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Georgia Power
the southern electric system

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LCV-0327

Docket Nos. 50-424
50-425

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

Gentlemen:

VOGTLE ELECTRIC GENERATING PLANT
10 CFR 50.46 ECCS EVALUATION MODELS 1993 ANNUAL REPORT

Attached is Georgia Power Company's 10 CFR 50.46 Emergency Core Cooling System (ECCS) Evaluation Models 1993 Annual Report based on WCAP-13451 and in compliance with the reporting requirements of 10 CFR 50.46(a)(3)(ii). It is based on information provided by Westinghouse on February 8, 1994, of errors and changes affecting the Vogtle Electric Generating Plant (VEGP) ECCS Evaluation Models for the calendar year 1993.

The attached annual report summarizes the effects of changes and errors in the ECCS Evaluation Models on peak clad temperature (PCT). The results presented for the small-break loss of coolant accident (SBLOCA) are based on an ECCS reanalysis which incorporated a correction to the Bessel function error. New assessments against both large-break (LB) and SBLOCA are also presented. Also, the annual report provides a summary of the plant change safety evaluations performed under the provisions of 10 CFR 50.59 that also affect PCT. The annual report results will be incorporated into the Final Safety Analysis Report (FSAR) update.

The assessed sum of the absolute magnitude of the assessments remains greater than 50°F PCT for the NOTRUMP SBLOCA Model results; however, the net effect of the assessments is a reduction in the SBLOCA PCT for VEGP. The SBLOCA PCT results are affected by two main issues as reported in our Significant Change Report (LCV-0199 dated November 5, 1993): safety injection in the broken loop and the improved

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condensation model. The LBLOCA PCT results are not affected by these two issues. Because these two NOTRUMP small-break ECCS model errors/changes affect many plants, the Westinghouse Owners Group is still reviewing the issues and possible development of a generic program for resolution that is acceptable to the NRC. A schedule for resolution and reanalysis will be provided following the completion of the Westinghouse Owners Group review.

Based on the attached 1993 Annual Report, it has been determined that compliance with the requirements of 10 CFR 50.46 continues to be maintained when the effects of plant design changes are combined with the effects of the ECCS Evaluation Models assessments applicable to VEGP Units 1 and 2.

If you have any questions regarding this report, please contact this office.

Sincerely,

C. K. McCoy

CKM/BCA/HWM:gps/gmb

Attachment

cc: Georgia Power Company
Mr. J. B. Beasley, Jr.
Mr. M. Sheibani
NORMS

U.S. Nuclear Regulatory Commission
Mr. S. D. Ebneter, Regional Administrator
Mr. D. S. Hood, Licensing Project Manager, NRR
Mr. B. R. Bonser, Senior Resident Inspector, Vogtle

LCV-0327

ATTACHMENT

10 CFR 50.46 ECCS EVALUATION MODELS 1993 ANNUAL 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. Reference 1 defines a significant error or change as 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 as 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 an assessment of the effects of the 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. The current LOCA analyses results were reported in the 1992 Annual Report (reference 1) and Significant Change Report (reference 2) based on the format presented in WCAP-13451 (reference 3). The LOCA 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

The large-break LOCA (LBLOCA) analysis PCT for VEGP Units 1 and 2 remains unchanged since the 1992 Annual Report. 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). The limiting size break analysis assumed the following information important to the LBLOCA analyses:

- 17x17 VANTAGE-5 Fuel Assembly
- Core Power = 1.02 * 3565 MWt
- Vessel Average Temperature = 571.9°F
- Steam Generator Plugging Level = 10%
- FQ = 2.50
- F-delta-H = 1.65

ATTACHMENT (CONTINUED)
10 CFR 50.46 ECCS EVALUATION MODELS 1993 ANNUAL REPORT

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 CD = 0.6. The LBLOCA analysis calculated PCT remains 2025°F (references 1 and 2).

The containment purge, Tavg uncertainty, and transition core penalty items continue to be listed separately per the format of WCAP-13451. The items are listed separately because these items are not explicitly modeled. The PCT assessment values on these items are 10, 11, and 50°F, respectively.

The steam generator flow area application and structural metal heat modeling assessments continue to be listed separately per the format of WCAP-13451. These items are prior BASH large-break ECCS Evaluation Model assessments. The PCT assessment values on these items are 10 and -25°F,respectively.

NEW BASH LARGE-BREAK ECCS EVALUATION MODEL ASSESSMENTS

Since the 1992 Annual Report, the following new assessment to the BASH large-break ECCS Evaluation Model that would affect the VEGP LBLOCA PCT analysis is as follows:

LUCIFER Error Corrections

The LUCIFER code is used to generate, from raw input data, the component databases to be used in the small-break and LBLOCA analyses. Errors were found in the VESCAL subroutine of the LUCIFER code. These errors were in the geometric and mass calculations of the vessel and steam generator portions of the needed data. All LOCA analyses using the LUCIFER code outputs are affected by these error corrections. The errors were corrected in a manner to maintain the consistency of the LUCIFER code. The effect of this issue on the VEGP LBLOCA analysis is a benefit to the PCT results (-6°F).

LBLOCA ECCS EVALUATION MODEL ASSESSMENT SUMMARY

When combining the previous BASH LBLOCA ECCS Evaluation Model assessments with the new assessment for 1993 (LUCIFER Error Corrections), the absolute sum of the PCT assessments remains below 50°F. Therefore, no LBLOCA ECCS reanalysis is required for VEGP Units 1 and 2.

ATTACHMENT (CONTINUED)
10 CFR 50.46 ECCS EVALUATION MODELS 1993 ANNUAL REPORT

10 CFR 50.59 EVALUATION ASSESSMENTS

Two plant modifications pursuant to 10 CFR 50.59 which affect the LBLOCA analysis results were previously reported (reference 2): fuel reconstitution and the addition of a permanent radiation shield.

Because the VEGP Unit 1 Cycle 5 core design contains one fuel assembly that has been reconstituted with one stainless steel filler rod, an evaluation of the LBLOCA PCT was performed. The evaluation concluded that a 2°F penalty must be assessed to the VEGP Unit 1 PCT results.

A permanent reactor vessel head radiation shield was installed on VEGP Unit 2. The previous radiation shielding was temporary, installed during the refueling outage and removed following the outage. The shield will now become an integral part of the reactor vessel head. Due to the additional heat sink surface area and mass, the vessel flooding rate is reduced which results in a 1°F increase in PCT. Thus, the evaluation concluded that a 1°F penalty must be assessed to the VEGP Unit 2 PCT results. At the next refueling outage for VEGP Unit 1, the permanent shielding will also be installed; thus, the same 1°F penalty will be assessed to VEGP Unit 1 at that time.

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. 1992 Annual Report LBLOCA Analysis of Record (references 1 and 2)	
1. BASH Large-Break ECCS Model Analysis Result	2025.0°F
2. Evaluation for Containment Purging	+ 10.0°F
3. Evaluation for +/- 6°F Uncertainty Band	+ 11.0°F
4. Evaluation for Transition Cycle Penalty	+ 50.0°F
B. BASH Large-Break ECCS Model Assessments Prior to 1993	
1. Steam Generator Flow Area Application	+ 10.0°F
2. Structural Metal Heat Modeling	- 25.0°F
C. 10 CFR 50.59 Evaluations	
1. Fuel Reconstitution (VEGP Unit 1)	+ 2.0°F
2. Permanent Radiation Shield (VEGP Unit 2)	+ 1.0°F
D. 1993 BASH Large-Break ECCS Model Assessments	
Lucifer Error Corrections	- 6.0°F
LICENSING BASIS LBLOCA PCT (Unit 1) =	2077.0°F
(Unit 2) =	2076.0°F

CONCLUSION

An evaluation of the effect of assessments to the Westinghouse BASH large-break ECCS Evaluation Model was performed on the LBLOCA analysis results. When the effects of the BASH ECCS Evaluation Model assessments and safety evaluations were combined with the VEGP LBLOCA analysis results, it was determined that VEGP Units 1 and 2 are in compliance with the requirements of 10 CFR 50.46(b).

SMALL-BREAK LOCA

ECCS EVALUATION MODEL

As previously reported (reference 2), significant errors/changes were assessed against the small-break LOCA (SBLOCA) analysis PCT for VEGP Units 1 and 2 since the 1992 annual report (reference 1). The SBLOCA analysis results are based on the Westinghouse NOTRUMP small-break ECCS Evaluation Model (reference 7) as approved by the NRC for VEGP-specific application (references 5 and 6). The limiting size break analysis assumed the following information important to the SBLOCA analyses:

- 17x17 VANTAGE-5 Fuel Assembly
- Core Power = 1.02 * 3565 MWt
- Vessel Average Temperature = 571.9°F
- Steam Generator Plugging Level = 10%
- FQ = 2.48 at 9.5 ft
- F-delta-H = 1.70

For VEGP Units 1 and 2, the limiting size small-break continues to be a 3-inch equivalent diameter break in the cold leg. A reanalysis of the SBLOCA ECCS was performed in 1993. The revised SBLOCA analysis calculated PCT is 1834°F. This ECCS reanalysis value incorporates correction of the Bessel function error which was previously assessed as a 25°F penalty (references 1 and 2) to the NOTRUMP small-break ECCS Evaluation Model.

The steam generator lower level tap relocation and Tavg uncertainty items continue to be listed separately per the format of WCAP-13451. The items are listed separately because these items are not explicitly modeled. The PCT assessment values on these items are 15 and 4°F, respectively.

NEW NOTRUMP SMALL-BREAK ECCS EVALUATION MODEL ASSESSMENTS

Since the 1992 annual report, new assessments to the NOTRUMP small-break ECCS Evaluation Model that would affect the VEGP SBLOCA PCT analysis results are as follows:

1. Safety Injection in the Broken Loop

   As previously reported (reference 2), Westinghouse completed an evaluation of a potential issue concerning the modeling of safety injection (SI) flow into the broken RCS loop for the SBLOCA. In previous analyses, Westinghouse assumed that modeling SI flow into the broken RCS loop would result in a lower calculated PCT because additional SI flow would be expected to provide additional core cooling. Therefore, in previous analyses, SI flow into the broken RCS loop was modeled as spilling directly into the containment sump to provide conservative PCT results. For SBLOCA events using NOTRUMP, recent evaluations indicate that modeling SI flow into the broken RCS loop will actually result in a significant increase in PCT. The increase in PCT occurs as a result of competition between the steam venting out the break and the SI to the broken loop both exiting through the break. The competition between the steam and the SI results in higher RCS pressures; therefore, lower delivered SI flow rates to the intact RCS loops and an increase in PCT are the results. The effect of this issue is a 150°F increase in PCT. Therefore, a 150°F penalty was assessed against the VEGP SBLOCA PCT results.

2. Improved Steam Condensation Model

   The SI in the broken loop issue described above is significant with regard to the effect on calculated SBLOCA PCT results. As previously reported (reference 2), an offsetting steam condensation benefit has been identified which more than offsets the above 150°F PCT penalty. Improved condensation of the loop steam in the intact loops results in lower RCS pressures and increased SI flow rates. The increased SI flow rates result in a lower calculated PCT. Thus, the negative effects of SI in the broken loop can be fully offset by an improved SI steam condensation model in the intact RCS loops. Thus, a 150°F benefit was assessed against the VEGP SBLOCA PCT results to offset the SI in the broken loop PCT penalty.

The Westinghouse Owners Group continues to review both issues -- SI in the broken loop and the improved SI steam condensation model -- and is pursuing a generic program for resolution that is acceptable to the NRC. Westinghouse is keeping the NRC (Reactors Systems Branch) informed of the resolution of these two issues.

3. Drift Flux Flow Regime Errors

As previously reported (reference 2), errors were discovered by Westinghouse in both WCAP-10079-P-A and related coding in NOTRUMP where the improved TRAC-P1 vertical flow regime map is evaluated. This flow regime map is only used during counter-current flow conditions in vertical flow links. The error occurs as a result of an unbounded parameter which may lead to a discontinuity in the flow regime map under certain circumstances. The effect of this issue is a 13°F decrease in PCT. The error has been corrected in NOTRUMP. A benefit of 13°F was assessed against the VEGP SBLOCA PCT results.

4. Burst and Blockage/Time in Life

An evaluation of a potential issue with regard to burst/blockage modeling in the Westinghouse SBLOCA Evaluation Model was recently completed. This potential issue involved a number of synergistic effects, all related to the manner in which the SBLOCA model accounts for the swelling and burst of fuel rods, modeling of the rod burst strain, and resulting effects on clad temperature and oxidation from the metal/water reaction models and channel blockage.

Fuel rod burst during the course of a SBLOCA analysis was found to potentially result in a significant temperature excursion above the clad temperature transient for a non-burst case. Since the methodology for SBLOCA analyses had been to perform the analyses at a near beginning-of-life (BOL) condition, where rod internal pressures are relatively low, most analyses did not result in the occurrence of rod burst, and therefore may not have reflected the most limiting time in life PCT. In order to evaluate the effects of this phenomenon, Westinghouse has developed an analytical model which allows the prediction of rod burst PCT effects based upon the existing analysis-of-record.

The effect of this issue is a 15°F increase in PCT. Therefore, a 15°F penalty has been assessed against the VEGP SBLOCA PCT results.

5. Hot Assembly Average Rod Burst Strain

The rod heatup code used in SBLOCA calculations contains a model to calculate the amount of clad strain that accompanies rod burst. However, the methodology which has historically been used is to not apply this burst strain model to the hot assembly average rod. This was done so as to minimize the rod gap and th[illegible]fore maximize the heat transferred to the fluid channel, which in turn would maxin[illegible] hot rod temperature. However, due to mechanisms governing the zirc-w[illegible] temperature excursion (which is the subject of the above burst and blockage/time in life penalty for the hot rod), modeling of clad burst strain for the hot assembly average rod can result in a penalty for the hot rod by increasing the channel enthalpy at the time of PCT. Therefore, the methodology has been revised such that burst strain will also be modeled on the hot assembly average rod.

Representative plant calculations have shown that this change in[illegible]roduces an approximate 10 percent increase in the SBLOCA limiting time-in-life penalty on the hot rod. The effect of this issue is a 2°F increase in PCT. Therefore, a 2°F penalty has been assessed against the VEGP SBLOCA PCT results.

6. Revised Fuel Rod Burst Strain Limit

A revised burst strain limit model which limits strains is being implemented into the rod heatup codes used in both LBLOCA and SBLOCA analyses. This model is identical to that previously approved for use for Appendix K analyses of Upper Plenum Injection plants with WCOBRA/TRAC as described in WCAP-10924-P-A, Rev. 1, Vol. 1, Add. 4, "Westinghouse LBLOCA Best-Estimate Methodology: Volume 1: Model Description and Validation, Addendum 4: Model Revisions," dated 1991.

For SBLOCA, representative plant calculations indicate that the magnitude of the benefit is conservatively estimated to be exactly offsetting to the SBLOCA penalty introduced by the hot assembly average rod burst strain issue documented on the previous page. Therefore, a 2°F benefit was assessed against the VEGP SBLOCA PCT results to offset the hot assembly average rod burst strain PCT penalty.

7. LUCIFER Error Corrections

As discussed in the LBLOCA section of this Annual Report, a LUCIFER code error was found in both the LBLOCA and SBLOCA analyses. The effect of this issue on the VEGP SBLOCA analysis is a benefit to the PCT results (-16°F).

SBLOCA ECCS MODEL ASSESSMENT SUMMARY

The absolute sum of the SBLOCA PCT assessments remains above 50°F for the VEGP NOTRUMP SBLOCA ECCS model. However, the net effect of the assessments is a reduction in VEGP SBLOCA PCT results. A resolution and reanalysis schedule for the VEGP SBLOCA analysis will be provided as soon as the Westinghouse Owner's Group has resolved the significant NOTRUMP SBLOCA model issues satisfactorily with the NRC.

10 CFR 50.59 EVALUATION ASSESSMENTS

Two plant modifications pursuant to 10 CFR 50.59 which affect the SBLOCA analysis results were previously reported (reference 2) -- fuel reconstitution and loose part.

Because the VEGP Unit 1 Cycle 5 core design contains one fuel assembly that has been reconstituted with one stainless steel filler rod, an evaluation of the SBLOCA PCT results was performed. The evaluation concluded that a 1°F penalty must be assessed to the VEGP Unit 1 SBLOCA PCT results.

An evaluation was performed to determine the effect of a loose part in the RCS. The loose part has been identified as the ring from the quick click pin on the fuel handling tool. The ring was lost in the spent fuel pool and may have been carried to the RCS by a fuel assembly. The evaluation concluded that a 2°F PCT penalty must be assessed against the VEGP Unit 1 SBLOCA PCT results.

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. 1992 Annual Report SBLOCA Analysis-of-Record (references 1 and 2)
   1. Previous NOTRUMP Small-Break ECCS Evaluation Model Analysis Result 1809.0°F
   2. Revised NOTRUMP Small-Break ECCS Evaluation Model Analysis Result Incorporating Bessel Function Error Correction 1834.0°F
   3. Evaluation for Steam Generator Lower Level Tap Relocation + 15.0°F
   4. Evaluation for +/- 6°F Uncertainty Band + 4.0°F

B. NOTRUMP Small-Break ECCS Evaluation Model Assessments Prior to 1993
   None + 0.0°F

C. 10 CFR 50.59 Evaluations
   1. Fuel Reconstitution (VEGP Unit 1) + 1.0°F
   2. Loose Part (VEGP Unit 1) + 2.0°F

D. 1993 10 CFR 50.46 NOTRUMP Small-Break ECCS Evaluation Model Assessments
   1. SI in Broken Loop (previously reported in reference 2) + 150.0°F
   2. Improved Condensation Model (previously reported in Reference 2) - 150.0°F
   3. Drift Flux Flow Regime (previously reported in reference 2) - 13.0°F
   4. Burst and Blockage/Time in Life + 15.0°F
   5. Average Rod Burst Strain + 2.0°F
   6. Fuel Rod Burst Strain Limit - 2.0°F
   7. LUCIFER Error Corrections - 16.0°F

LICENSING BASIS SBLOCA PCT (Unit 1) = 1842.0°F
(Unit 2) = 1839.0°F

CONCLUSION

An evaluation of the effect of assessments to the Westinghouse NOTRUMP small-break ECCS Evaluation Model was performed on the SBLOCA analysis results. When the effects of the NOTRUMP ECCS Evaluation Model assessments and safety evaluations were combined with the VEGP SBLOCA analysis result, it was determined that the sum of the absolute magnitude of the assessments remains greater than 50°F. However, the net effect of the assessments is a reduction in SBLOCA PCT results.

Because the NOTRUMP small-break ECCS errors/changes affect many plants, the Westinghouse Owners Group is continuing their review and is pursuing a generic program for resolution that is acceptable to the NRC. A schedule for resolution and reanalysis for the VEGP SBLOCA model will be provided following the completion of the Westinghouse Owners Group review.

REFERENCES

1. ELV-05255, "Vogtle Electric Generating Plant, 10 CFR 50.46 ECCS Model 1992 Report," letter from C. K. McCoy (GPC) to USNRC, dated February 23, 1993.

2. LCV-0199, "Vogtle Electric Generating Plant, 10 CFR 50.46 ECCS Model Significant Change Report," letter from C. K. McCoy (GPC) to the USNRC, dated November 5, 1993.

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-11524-A (Non-Proprietary), March 1987.

5. ELV-02166, "Vogtle Electric Generating Plant, Request for Technical Specifications Changes VANTAGE-5 Fuel Design," letter from W. G. Hairston, III, to USNRC, dated November 29, 1990.

6. ELV-03375, "Vogtle Electric Generating Plant, Licensing Change Power Uprating," letter from C. K. McCoy (GPC) to the NRC, dated February 28, 1992.

7. "Westinghouse Small-Break ECCS Evaluation Model Using the NOTRUMP Code," WCAP-10081-A (Non-Proprietary).