Georgia Power Company
333 Piedmont Avenue
Atlanta, Georgia 30308
Telephone 404 526-6526

Mailing Address:
Post Office Box 4545
Atlanta, Georgia 30302

W. G. Hairston, III
Senior Vice President
Nuclear Operations

*the southern electric system*

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

PLANT VOGTLE - UNIT 1
NRC DOCKET 50-424
OPERATING LICENSE NPF-68
REPORT OF LOCA REANALYSIS

Gentlemen:

Georgia Power Company (GPC) in our letter VL-51 dated August 30, 1988, withdrew a request to revise the value of the Heat Flux Hot Channel Factor $F_Q(z)$ found in Technical Specification 3.2.2. This withdrawal was based upon an analysis performed by Westinghouse Electric Corporation (Westinghouse) which demonstrated the acceptability of a value of $F_Q(z)$ of 2.30. A report on the Westinghouse analysis and its conclusions is hereby provided as Enclosure 1 for NRC review.

Revisions to the FSAR are being evaluated in accordance with 10 CFR 50.59 and will be included in an upcoming FSAR amendment. Upon restart from the current refueling outage, the administrative limit for $F_Q(z)$ of 2.25 which was imposed pending completion of the Westinghouse analysis will be rescinded, and Plant Vogtle will return to operation with a value of $F_Q(z)$ of 2.30.

The analyses and conclusions discussed herein are equally valid for Plant Vogtle Unit 2.

If you have questions regarding this information, please contact this office.

Sincerely,

W. G. Hairston, III

W. G. Hairston, III

WEB/11h

Enclosure

c: (see next page)



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Georgia Power



c: <u>Georgia Power Company</u>
Mr. P. D. Rice
Mr. G. Bockhold, Jr.
GO-NORMS

<u>U. S. Nuclear Regulatory Commission</u>
Dr. J. N. Grace, Regional Administrator
Mr. J. B. Hopkins, Licensing Project Manager, NRR (2 copies)
Mr. J. F. Rogge, Senior Resident Inspector - Operations, Vogtle

ENCLOSURE

# REPORT OF THE EVALUATION FOR INCREASED CSS FLOW RATE FOR VOGTLE UNIT 1

## BACKGROUND

As an indirect result of pre-operational testing at Vogtle Unit 2, it was determined that the Containment Spray System (CSS) maximum flow rate for Unit 1 was higher than was quoted in several sections of the FSAR. Further investigation by Westinghouse Fluid Systems indicated a minimum increase of 169 gpm. The following presents the summaries of safety evaluations performed to assess the effect of increased CSS flow rates on the LOCA-related analyses performed by Westinghouse for Vogtle Unit 1.

## BASES

LARGE BREAK LOCA - FSAR CHAPTER 15.6.5

The large break LOCA analysis which formed the licensing basis for Vogtle Unit 1 had very little margin to the 2200°F peak clad temperature (PCT) limit specified in 10CFR 50.46. The limiting case had a PCT of 2172°F at an overall peaking factor ($F_Q$) of 2.30 for the limiting discharge coefficient ($C_D$) of 0.6 (Reference 1), as computed using the 1981 version of the large break Westinghouse Evaluation Model (Reference 2). The effect of containment purging as reported in Chapter 6.2.1.5 of the Vogtle FSAR (Reference 1) increases the PCT by 10°F. A safety evaluation performed by Westinghouse which considers the effect of thimble tube modeling and chamfered fuel pellets resulted in an 8°F increase in the PCT. Therefore, the overall PCT that served as the licensing basis was 2190°F. An increase of 169 gpm in the containment spray system flow rate (from 6400 to 6569 gpm) would have resulted in a PCT increase of approximately 25°F based on conservative sensitivities. This would have resulted in an overall PCT of approximately 2215°F which exceeded the 2200°F PCT limit as specified in 10CFR 50.46. A Justification for Continued Operation (JCO) was submitted to the NRC and Vogtle Unit 1 was allowed to operate at a reduced $F_Q$ of 2.25.

In order to address the increased CSS flow rate and return to an $F_Q$ of 2.30, the large break LOCA was reanalyzed. The reanalysis was performed with the 1981 version of the large break Westinghouse Evaluation Model (Reference 2) with modifications for thimble tube modeling as specified in Reference 3. The analysis incorporated the following considerations:

1) increased containment spray flow from 6400 gpm to 6669 gpm
2) increased RCS pressure from 2280 psia to 2295 psia to account for instrument uncertainty (Veritrak issue resolution)
3) reduced fuel rod backfill pressure from 350 psia to 275 psia
4) chamfered fuel data (17x17 STD fuel)
5) reduced accumulator L/D ratios from calculated to measured values

6) revised containment heat sink data
7) thimble tube modeling as required by WCAP-9561-P-A
8) reduced RHR flows
9) 5% steam generator tube plugging

Items 2, 4, 7, and 8 have been addressed previously via a 10CFR 50.59 Safety Evaluation.

Analysis results show the limiting break continues to be the double ended cold leg guillotine (DECLG) with maximum safeguards safety injection flow and $C_D$=0.6 resulting in a PCT of 1995.8°F for an $F_Q$ of 2.32. The increased PCT margin to the regulatory limit can be largely attributed to the benefit which accrues from the reduced fuel rod backfill pressure (Item 3 above). In the previous 1981 Model ECCS analysis, performed in 1983, the hot assembly average fuel rod burst at 105.1 seconds resulting in an assembly average blockage of 56.4% and a burst/blockage penalty of 270°F when compared to the unblocked rod temperature (according to NRC imposed burst/blockage models of NUREG-0630). Because of the reduced backfill pressure the average hot assembly rod did not burst and, therefore, did not incur the 270°F penalty. This behavior is known as the cliff effect since a small change in plant parameters or model input may cause rod burst. This cliff effect is characteristic of the NUREG-0630 burst/blockage models.

In addition to reanalyzing the $C_D$=0.6 maximum safeguards case, the $C_D$=0.6 and 0.8 case for minimum safeguards were also reanalyzed. The results and FSAR changes for the reanalysis were provided to Georgia Power Company (GPC) in Reference 4. These results demonstrate compliance with the limits set forth in 10CFR 50.46 for the increased containment spay system flow rate for Vogtle Unit 1.

Of the changes to the large break LOCA analysis specified above (items 1 to 9), only increased containment spray flow had the potential to effect radiological consequences. Regulatory Guide 1.4 dictates a set of assumptions regarding core damage and containment leakage which defines a conservative and bounding case that effectively eliminates any effect that might be realistically expected from these changes. The exception, as stated, is containment spray flow which is used in determining the rate of removal of airborne iodine from the containment. However, increased containment spray increases the iodine removal rate thereby decreasing the radiological consequences. Therefore, the reported values continue to be bounding with respect to increased containment spray flow.

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SMALL BREAK LOCA - FSAR CHAPTER 15.6.5

The current FSAR small break LOCA analysis for Vogtle Unit 1 was performed using the NRC approved Small Break LOCA ECCS Evaluation Model (Reference 5), which resulted in the most limiting PCT of 1537°F for the 4 inch equivalent diameter break at an $F_Q$ of 2.32 (Reference 1). A containment analysis is not performed as part of the small break LOCA analysis (unlike large break LOCA), therefore, no modeling of the containment spray system is considered. Consequently, an increase in the containment spray system flow rate will have no effect on the small break LOCA and the current results remain valid.

ROD EJECTION MASS AND ENERGY RELEASE FOR DOSE CALCULATION - FSAR CHAPTER 15.4.8.3 and TABLE 15.4.8-2

Similar to a small break LOCA, a rod ejection accident analysis is performed to provide primary and secondary mass and energy releases for use in computing the radiological consequences of a rod ejection accident as per Regulatory Guide 1.77. This analysis is a long term transient performed specifically to determine primary RCS mass and energy releases through the upper head break and secondary mass and energy releases via the secondary code safety valves. These mass and energy releases are then used to compute the radiological consequences of a rod ejection accident. As with small break LOCA, no modeling of the containment spray system is performed. Therefore, an increase in the CSS flow rate will have no effect on the computed mass and energy releases and the subsequent calculated doses remain valid.

CONTAINMENT INTEGRITY - (SHORT AND LONG TERM MASS AND ENERGY RELEASES AND INADVERTENT CONTAINMENT SPRAY ACTUATION) FSAR CHAPTER 6.2

The containment integrity analyses are described in FSAR Chapter 6.2. This chapter considers, Subcompartment Pressure Transient Analyses, Short Term and Long Term Mass and Energy Release Analyses for Postulated Loss-of-Coolant Accidents (LOCA), Containment Response Analyses following a LOCA or Steamline Break Inside Containment, and Inadvertent Spray Actuation Analyses.

For subcompartment pressure transient and short term mass and energy analyses, an increase in the containment spray flowrate would have no effect on the calculated results since, because of the short duration of the transient ($\leq$ 3 seconds), containment spray actuation is not considered. The long term mass and energy release and containment response calculations following a LOCA or a steamline break inside containment do take credit for the containment spray system. However, a low spray flowrate is modeled to minimize heat removal in order to conservatively calculate peak containment pressure and temperature responses. An increase in the containment spray flowrate would be a benefit to these above identified analyses. Therefore, the conclusions presented in the current Vogtle FSAR will remain valid.

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The Inadvertent Spray Actuation Analysis is documented in Section 6.2.1.1.3.3 of the Vogtle FSAR. The purpose of this analysis is to determine the minimum pressure inside containment to calculate the peak differential pressure across the containment shell. In the event of inadvertent spray, the containment will depressurize until the air temperature is approximately equal to the spray temperature or the operator takes action to terminate the spray.

A reanalysis was performed based upon the revised containment spray flowrate. Results indicate a reduced containment pressure of 12.3 psia at approximately 10 minutes into the transient. Thus, the peak differential pressure is 2.36 psi across the containment shell. The design differential pressure for Vogtle is 3.0 psi. Therefore, the results of this analysis are within design limits and conform to the acceptance criteria of NUREG-0880.

## STEAM GENERATOR TUBE RUPTURE - FSAR CHAPTER 15.6.3

For a steam generator tube rupture (SGTR) accident, safety injection (SI) is actuated on a low pressurizer pressure signal shortly after reactor trip due to the decrease in reactor coolant inventory. For the SGTR analysis, it is assumed that the SI flow is delivered to the RCS until the operator actions are completed to terminate SI. Since the containment spray system is not actuated for an SGTR, operation of the spray system is not modeled in the analysis. Therefore, it is concluded that the increase in the containment spray flow for Vogtle will not effect the SGTR analysis currently in the Vogtle FSAR and the revised SGTR analysis presented in WCAP-11731 (Reference 6).

## BLOWDOWN REACTOR VESSEL AND LOOP FORCES - FSAR CHAPTER 3.6.2

The blowdown hydraulic forcing functions resulting from a loss of coolant accident are considered in Section 3.6.2.2 (Analytical Methods to Define Forcing Functions and Response Models) of Volume 8 of the Vogtle FSAR (Reference 1). The increase in the CSS flow rate will have no effect on the LOCA blowdown hydraulic loads since the maximum loads are generated within the first few tenths of a second after break initiation. For this reason the containment, including the containment spray system, is not considered in the LOCA hydraulic forces modeling and thus the increase in the CSS flow rate will have no effect on the results of the LOCA hydraulic forces calculations.

## POST LOCA LONG TERM CORE COOLING SUBCRITICALITY REQUIREMENT; WESTINGHOUSE LICENSING POSITION - FSAR CHAPTER 15.6.5

The Westinghouse licensing position for satisfying the requirements of 10CFR Part 50 Section 50.46 Paragraph (b) Item (5) "Long Term Cooling" is defined in

WCAP-8339 (Reference 7, pp. 4-22). The Westinghouse commitment is that the reactor will remain shutdown by borated ECCS water residing in the sump following a LOCA (Reference 8). Since credit for the control rods is not taken for large break LOCA, the borated ECCS water provided by the accumulators and the RWST must have a concentration that, when mixed with other sources of borated and non-borated water, will result in the reactor core remaining subcritical assuming all control rods out. An increase in the containment spray system flow rate will have no effect on those volumes and boron concentrations assumed for this calculation. Therefore, the current values are unaffected by the increase in CSS flow rate for Vogtle Unit 1.

HOT LEG SWITCHOVER TO PREVENT POTENTIAL BORON PRECIPITATION - FSAR CHAPTER 6.3.2.5.4

The hot leg recirculation switchover time analysis has been performed to determine the time following a LOCA that hot leg recirculation should be initiated. During a LOCA the plant switches to cold leg recirculation after the RWST switchover setpoint has beer reached. If the break is in the cold leg there is a concern that the cold leg injection water will fail to establish flow through the core. Safety injection entering the broken loop will spill out the break, while SI entering the intact cold legs will circulate around the downcome and out the break. With no flow path established through the core, core decay heat will cause boiling. As steam is produced, the boron associated with the steam remains in the vessel, thereby increasing the boric acid concentration in the core. The boron concentration in the vessel will increase to the solubility limit of the boric acid solution and the boron precipitates, plating out on the fuel rods, and adversely affecting their heat transfer characteristics.

The hot leg recirculation switchover time analysis establishes the time at which hot leg recirculation must be initiated to prevent boron precipitation in the core. This time is dependent on power level, and the RCS, RWST, and accumulator water volumes, masses, and boron concentrations. An increase in the containment spray system flow rate will have no effect these parameters such that there will be no effect on the post-LOCA hot leg switchover time of 11 hours.

CONCLUSIONS

The effect of an increase in the containment spray system flow rate on the LOCA related FSAR analyses for Vogtle Unit 1 has been evaluated by Westinghouse. In all cases, this change did not result in exceeding any design or regulatory limit. Therefore, the increased containment spray system flow rate for Vogtle Unit 1 is acceptable from the standpoint of the FSAR accident analyses discussed in this evaluation. Table 1 summarizes the results of this checklist. These analyses and conclusions are equally vaild for Plant Vogtle Unit 2.

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FOR VOGTLE UNIT 1

## REFERENCES


1. Vogtle Units 1 and 2 (GAE/GBE) FSAR - Updated 6/30/88 Amendment 36.

2. WCAP-9220-P-A (Proprietary), WCAP-9221 (Non-Proprietary), Eicheldinger, C., "Westinghouse ECCS Evaluation Model - 1981 Version", Revision 1, 1981.

3. WCAP-9561-P-A Addendum 3, Revision 1 (Proprietary), Young, M.Y., "Addendum To: BART-A1: A Computer Code For The Best-Estimate Analysis Of Reflood Transients (Special Report: Thimble Modeling In Westinghouse ECCS Evaluation Model)", July, 1986.

4. NS-SAT-SAI-88-318, "Vogtle Units 1 and 2 (GAE/GBE) Final Large Break LOCA Analysis Results", August 24, 1988.

5. WCAP-8970 (Proprietary) and WCAP-8971 (Non-Proprietary), "Westinghouse Emergency Core Cooling System Small Break October 1975 Model", April 1977.

6. WCAP-11731 (Proprietary), Lewis, R. N., Mendler, O. J., Miller, T. A., and Rubin, K., "LOFTTR2 Analysis for a Steam Generator Tube Rupture Event for the Vogtle Electric Generating Plant Units 1 and 2", January 1988.

7. WCAP-8339 (Non-Proprietary), Bordelon, F. M., et. al., "Westinghouse ECCS Evaluation Model - Summary", June 1974.

8. "Westinghouse Technical Bulletin NSID-TB-86-08, "Post-LOCA Long-Term Cooling: Boron Requirements", October 31, 1986.

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REPORT OF THE EVALUATION FOR INCREASED CSS FLOW RATE
FOR VOGTLE UNIT 1

TABLE 1
TRANSIENT SUMMARY

| FSAR CHAPTER | ACCIDENT DESCRIPTION | EFFECT ON RESULTS |
|---|---|---|
| 15.6.5 | Large Break LOCA | Large Break LOCA reanalyzed. Compliance with 10CFR 50.46b(1-3) maintained. |
| 15.6.5 | Small Break LOCA | No adverse effect on the FSAR peak cladding temperature calculations, maximum cladding oxidation or maximum hydrogen generation. Compliance with 10CFR 50.46b(1-3) maintained. |
| 15.4.8.3 | Rod Ejection Accident | No adverse effect on mass and energy releases. Compliance with 10CFR 100.11 limits maintained. |
| 6.2 | Containment Integrity Short and Long Term Mass and Energy Release | No adverse effect on short or long term mass and energy releases. Compliance with current environmental qualification limits maintained. |
| | Inadvertent Spray Actuation | Inadvertent spray actuation reanalyzed. Compliance with Tech Spec limit for minimum containment pressure maintained. |
| 15.6.3 | Steam Generator Tube Rupture | No adverse effect on primary-to-secondary mass release. Compliance with 10CFR 100.11 limits maintained. |
| 3.6.2 | Blowdown Reactor Vessel and Loop Forces | No adverse effect on the LOCA hydraulic forcing functions. |
| 15.6.5 | Post-LOCA Long term Core Cooling | No adverse effect on the post-LOCA sump boron concentration. Compliance with 10CFR 50.46b(5) maintained. |
| 6.3.2.5.4 | Hot Leg Switchover to Prevent Potential Boron Precipitation. | No adverse effect on the post-LOCA hot leg switchover time. |