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

Ladies and Gentlemen:

**VOGTLE ELECTRIC GENERATING PLANT**  
**10 CFR 50.46 ECCS EVALUATION MODELS SIGNIFICANT ERROR REPORT**

Pursuant to the requirements of 10 CFR 50.46 (a)(3)(ii), Southern Nuclear Operating Company (SNC) is submitting a significant error report to report errors in the Emergency Core Cooling System (ECCS) model. Attached is a description of the errors along with a revised assessment of the Large-Break Loss of Coolant Accident (LBLOCA) peak clad temperature (PCT). The report is based on information provided by Westinghouse of errors assessed against the Vogtle Electric Generating Plant (VEGP) ECCS Evaluation Model and has been prepared in accordance with the guidance in WCAP-13451.

The sum of the absolute magnitudes of additional assessments against the VEGP ECCS Evaluation Model for LBLOCA has resulted in a total error greater than 50 °F which is considered to be significant per 10 CFR 50.46 (a)(3)(i). Pursuant to 10 CFR 50.46 (a)(3)(ii), SNC is required to submit a report within 30 days.

In the 1998 Annual Report (letter LCV-1342, April 29, 1999), SNC reported a LBLOCA PCT of 2046 °F for Unit 1 and 1996 °F for Unit 2. Since then, the transition core penalty of 50 °F for Unit 1 has been reduced to 0 °F; the assessment for increased accumulator line resistances has been reduced from 43 °F to 29 °F for both units; and a total of 177 °F of additional assessments has been made for both units as a result of recently identified model errors. The resultant total LBLOCA PCT for both units is 2159 °F, which is in compliance with the criterion set forth in 10 CFR 50.46 (b)(1) that the fuel element cladding temperature not exceed 2200 °F. The Small-Break Loss of Coolant (SBLOCA) PCT is not affected, but has been included in this report for completeness.

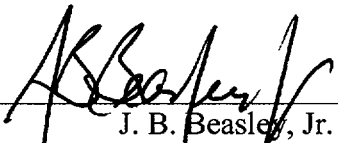
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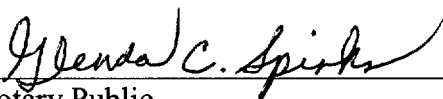
Per 10 CFR 50.46 (a)(3)(ii), reanalysis or taking other action is not required because compliance with 10 CFR 50.46 (b)(1) has been demonstrated. However, SNC does intend to commence a reanalysis of the LBLOCA in the near future. The results of the significant error report will be incorporated in a future Final Safety Analysis Report (FSAR) update.

Mr. J. B. Beasley, Jr. states that he is a Vice President of Southern Nuclear Operating Company (Southern Nuclear) and is authorized to execute this oath on behalf of Southern Nuclear and that, to the best of his knowledge and belief, the facts set forth in this letter and enclosures are true.

SOUTHERN NUCLEAR OPERATING COMPANY

By:   
J. B. Beasley, Jr.

Sworn to and subscribed before me this 19<sup>th</sup> day of October, 1999.

  
Notary Public

My Commission Expires: 11/10/02

Attachment

cc: Southern Nuclear Operating Company  
Mr. J. T. Gasser  
Mr. M. Sheibani  
SNC Document Management

U. S. Nuclear Regulatory Commission  
Mr. L. A. Reyes, Regional Administrator  
Mr. Ramin R. Assa, Vogtle Project Manager, NRR  
Mr. J. Zeiler, Senior Resident Inspector, Vogtle

State of Georgia  
Mr. L. C. Barnett, Commissioner, Department of Natural Resources

**ATTACHMENT**  
**VOGTLE ELECTRIC GENERATING PLANT**  
**10 CFR 50.46 ECCS EVALUATION MODELS SIGNIFICANT ERROR REPORT**

**BACKGROUND**

Provisions in 10 CFR 50.46 require applicants and holders of operating licenses or construction permits to notify the Nuclear Regulatory Commission (NRC) of errors and changes in the Emergency Core Cooling System (ECCS) Evaluation Models on an annual basis when the errors and changes are not significant, and within 30 days of discovery when the errors and changes are significant. A significant error or change, as defined by 10 CFR 50.46, is one which results in a calculated fuel peak cladding temperature (PCT) different by more than 50 °F from the temperature calculated for the limiting transient using the last acceptable model, or a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than 50 °F.

The following presents a summary of the effects of errors and changes to the Westinghouse ECCS Evaluation Models on the Vogtle Electric Generating Plant (VEGP) Units 1 and 2 loss of coolant accident (LOCA) analyses since the 1998 annual report (Reference 1). This report has been prepared in accordance with the methodology presented in WCAP-13451 (Reference 3). The LBLOCA and SBLOCA analyses, Evaluation Model assessments, and safety evaluation results reported herein will be included in a future VEGP Final Safety Analysis Report (FSAR) update.

**LARGE-BREAK LOCA**

ECCS Evaluation Model

Since the 1998 annual report (Reference 1), two new assessments against the VEGP LBLOCA analysis have been identified. In addition, a previous assessment reported in Reference 1 has been revised. The two new assessments are: LOCBART Spacer Grid Single-Phase Heat Transfer Error (+15 °F) and LOCBART Zirc-Water Oxidation Error (+162 °F). The assessment for the increased accumulator line resistance of 43 °F reported in Reference 1 has been reduced to 29 °F. These three assessments are the only assessments since the last VEGP LBLOCA significant error report (Reference 2).

In addition to the above assessments, the cycle-specific transition core penalty of 50 °F reported in the Analysis-of-Record category has been reduced to 0 °F for the current cycles.

The LBLOCA analysis results are based on the Westinghouse BASH large-break ECCS Evaluation Model (Reference 4), as approved by the NRC for VEGP-specific application (References 5 and 6), and the latest acceptable LOCBART model. The limiting size

## Attachment

### Page 2

break analysis continues to assume the following information important to the LBLOCA analyses:

- o 17x17 VANTAGE-5 Fuel Assembly
- o Core Power = 1.02 \* 3565 MWT
- o Vessel Average Temperature = 571.9 °F
- o Steam Generator Plugging Level = 10%
- o  $F_Q = 2.50$
- o  $F_{\Delta H} = 1.65$

For VEGP Units 1 and 2, the limiting size break continues to be the double-ended guillotine rupture of the cold leg piping with a discharge coefficient of  $C_D = 0.6$ . The LBLOCA LOCBART analysis-of-record calculated PCT value is 1915 °F.

The Analysis-of-Record category continues to include an assessment of - 4 °F for the LOCBART clad creep and burst error.

The containment purge,  $T_{avg}$  uncertainty, and transition core penalty items continue to be listed separately. The items are listed separately because these items are not explicitly modeled. The PCT assessment values of the containment purge and  $T_{avg}$  penalties remain at 10 and 11 °F, respectively. The cycle-specific transition core penalty of 50 °F will be reduced to 0 °F as discussed below. Because this penalty may be used in subsequent cycles, depending on core design, it will remain as a line item but will be reported as having a value of 0 °F.

The intent of the transition core penalty was to address cycles where full regions of both LOPAR and VANTAGE-5 fuel may exist within the same core. In these cases, a conservative 50 °F penalty is applied until all LOPAR fuel has been removed from the core. For Unit 1 Cycle 9 (current operating cycle), all but eight LOPAR assemblies have been discharged, and these are only used on the periphery in corner locations. A cycle-specific evaluation has determined that neither the LOPAR fuel nor the surrounding assemblies, in their current locations, will be limiting with respect to LBLOCA since the operating power for both the LOPAR fuel and surrounding assemblies is at lower levels relative to the LOCA assumed core lead assembly. Therefore, the transition core penalty can be eliminated for Unit 1 Cycle 9. There is no LOPAR fuel in the Unit 2 Cycle 7 core (current operating cycle at the time the errors were identified) or in the currently planned Unit 2 Cycle 8 core (to be loaded in Fall 1999).

VEGP cores contain ZIRLO clad IFBA fuel rods with a backfill pressure of 100 psig. The ZIRLO clad IFBA rods result in a penalty of 21 °F PCT as calculated by the latest acceptable LOCBART model.

## Attachment

### Page 3

VEGP cores contain ZIRLO clad fuel rods. The use of ZIRLO clad fuel rods results in a penalty of 5 °F PCT as calculated by the latest acceptable LOCBART model.

VEGP cores continue to contain a mix of Zircaloy and ZIRLO clad fuel rods and IFBA and non-IFBA rods. VEGP will continue to show an analysis-of-record LOCBART calculated PCT value based on non-IFBA, Zircaloy fuel rods (1915 °F), and will apply PCT penalties to address the use of ZIRLO clad fuel rods.

#### Prior 10CFR50.46 BASH Large-Break ECCS Evaluation Model Assessments

In the following table and as reported in Reference 2, four prior model assessments have been combined into a single assessment of – 6 °F. These assessments are: (1) Steam Generator Flow Area Application, (2) Structural Metal Heat Modeling, (3) LUCIFER Error Correction, and (4) Translation of Fluid Conditions from SATAN to LOCTA.

#### 1999 To-Date 10CFR50.46 BASH Large-Break ECCS Evaluation Model Assessments

In the 1998 annual report (Reference 1), an assessment to the BASH large-break ECCS Evaluation Model that would affect the VEGP LBLOCA PCT analysis was identified as a result of a model application error. A 43 °F PCT penalty for an increase in accumulator line resistances was assessed.

The ECCS accumulator check valves are tested as part of the Inservice Test Program. As part of the test, the accumulator line resistances are verified for comparison with the safety analysis. This is done as a backup to the check valve test. During measurement of the accumulator line resistances in the Unit 2 end-of-cycle 6 outage (spring 1998), it was discovered that the measurements were not consistent with the safety analysis. The LOCA analyses were revised to reflect higher line resistances. The increased line resistances in the analyses resulted in an increase in the peak clad temperature (PCT) for the limiting break.

A review of the as-built accumulator line geometric data showed that the line resistances are lower than that assumed in the safety analyses. Using the revised data, it was determined that the penalty for higher accumulator line resistance can be reduced by 14 °F from 43 °F to 29 °F.

The Yao-Hochreiter-Leech correlation is used in the LOCBART code to compute the single-phase heat transfer enhancement for axial elevations located downstream of spacer grids. The methodology requires that a length-averaged value be used to specify the heat transfer coefficient for a given fluid cell, since use of a local value corresponding to the forward edge or the rear edge of the cell could be non-conservative. It was determined that the length-averaging in LOCBART was not being performed correctly in all cases. A bounding PCT penalty of 15 °F has been assessed.

A logic error in the LOCBART code caused the Baker-Just metal-water reaction calculations to be performed three times per time step. The algorithm for calculating the reaction rate overestimated the amount of cladding oxidation and underestimated the heat generation and PCT. Correcting the error resulted in a reduction in the total cladding oxidation and an increase in the heat deposition in the cladding and thus, an increase in the PCT. A bounding PCT penalty of 162 °F was assessed.

LBLOCA 10CFR50.46 ECCS Evaluation Model Assessment Summary

The absolute sum of the LBLOCA PCT assessments since the last LBLOCA significant error report (Reference 2) is 206 °F.

10 CFR 50.59 Evaluation Assessments

There are three plant modifications pursuant to 10 CFR 50.59 which affect the LBLOCA analysis results. The combined PCT effects from the two evaluations for the permanent radiation shield and for the trisodium phosphate baskets result in only a 1 °F PCT assessment. A third plant modification, the addition of metal mass in containment, is being tracked for completeness, even though the PCT penalty is much less than 1 °F and is reported as 0 °F.

Licensing Basis LBLOCA PCT

Based on the above discussions concerning the VEGP-specific application of the Westinghouse BASH large-break ECCS Evaluation Model, the licensing basis LBLOCA PCT is as follows:

A. LBLOCA BASH ECCS Model Analysis-of-Record

1. LOCBART Analysis Result	1915 °F
2. LOCBART Clad Creep and Burst Error	- 4 °F
3. Evaluation for Containment Purging	+ 10 °F
4. Evaluation for +/- 6 °F Uncertainty Band	+ 11 °F
5. Evaluation for Transition Cycle Penalty	+ 0 °F
6. 100 psig Backfill Pressure with ZIRLO Clad	+ 21 °F
7. ZIRLO Clad Fuel Rods	+ 5 °F

**Attachment**  
**Page 5**

B. Prior 10CFR50.46 BASH Large-Break ECCS Model Assessments

Steam Generator Flow Area Application, Structural Metal Heat Modeling, LUCIFER Error Corrections, and Translation of Fluid Conditions from SATAN to LOCTA as reported to the NRC in Reference 2. - 6 °F

C. 1999 To-Date 10CFR50.46 BASH Large-Break ECCS Model Assessment

- 1. Increased Accumulator Line Resistances + 29 °F
- 2. LOCBART Spacer Grid Single-Phase Heat Transfer Error + 15 °F
- 3. LOCBART Zirc-Water Oxidation Error + 162 °F

D. 10 CFR 50.59 Evaluations

- 1. Permanent Radiation Shield/TSP Baskets + 1 °F
- 2. Addition of Metal Mass in Containment 0 °F

Licensing Basis LBLOCA PCT (Unit 1 and Unit 2) = 2159 °F

Conclusion

When the effects of assessments to the BASH ECCS Evaluation Model and of safety evaluations were combined with the VEGP LBLOCA analysis results, it was determined that compliance with the requirements of 10 CFR 50.46 is being maintained for both Units 1 and 2.

## **SMALL-BREAK LOCA**

### ECCS Evaluation Model

Since the last annual report (Reference 1), no new assessments were identified against the small-break LOCA (SBLOCA) analysis PCT for VEGP Units 1 and 2. The current SBLOCA analysis results are based on the earlier Westinghouse NOTRUMP small-break ECCS Evaluation Model (Reference 7), as approved by the NRC for VEGP-specific application (References 5 and 6), and the latest acceptable SBLOCTA model. The limiting size break analysis continues to assume the following information important to the SBLOCA analyses:

- o 17x17 VANTAGE-5 Fuel Assembly
- o Core Power = 1.02 \* 3565 MWT
- o Vessel Average Temperature = 571.9 °F
- o Steam Generator Plugging Level = 10%
- o  $F_Q = 2.58$
- o  $F_{\Delta H} = 1.70$

For VEGP Units 1 and 2, the limiting size small-break continues to be a three-inch equivalent diameter break in the cold leg. The SBLOCA analysis-of-record SBLOCTA calculated PCT value is 1770 °F.

The Analysis-of-Record category continues to include an assessment of +8 °F for the SBLOCA fuel rod initialization error.

The steam generator lower level tap relocation and  $T_{avg}$  uncertainty items continue to be listed separately. The items are listed separately because these items are not explicitly modeled. The PCT assessment values on these items are 15 °F and 4 °F, respectively. A PCT assessment of 30 °F is also listed separately for Burst and Blockage/Time in Life.

VEGP cores contain ZIRLO clad fuel rods. The use of ZIRLO clad fuel rods results in a penalty of 3 °F PCT as calculated in the latest acceptable SBLOCTA model. This penalty applies to both IFBA and non-IFBA rods.

### Prior 10CFR50.46 NOTRUMP Small-Break ECCS Evaluation Model Assessments

In the following table and as reported in References 2 and 8, five prior model assessments have been combined. These assessments are: (1) Safety Injection (SI) Flow into the Broken RCS Loop/Improved Steam Condensation Model, (2) Drift Flux Flow Regime Error, (3) LUCIFER Error Corrections, (4) Boiling Heat Transfer Correlation Error, and (5) Steam Line Isolation Logic Error.



The NOTRUMP specific enthalpy error continues to be listed separately in accordance with WCAP-13451 since it was not combined with the prior model assessments (see Reference 2).

1999 To-Date 10CFR50.46 NOTRUMP Small-Break ECCS Evaluation Model Assessments

No new assessments have been identified to the NOTRUMP SBLOCA ECCS Evaluation Model that would affect the VEGP analysis results.

SBLOCA 10CFR50.46 ECCS Model Assessment Summary

The absolute sum of the new SBLOCA PCT assessments since the last SBLOCA significant error report (Reference 9) is less than 50 °F for the VEGP NOTRUMP SBLOCA ECCS model.

10 CFR 50.59 Evaluation Assessments

There are two plant modifications pursuant to 10 CFR 50.59 which affect the SBLOCA analysis results for VEGP Unit 1. These are: (1) annular pellet blankets, and (2) loose part in the RCS. The PCT penalty on annular pellet blankets is the only one of the two which is applicable to VEGP Unit 2.

Licensing Basis SBLOCA PCT

Based on the above discussions concerning the VEGP-specific application of the Westinghouse NOTRUMP small-break ECCS Evaluation Model, the licensing basis SBLOCA PCT is as follows:

A. SBLOCA NOTRUMP ECCS Model Analysis-of-Record

1. SBLOCA Analysis Result	1770 °F
2. SBLOCA Fuel Rod Initialization Error	+ 8 °F
3. Evaluation for Steam Generator Lower Level Tap Relocation	+ 15 °F
4. Evaluation for +/- 6 °F Uncertainty Band	+ 4 °F
5. Burst and Blockage/Time in Life	+ 30 °F
6. ZIRLO Clad Fuel Rods	+ 3 °F

**B. Prior 10CFR50.46 NOTRUMP Small-Break ECCS Model Assessments**

- |  |         |
|--|---------|
| 1. Safety Injection Flow into Broken RCS Loop/Improved Steam Condensation Model, Drift Flux Flow Regime, LUCIFER Error Corrections, Boiling Heat Transfer Correlation Error, and Steam Line Isolation Logic Error as reported to the NRC in Reference 8. | - 17 °F |
| 2. NOTRUMP Specific Enthalpy Error   | + 20 °F |

**C. 1999 To-Date 10CFR50.46 NOTRUMP Small-Break ECCS Model Assessments**

No new assessments have been identified in 1999 to-date. 0 °F

**D. 10 CFR 50.59 Evaluations**

- |                                  |         |
|----------------------------------|---------|
| 1. Annular Pellet Blankets       | + 10 °F |
| 2. Loose Part (VEGP Unit 1 only) | + 2 °F  |

Licensing Basis SBLOCA PCT (Unit 1) =	<u>1845 °F</u>
(Unit 2) =	<u>1843 °F</u>

**Conclusion**

When the effects of assessments to the NOTRUMP ECCS Evaluation Model and the effects of safety evaluations were combined with the VEGP SBLOCA analysis results, it was determined that compliance with the requirements of 10 CFR 50.46 is being maintained for both Units 1 and 2.

## REFERENCES

1. LCV-1342, "Vogtle Electric Generating Plant, 10CFR50.46 ECCS Evaluation Models 1998 Annual Report," letter from J. B. Beasley, Jr. (SNC) to USNRC, dated April 29, 1999.
2. LCV-0998, "Vogtle Electric Generating Plant, 10 CFR 50.46 ECCS Evaluation Models 1996 Annual Report and Significant Error Report," letter from C. K. McCoy (SNC) to USNRC, dated March 31, 1997.
3. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," dated October 1992.
4. "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code," WCAP-10266-P-A, Rev. 2, (Proprietary), March 1987.
5. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment Nos. 43 and 44 to Facility Operating License NPF-68 and Amendment Nos. 23 and 24 to Facility Operating License NPF-81, attachment to letter from Hood (USNRC) to Hairston (GPC), dated September 19, 1991.
6. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 60 to Facility Operating License NPF-68 and Amendment No. 39 to Facility Operating License NPF-81, attachment to letter from Hood (USNRC) to Hairston (GPC), dated March 22, 1993.
7. "Westinghouse Small-Break ECCS Evaluation Model Using the NOTRUMP Code," WCAP-10054-P-A (Proprietary) and WCAP-10081-A (Non-Proprietary), August 1985.
8. LCV-0579, "Vogtle Electric Generating Plant, 10 CFR 50.46 ECCS Evaluation Models 1994 Annual Report," letter from C. K. McCoy (GPC) to USNRC, dated March 17, 1995.
9. LCV-0327-B, "Vogtle Electric Generating Plant, 10 CFR 50.46 ECCS Evaluation Models Significant Change Report," letter from C. K. McCoy (GPC) to USNRC, dated December 8, 1994.