodal k (i.e., a simple average of all 24 values was used). With a downskew rod axial power shape ([ ]), 1000 psia pressure, 0.10 Mlb/hr mass flow rate, and 20 Btu/lb inlet subcooling, the critical power is predicted by the ACE critical power correlation to be [ ] . The predicted location of onset of dryout is [ ].

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In the example presented, the K-factor applied in the original method is too low (and nonconservative) below node 15 because all locations in the heated length were used in the average. [

]

The original method calculated the averaged K-factor based on an assumption of uniform axial weighting. [

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[

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NRC Question 4

ANP-3086(P) indicates that only 80% of the CHF database was used to develop the critical power correlation, according to EMF-2022(P) which is not available to the NRC staff. What criteria, if any, are used for this selection of database? With the remaining 20% of the database unused, is there a loss of accuracy or increase in statistical error/uncertainty in the correlation?

Response to NRC Question 4

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The document EMF-2022(P), *Correlation Development Guideline,* has been available for review by the NRC during audits of AREVA critical power correlations since 1998. If requested, AREVA can make this document available to the NRC.

NRC Question 5

Section 3.3 of ANP-3086(P) states that additive constants can be considered as flow/enthalpy redistribution characteristic for given bundle and spacer design. The questions below are with reference to Figure 3-5 of ANP-3036(P):

(a) What are the physical significances of positive and negative additive constants?

(b) Figure 3-5 lists rod position, ACE/ATRIUM 10XM additive constants and ATRIUM 10XM SLMCPR Operability Assessment Correlation additive constants. The operability assessment correlation additive constants are derived using the improved K-factor methodology for rods observed to dryout, for rods not observed to dryout and for part length rods. The staff could not find any trend in the change of additive constants from the ATRIUM 10XM to the new additive constants for the BSEP operability assessment. If there is a trend, please explain. If there is no trend, explain why not.

Response to NRC Question 5a

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Response to NRC Question 5b

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NRC Question 6

On several locations in ANP-10307PA, it is mentioned that the ACE critical power correlation uses more detailed power distribution than required for previous correlations. Explain what is meant by "detailed power distribution" and how this new detailed power distribution is used to revise the SLMCPR methodology.

Response to NRC Question 6

Previous AREVA critical power correlations were based [

] is used to determine the critical power of the assembly. The use of a more detailed power distribution by the ACE correlation does not revise the ANP-10307PA SLMCPR methodology. The fact that the ANP-10307PA SLMCPR methodology has a more detailed power distribution allows for its use in the ACE correlation calculations. The response to Comment 7 below describes how the more detailed power distribution is used in the overall methodology.

NRC Question 7

Apart from using 3D core nodal power distribution (core nodal power) obtained from MICROBURN-B2 code system, what other improvements are implemented through the "expanded coupling with MICROBURN-B2" in the SLMCPR methodology.

Response to NRC Question 7

With the expanded coupling with MICROBURN-B2, the following improvements to the SLMCPR methodology are realized.

(a) [

]

(b) In the SAFLIM3D methodology, [

] This approach provides the best representation of the conditions in each assembly in the core at the conditions consistent with the SLMCPR calculations.

(c) [

] The previous methodology conservatively assumed that each and every assembly of a particular fuel type experienced the most adverse channel bow condition simultaneously and applied the most conservative uncertainty of the most limiting rod of that fuel type to all rods of that fuel type. The use of MICROBURN-B2 [

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NRC Question 8

(a) Should indications of "abnormal channel bow" be experienced by Brunswick nuclear plant Units, describe how the channel bow model will be applied for the SLMCPR methodology as prescribed in ANP-10307P.
(b) For a "mixed core" such as BSEP units, what programs could be in place to minimize or prevent abnormal channel bow.

Response to NRC Question 8a

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Response to NRC Question 8b

BSEP Unit 1 is currently operating in Cycle 19. The BSEP Unit 1 Cycle 19 core is not considered a mixed core, as it consists entirely of AREVA fuel assemblies channeled with Zircaloy-4 AREVA fuel channels.

BSEP Unit 2 is currently operating in Cycle 20. The BSEP Unit 2 Cycle 20 core design included 96 third-cycle GE14 fuel assemblies (i.e., approximately 17% of the core) with Zircaloy-2 Global Nuclear Fuel supplied fuel channels loaded on or near the core periphery. The remainder of the Unit 2 Cycle 20 core consists of AREVA fuel with Zircaloy-4 AREVA fuel channels. BSEP Unit 2 Cycle 21 is projected to begin operation in the Spring of 2013 and will not be a mixed core (i.e., it will consist entirely of AREVA fuel with Zircaloy-4 AREVA fuel channels).

Industry experience has shown Zircaloy-2 fuel channel material is particularly susceptible to abnormal channel bow associated with control blade induced shadow corrosion. CP&L now specifies Zircaloy-4 material for BSEP fuel channels, because this material is resistant to abnormal channel bow caused by control blade induced shadow corrosion. BSEP cores are also designed to minimize the exposure of channels to control blades by alternating use of four different control blade sequences. The remaining Zircaloy-2 GE14 fuel channels operating in the BSEP Unit 2 Cycle 20 core will not exceed experience based control blade exposure history thresholds for the onset of abnormal channel bow prior to their permanent discharge at the end of Cycle 20.

Industry experience has also shown excessive channel bow can result from high differential channel growth due to large fluence gradients across the channel. CP&L mitigates channel bow due to fluence gradients across BSEP channels with core design restrictions on channel location and orientation. These restrictions include empirical design guidance based on prior cycle operating history on or near the core periphery, where higher flux gradients than in the core interior are generally experienced due to neutron leakage on the core periphery. Additional core wide restrictions on channel location and orientation are based on fuel channel bow model predictions. CP&L programmatically implements these restrictions as core design inputs.

Based on the design controls described above, BSEP does not expect to experience abnormal channel bow. Regardless, CP&L monitors actual BSEP core operation and periodically assesses fuel channel bow model predictions through projected operation of current cycles to their next refueling outage. Based on the predicted channel bow assessment and scram time surveillance test data, settle or friction force tests are recommended for a sample of control blade locations from those locations predicted to have the least channel bow margin. The purpose of these tests is to confirm the absence of abnormal channel bow during operation. CP&L programmatically implements this monitoring process via administrative procedures.

NRC Question 9

The NRC staff is currently reviewing two supplements to AREVA's topical reports for critical power correlations; They are (1) ANP-10249PA, Revision 1, Supplement 1P, Revision 0, "Improved K-factor Model for ACE/ATRIUM-10 Critical Power Correlation," and (2) ANP-10298PA, Revision 0, Supplement 1P Revision 0, "Improved K-factor Model for ACE/ATRIUM 10XM Critical Power Correlation." These supplements to the TRs describe the improved K-factor methodology similar to what is described in ANP-3086P. What is the licensee's plan and schedule to incorporate these supplements into its list of analytical methods for determining core operating limits, if these supplements are approved by the NRC?

Response to NRC Question 9

BSEP plans to request license amendments to incorporate ANP-10298PA, Revision 0, Supplement 1P, Revision 0, *Improved K-factor Model for ACE/ATRIUM 10XM Critical Power Correlation*, into the TS 5.6.5.b list of NRC-approved analytical methods used to determine core operating limits, if this supplement is approved by the NRC.

Such license amendments would be requested approximately one year prior to the refuel outage preceding the operating cycle for which BSEP plans to use ANP-10298PA, Revision 0, Supplement 1P, Revision 0, to determine core operating limits. This implementation operating cycle would be selected such that the preceding refuel outage begins at least one year later than NRC approval of this supplement. Without this lead time, the core design for the implementation operating cycle could not be completed using this supplement, without potentially incurring a risk that this supplement may not be approved by the NRC.

No BSEP license amendments are planned to incorporate ANP-10249PA, Revision 1, Supplement 1P, Revision 0, *Improved K-factor Model for ACE/ATRIUM-10 Critical Power Correlation*, because BSEP does not use the ACE/ATRIUM-10 critical power correlation to determine core operating limits for ATRIUM-10 fuel. Core operating limits for BSEP ATRIUM-10 fuel are determined using Topical Report EMF-2209(P)(A), *SPCB Critical Power Correlation.*