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Georgia Power
the southern electric system

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Docket Nos. 50-321
50-366

HL-5043

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

Edwin I. Hatch Nuclear Plant
Reply to a Notice of Violation

Gentlemen:

In response to your letter dated September 22, 1995, and according to the requirements of 10 CFR 2.201, Georgia Power Company (GPC) is providing the enclosed response to the Notice of Violation associated with Inspection Report 95-17. In the enclosure, a transcription of the NRC violation precedes GPC's response.

Sincerely,

J. T. Beckham, Jr.

JKB/JP/eb

Enclosure: Violation 95-17-01 and GPC Response

cc: *Georgia Power Company*
Mr. H. L. Sumner, Jr., Nuclear Plant General Manager
NORMS

U. S. Nuclear Regulatory Commission, Washington, D. C.
Mr. K. Jabbour, Licensing Project Manager - Hatch

U. S. Nuclear Regulatory Commission, Region II
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Enclosure

Edwin I. Hatch Nuclear Plant
Violation 95-17-01 and GPC Response

VIOLATION 95-17-01

10 CFR 50, Appendix B, Criterion XVI, "Corrective Actions", as implemented by the Georgia Power Company, Hatch Quality Assurance Program, Revision 44, Section 16.1, requires, in part, that measures be established to assure that conditions adverse to quality, such as failures, malfunctions, and defective material and equipment, are promptly identified and corrected.

Contrary to the above, the licensee failed to promptly correct conditions adverse to quality, namely, the degradation of safety-related Low Pressure Coolant Injection (LPCI) and Core Spray Injection (CSI) valves. These failures are evidenced by the following examples:

1. The licensee failed to provide prompt corrective action for LPCI inboard injection valve failures in that:

   - Following a May 19, 1995, failure, the licensee determined the valves should be manually unseated to reduce the opening motor load during surveillance tests; however, this corrective action was not adequately implemented until after additional failures occurred on June 18, 1995, and July 2, 1995.

   - Following failures of valve 2E11F015B actuator motor on May 19, 1995, and June 18, 1995, the licensee failed to promptly inspect the other LPCI inboard injection valves to determine if they were experiencing similar problems. After valve 1E11F015B failed its surveillance test on July 2, 1995, the "A" valves were inspected and degradation was noted.

2. Due to leakage of system check valves, the potential existed for the leakage of reactor coolant into the LPCI and CSI inboard injection valve bonnets. Industry information indicated pressure locking of such valves caused by leakage into the valve's bonnet could occur during accident conditions, resulting in the valve being unable to stroke such that the system can perform its safety-related function. The licensee did not consider the potential for pressure locking of the LPCI and CSI inboard injection valves in their original pressure locking evaluations.

This is a Severity Level IV violation (Supplement I).

RESPONSE TO VIOLATION 95-17-01

During the September 13, 1995, predecisional enforcement conference, Georgia Power Company (GPC) affirmed the emphasis assigned to the low pressure coolant injection (LPCI) valves and the concern caused by the recent failures of the valves. GPC presented details of the investigations and analyses of the failures and a description of the actions taken based on the information available. However, given the current understanding of the technical aspects, timing of the failures, and assumptions applied, GPC has concluded that certain actions were not as definitive and aggressive as required at the time. Sufficient actions, as described in the response, have been taken to address these concerns. In view of these considerations, the Violation is accepted.

Reason for the Violation

Item 1 of the Notice Of Violation

On June 8, 1994, Southern Company Services, Plant Hatch's Architect/Engineer, issued a letter which stated the motor operators for Unit 1 and Unit 2 LPCI system injection valves 1E11-F015A&B and 2E11-F015A&B had adequate capability for operation under Design Basis Accident conditions, but lacked margin for operation under quarterly surveillance test conditions. This conclusion was based on analysis using the conservative operator sizing techniques developed in response to Generic Letter 89-10. The valves were originally designed to operate under full reactor pressure.

Plant Hatch's Inservice Test (IST) Program required the stroke times of these valves to be tested and recorded once per quarter; this is in accordance with the standard requirements of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section XI. Quarterly stroke-time testing potentially subjected these valves to differential pressures of approximately 1000 psid, which is significantly greater than their post Design Basis Loss of Coolant Accident (LOCA) differential pressure of less than 450 psid. Because of the high differential pressure, Southern Company Services recommended the surveillance procedures be revised to require the pressure to be relieved prior to stroking the valves. Additionally, the evaluation determined that 100 valve cycles at the higher pressure was allowable when considering actuator capabilities. The Nuclear Regulatory Commission (NRC) staff subsequently reviewed this letter and concluded no safety concern existed.

In response to the June 8, 1994 letter from Southern Company Services, GPC initiated efforts to change the Plant Hatch IST Program requirements for the LPCI valves. In particular, the required frequency of testing was to be changed from once per quarter to once per cold shutdown. This frequency change would eliminate the potential for the valves to be stroked at unnecessarily high differential pressures. Because of the numerous past successful quarterly surveillance tests and the 100-cycle allowance, GPC determined

no "impracticality" basis for making this test frequency change existed as required by IWV-3412 of ASME B&PV Code Section XI. Therefore, concluding that an immediate change was inappropriate, the change was scheduled for submittal to the NRC in September 1995 as part of the 10-year IST Program update in order to provide for NRC staff review. As a result, the surveillance procedure was not immediately revised to remove the potential high differential pressure condition prior to the valve motor failures.

On May 19, 1995, LPCI valve 2E11-F015B failed to open when its motor failed during a regularly scheduled quarterly surveillance test. The motor was replaced and a Significant Occurrence Report (SOR) was generated to initiate a formal, documented root cause analysis of the failure. In addition, a GPC motor expert was asked to examine the failed motor; he found it to have failed in a "stand still" or locked rotor condition. GPC conservatively assumed high differential pressure might be the cause for the reduction in motor life and expedited the IST Program frequency change for these valves by invoking the "impracticality" basis as allowed by the ASME B&PV Code.

The 2E11-F015B valve motor failed when motor stall caused high current conditions which shorted the motor windings. In retrospect, the May 19, 1995 failure was likely caused by a combination of several factors:

1. rotor degradation due to locked rotor occurrences in 1986,

2. length of time in service (approximately nine years),

3. high motor torque requirements due to high differential pressure conditions during testing and high valve speed.

Replacing the failed motor resolved the first two factors; the third factor was to be resolved through the IST Program frequency change. Following the motor failure and in recognition of the delay in implementing the IST program revision, GPC initiated action to revise the surveillance test procedure to manually unseat the LPCI injection MOVs to relieve the differential pressure prior to motor operation. As the next surveillance was not scheduled until July 2, 1995, personnel assumed there was no need to expedite the revision and scheduled the revision to be effective before that date. The action to manually unseat the LPCI valves prior to motor operation was intended as an interim action until the IST program could be revised. As a result, the procedure revision had not been implemented by June 18, 1995.

On June 18, 1995, valve 2E11-F015B failed to open when its motor failed during a functional test performed after overload relay and heater element replacement. The overload relay and heater elements were replaced as a conservative measure following the overcurrent condition experienced during the May 19, 1995 failure. The valve was required to be stroked and timed to restore it to an operable status following this work

irrespective of the frequency of testing required by Plant Hatch's IST Program. Also, the procedure revision to manually unseat the valves had not been implemented, as described earlier. The motor was replaced and an investigation was initiated. A GPC motor expert examined the failed motor and found it to have failed in a manner very similar to the previous failure, i.e., in a locked rotor condition. As a result of the failure, GPC temporarily changed the Unit 1 and Unit 2 LPCI valve surveillance procedures to require the valves to be manually moved off their closed seats prior to stroking with their motors.

The motor for 2E11-F015B failed when motor stall caused high current conditions which shorted the motor windings. Again, GPC conservatively assumed high differential pressure was the cause of the failure and took additional actions accordingly. However, further analysis showed the new motor's capability was reduced as the result of an improperly sized bushing which caused higher worm shaft bushing friction. This particular bushing is installed by the vendor and the valve operator vendor does not recommend a check of worm-shaft-to-bushing clearance. This bushing, in combination with high motor torque requirements due to high differential pressure conditions during testing and high valve speed, resulted in the relatively immediate motor failure on June 18, 1995. Following the discovery of the bushing problem, GPC revised appropriate maintenance procedures to require a check to be performed to verify a minimum clearance exists between the bushing and the worm shaft.

Had the bushing been properly sized, the motor likely would not have failed on June 18, 1995, and the corrective actions taken following the May 19, 1995 failure would have prevented future motor failures until the valve stroke testing frequency change to once per cold shutdown was implemented. The bushing sizing problem was not a contributor to the previous failure nor was it a known problem prior to either of these motor failures. Furthermore, the vendor manual for these valve operators did not require or recommend a check of worm-shaft-to-bushing clearance.

On July 2, 1995, valve 1E11-F015B failed to open when its motor shaft failed during a regularly scheduled quarterly surveillance test. The motor was replaced and an Event Review Team was initiated by Plant Hatch management. As part of the event investigation, non-destructive testing was performed on the broken shaft and extensive cracking radiating from the motor pinion gear keyway was found. Non-destructive testing was performed on the motor shafts for valves 1E11-F015A and 2E11-F015A and on the shaft of the motor removed from valve 2E11-F015B on May 19, 1995. Cracks radiating from the motor pinion gear keyway were found on all shafts except the shaft for the motor on valve 1E11-F015A. The 1E11-F015A motor pinion gear was keyed to the shaft with a key made of AISI 1018 material whereas the other three valves' motor pinion gears were keyed to the shaft with a key made of AISI 4140 material. The AISI 1018 key material is soft when compared to AISI 4140 and was found to have sheared. The harder AISI 4140 keys were found intact. The shearing of the AISI 1018 key prevented concentration of opening and closing forces at the keyway and the accompanying shaft cracking.

Metallurgical analyses performed on two of the cracked shafts by two different companies indicated the shafts were made of AISI 1144 material which has different material properties relative to AISI 4140 material strength.

The root cause analysis of the July 2, 1995 failure performed by the Event Review Team determined the shaft cracking and failure probably were the result of multiple factors:

1. key and shaft material,
2. hammer blow effect which is present when both opening and closing these valves,
3. high motor rpm,
4. high thrust due to high differential pressure and valve speed,
5. time in service, and
6. non-radiused keyway corners.

Additionally, following the motor failure on June 18, 1995, GPC revised the surveillance procedure to require the valves to be manually moved off their closed seats prior to stroking. However, the change was not adequately implemented in that the valve's limit switches did not provide an accurate indication of unseating. Consequently, the valve apparently was not unseated when the surveillance test on July 2, 1995 was performed.

GPC is currently in the process of inspecting other valve operator motor shafts for evidence of cracking during the current Unit 2 refueling outage. Additional motor shafts will be inspected during the next Unit 1 Spring 1996 refueling outage. The valves inspected will be chosen from those determined to be at high risk for shaft cracking based upon the causal factors listed previously. Selected valves at low or no known risk for shaft cracking also will be inspected to validate the cracking causal factors. GPC will continue to pursue with industry experts long-term solutions to motor shaft cracking problems.

The causes of the July 2, 1995 motor shaft failure are distinctly different from those which led to the motor failures on May 19 and June 18, 1995. None of the failures were the result of high differential pressure alone. Moreover, the causes of the previous two failures were, in large respect, different from each other and were the result of several causes unique to valve 2E11-F015B which would not have led to inspection of other valves. Shaft cracking is a failure mechanism previously unseen and unexpected at Plant Hatch. GPC had no prior knowledge of motor shaft cracking experienced at any other plant. After experiencing a motor shaft failure caused by crack propagation, GPC took steps to determine its extent and causes and to initiate corrective actions.

Item 2 of the Notice of Violation

Item 2 of the Notice of Violation was caused by inadequate documentation of the factors considered in the pressure locking evaluation as discussed in the September 13, 1995 predecisional enforcement conference. Recent research into the history of this issue revealed that the engineers responsible for the evaluations did indeed consider the potential for the LPCI and CS valve bonnets to experience full reactor pressure. Specifically, the design engineer, based on discussions with valve manufacturers at that time, concluded that if the originally specified design differential pressure rating of the valve was greater than reactor pressure, then the valve was not susceptible to process fluid induced pressure locking. For example, the Unit 1 and Unit 2 LPCI injection valves have a design differential pressure rating of 1350 psid which is significantly higher than nominal reactor pressure of approximately 1000 psig; thus, these valves were considered not to be susceptible to pressure locking. However, documentation of the various factors considered in the original pressure locking evaluations was inadequate.

When first questioned by NRC staff personnel on check valve leakage, it was not immediately apparent that such leakage and the corresponding pressure had been considered. Therefore, GPC personnel initially proceeded under the conservative assumption that it had not been considered. It is standard GPC practice to act in such a conservative manner until sufficient information is available to support another approach or conclusion. The potential safety significance of this issue dictated GPC's decision to perform new calculations rather than undertake a possibly extensive and time-consuming document search. In hindsight, GPC overreacted to the initial questions by the NRC staff. GPC made good faith efforts to act on that assumption by rapidly performing new calculations which specifically included check valve leakage using NRC-accepted methodology and taking timely actions based upon the results of those calculations.

The conservative calculations using methodology developed by Grand Gulf indicated LPCI valve 2E11-F015B may not open under hypothetical pressure locking accident conditions. In light of these results, the valve motor was replaced with a larger motor and the operator gearing was changed, in part, to provide sufficient margin to open the valve against the calculated forces from pressure locking conditions. The same changes were made to LPCI valve 2E11-F015A because the calculations showed only a small margin existed for this valve operator under hypothetical pressure locking accident conditions. However, calculations later performed by an independent engineering firm using the same methodology indicated that the force required to open the LPCI valves was significantly higher under quarterly testing conditions than under hypothetical pressure locking accident conditions. These valves have operated successfully for many years under test conditions. It is reasonable, therefore, to conclude the valves would have operated if called upon to do so under accident conditions.

As a result of the recent interactions between NRC and GPC personnel on the issue of potential pressure locking, GPC attempted to verify the validity of the assumptions made in the original evaluations. GPC's investigation, which focused on the Unit 2 LPCI valves, revealed that these valves were successfully tested by the manufacturer (William Powell Company) in 1976 under conditions which actually may have created pressure locking conditions. Specifically, each face of the valve disk was hydrostatically tested at 2200 psig. After testing both sides of the disk and depressurizing the attached piping, the valve was stroked open using the actual motor/operator set which was to be sent to Plant Hatch. It is important to recognize that this factory testing was accomplished using a 60 foot-pound operator. (The Unit 2 motors were subsequently upgraded to 80 foot-pounds in May, 1983, and 150 foot-pounds in July 1995.) Bonnet pressure was not monitored during this testing; however, GPC believes it reasonable to conclude that if a pressure locking concern exists at a process pressure of about 1000 psi, then it would likely be manifested at 2200 psi. Therefore, GPC maintains that the assumptions made in the original evaluation for pressure locking were realistic; however, documentation was inadequate.

Corrective steps which have been taken and the results achieved:

1. The Unit 1 and Unit 2 LPCI valve surveillance procedures were temporarily changed to require the valves to be manually moved off their closed seats prior to stroking with their motors. Limit switches were also adjusted to provide an accurate indication of manual unseating. This change has now been superseded by the IST changes for both and the modifications implemented on Unit 2. (See 2. and 3. below.)

2. The motors on valves 2E11-F015A&B were replaced with larger motors operating at a lower rpm and the valve operator gearing was changed to slow the valve speed. The result of these changes is to reduce the forces on the motor shaft and motor in order to preclude motor and shaft failures.

3. The IST Program frequency change for the Unit 1 valves was expedited by invoking the "impracticality" basis as allowed by the ASME B&PV Code. The testing frequency for valves 1E11-F015A&B has been changed to once per cold shutdown. Because the motors and operators for valves 2E11-F015A&B were modified, there was no immediate need to change the test frequency for these valves. However, the testing frequency for the Unit 2 valves will be changed once per cold shutdown.

4. The appropriate maintenance procedures were revised to require a check to be performed to verify a minimum clearance exists between the bushing and the worm shaft.

5. Appropriate personnel have been counseled relative to the need for definitive actions to resolve identified concerns and the need for clearer design documentation.

Corrective steps which will be taken to avoid further violations:

Other valve operator motor shafts will be inspected for evidence of cracking during the current Unit 2 refueling outage and the next Unit 1 refueling outage. The valves inspected will be chosen from those determined to be at high risk for shaft cracking based upon the causal factors listed previously. Selected valves at low or no known risk for shaft cracking also will be inspected to validate the cracking causal factors. GPC will continue to pursue with industry experts long-term solutions to motor shaft cracking problems.

In accordance with prior commitments to Generic Letter 89-10, GPC will modify motor-operated valves as necessary to alleviate potential pressure locking concerns based on the results of the operator sizing methodology imposed by the GL 89-10 program.

Date when full compliance will be achieved:

Plant Hatch is in compliance with applicable regulatory requirements regarding the LPCI and CS injection valves.