UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

Report Nos.: 50-321/95-17 and 50-366/95-17

Licensee: Georgia Power Company
P. O. Box 1295
Birmingham, AL 35201

Docket Nos.: 50-321 and 50-366 License Nos.: DPR-57 and NPF-5

Facility Name: Edwin I. Hatch Nuclear Plant Units 1 and 2

Inspection Conducted: July 5-7, 1995 on site
July 10 - August 15, 1995 in the Region II offices

Inspector: E. H. Girard 8/22/95
E. Girard, Reactor Inspector Date Signed

Approved by: Clum Hosto 8/23/95
M. Shymlock, Acting Chief Date Signed
Test Programs Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This special inspection was conducted to review the circumstances of three recent failures of Low Pressure Coolant Injection (LPCI) inboard injection Motor-Operated Valves (MOVs). The failures occurred during surveillance and functional tests performed in May, June, and July 1995.

Results:

It was determined that the licensee did not provide prompt corrective actions for conditions adverse to quality as follows:

- Following the first LPCI MOV failure, the licensee determined that procedural changes should be instituted to preclude further failures. The changes were not adequately implemented until after the third MOV failure.

- The licensee failed to inspect similar LPCI MOVs for degradation caused by exceeding the motor ratings until after the third failure had occurred. When the inspections were performed degradation was found in failed and unfailed LPCI MOVs.

- Industry information indicated LPCI inboard injection valves could pressure lock during a Loss of Coolant Accident (LOCA) as a result of reactor-side check valve leakage entering and becoming trapped in the bonnets of the LPCI valves. The licensee's MOV differential pressure calculation and their investigation of the LPCI inboard injection MOV failures both indicated the likelihood of reactor-side check valve leakage to the licensee's LPCI inboard injection valves. However, the licensee failed to provide prompt corrective action to ensure that the LPCI MOVs and similar Core Spray inboard injection MOVs would not pressure lock and be inoperable during a LOCA.

The licensee's failures to identify promptly and correct conditions adverse to quality were identified as apparent violation 50-321, 366/95-17-01, Failure to Provide Prompt Corrective Action to Preclude MOV Failures (paragraph 2.4). This is being considered for escalated enforcement.

Following the LPCI failures and a pressure locking evaluation performed at Region II's request, the licensee completed repairs and modifications which are considered adequate to assure operability of the MOVs until the next refueling outage for each unit. Additional investigation and any corrective actions found necessary are to be performed by the licensee during the refueling outages.

REPORT DETAILS

1.0 Persons Contacted

Licensee Employees

C. Burdett, Electrical Maintenance Foreman
*P. Fornel, Maintenance Manager
J. Graves, Motor-Operated Valve Maintenance Engineer
*J. Hammonds, Nuclear Safety and Compliance Supervisor
T. Metzler, Nuclear Safety and Compliance
*C. Moore, Assistant General Manager - Plant Operations
*J. Payne, Nuclear Safety and Compliance Senior Engineer
H. Sumner, General Manager - Nuclear Plant
*S. Tipps, Nuclear Safety and Compliance Manager

Other Organizations

Southern Nuclear Operating Company, Hatch Project Support

*S. Bethay, Engineering Manager
*D. Crowe, Manager of Nuclear Licensing
*J. Heidt, Nuclear Engineering and Licensing Manager
G. Warren, Senior Nuclear Specialist
*J. Branum, Project Engineer - Nuclear Licensing

Nuclear Regulatory Commission

*J. Canady, Resident Inspector
E. Christnot, Resident Inspector
*B. Holbrook, Senior Resident Inspector
*M. Shymlock, Section Chief, Division of Reactor Safety, Region II

*Attended exit interview

2.0 Review of LPCI Inboard Injection MOV Failures (IP 92903)

2.1 Purpose of Inspection

This inspection was conducted to review the circumstances of three recent failures of Low Pressure Coolant Injection (LPCI) inboard injection Motor-Operated Valves (MOVs) and to determine the adequacy of the licensee's corrective actions. Licensee actions were judged against 10 CFR 50, Appendix B, Criterion XVI and Technical Specification requirements.

2.2 Background

LPCI inboard injection MOVs failed during surveillance and functional tests performed on May 19, June 18, and July 2, 1995. Degradation was subsequently found in both the failed and unfailed LPCI inboard injection MOVs of both Hatch Nuclear Plant Units. The involved valves

were identified 1E11F015A, 1E11F015B, 2E11F015A, and 2E11F015B. Summary information on the failures and degradation is tabulated below:

Valve No.	Date	Description of Failure and Corrective Action
2E11F015B	05/19/95	Motor failed (burn up) while opening MOV for a quarterly surveillance test during normal plant operation. Replaced motor. High running current (50-60 A versus normal 18 A) was noted when the valve was opened following the motor replacement. Subsequently performed VOTES static diagnostic test and found no problem. Inspected gearing (except inaccessible worm gear) and found correct. Operator grease condition found acceptable. (Shaft of failed motor was inspected about 7/9/95 and cracks were found emanating from the keyway.)
2E11F015B	06/18/95	Motor failed (burn up) during functional test (similar to surveillance test) performed after thermal overload relay replacement. Plant was in normal operation. Motor inspection revealed partial melting and cracks in magnesium rotor. Replaced motor and performed VOTES static diagnostic test - no problem was identified. (Shaft of failed motor was inspected about 7/9/95 and no cracks were found.)
1E11F015B	07/02/95	Motor shaft failure found following unsuccessful quarterly surveillance test. Valve handwheel had been manually turned before the test in an attempt to unseat the disc and relieve any differential pressure. Manual opening following the test was difficult. Replaced motor and performed VOTES static diagnostic test - no problem was identified.
1E11F015A	07/08/95	Motor pinion key found sheared during inspection performed in response to F015B valve failures. Pinion gear was not loose and licensee personnel believed the MOV would have operated. The motor was reportedly replaced and the valve returned to service.
2E11F015A	07/09/95	Inspection found the motor pinion key partly dislodged from slot. There was evidence of some past movement of pinion gear on motor shaft. Penetrant inspections detected cracks in the motor shaft and a crack in key (both still intact). The valve had performed satisfactorily during its last quarterly surveillance test.

Prior to the above failures, the licensee had determined that the ratings of the motors installed on these 24-inch flexible-wedge gate valves were being exceeded during surveillance testing. Additionally, the actuator ratings were being exceeded on 1E11F015A and 1E11F015B. The licensee's evaluation of these conditions was documented in a memorandum dated June 8, 1994 (Ref. 1). The evaluation recommended revising the surveillance test to lower the differential pressure across the valve discs, thereby reducing the force required to open the valves to within the rated capabilities of the motors and actuators. The evaluation indicated it would be acceptable to continue the current surveillance testing for 100 cycles, pending revision of the procedures. Continued operation for this number of cycles was considered acceptable because (1) the valves had performed satisfactorily during years of previous quarterly surveillance tests, and (2) the valve actuator and motor ratings would not be exceeded in a design accident. The licensee's design-basis differential pressure calculations (Ref. 2) showed that the opening differential pressure across a LPCI inboard injection valve disc would be about 1000 psid (assuming reactor-side check valve leakage) during surveillance testing, but only about 230 psid during the worst-case design accident.

Region II had reviewed and accepted the above evaluation in NRC Inspection 95-02. During inspection 95-02 NRC inspectors verified that the licensee planned to change their surveillance testing to avoid the high test differential pressure in 1996, coincident with a required 10-year inservice testing program update. The inspectors also verified the lack of recent (3 years) failures from the licensee's maintenance database and confirmed satisfactory valve performance during diagnostic testing at accident differential pressure.

2.3 Description of Inspection and Findings

In this inspection the NRC inspector reviewed the circumstances of the LPCI injection MOV failures through discussions with licensee personnel and examination of related information in the reference list of documents included in Appendix A of this inspection report. Also, the motor shaft failure of valve 1E11F015B and sheared key of 1E11F015A were observed by the inspector. Individuals from the NRC Office of Nuclear Reactor Regulation provided consultation and assistance in review of several calculations. Following two days on-site, the inspection continued in the NRC offices. Additional information was provided by the licensee via FAX, mail, and telephone conference calls. The significant findings of this inspection were as follows:

2.3.1 Circumstances of Recent Failures and Degradation

The inspector confirmed the failure information described in the above table (paragraph 2.2) through discussions with licensee personnel and review of the licensee's maintenance database entries. As already mentioned, the motor shaft failure of valve 1E11F015B and sheared key of 1E11F015A were also observed by the inspector.

In discussing the repeated failures with licensee personnel, the inspector was informed that, after the first motor failure on 2E11F015B, they had planned to revise the surveillance test procedure to provide for the LPCI inboard injection MOVs to be manually unseated to relieve differential pressure before motor operation. This would presumably reduce the motor torque required to open the valves and preclude another failure. There did not appear to be any need to expedite the change, as the surveillance test was not scheduled to be repeated in the near future. It was not recognized that corrective maintenance would soon be performed to replace a thermal overload relay that had been degraded in the initial failure and that post maintenance functional testing would consist of cycling the valve as for the surveillance test. This post maintenance functional testing was performed and resulted in the repeat failure (June 18, 1995) of the motor on MOV 2E11F015B.

Following the second motor failure, the licensee changed the surveillance test procedure. The inspector verified the change and questioned why it had not prevented the failure of MOV 1E11F015B during surveillance testing on July 2, 1995. He was informed that it had not been recognized that indication of manual unseating might be inaccurate. The valve had apparently not been adequately unseated when the test was performed. Licensee personnel stated that to assure against recurrence in subsequent tests, the limit switches were now adjusted to provide indication of unseating.

2.3.2 Licensee Investigation of Failures

An evaluation of the LPCI inboard injection valve failures by a licensee Event Review Team (ERT) was in progress during the inspector's review. In discussions with the ERT members and other involved personnel, the inspector was informed that the root cause of the failures appeared to be inadequate design or application. Additional information provided, and its review by the NRC is discussed below:

(1) The inspector was informed that the team had reviewed the maintenance history for the LPCI valves and had found no evidence of previous similar failures or degradation. The inspector reviewed summary information in the licensee's maintenance database and concurred with the team's finding. Additionally, summary surveillance test data was reviewed by the inspector which indicated routine quarterly surveillance testing had been performed as required.

(2) Licensee personnel stated that the motor pinion key that sheared on valve 1E11F015A was an originally installed low strength key that was scheduled to be replaced in response to Information Notice 94-10, Failure of Motor-Operated Valve Electric Power Train Due to Sheared or Dislodged Motor Pinion Key. The inspector verified the planned inspection and replacement of the key was specified in the licensee's maintenance database. The inspector

also noted that the licensee had other MOVs with such keys. He reviewed the licensee's internal correspondence dated September 22, 1994, which documented plans to replace the keys.

(3) The inspector was informed that an analysis of the motor shaft failure on valve 1E11F015B concluded that the failure had apparently occurred during opening and that it was a fatigue failure.

(4) Licensee personnel stated that the failures were specifically caused by aging and impact loading. The possibility of incorrect motor shaft material having been used was also mentioned. The inspector found that this did not explain the second motor burn up failure. The second motor to fail had been installed less than a month when it failed. The inspector was informed that the motor failure might have been due to a defective or misaligned bushing.

(5) In discussions with a licensee engineer and from a review of the licensee's Investigation Report for 2E11F015B motor failures (Ref. 3), the inspector found that the licensee had considered whether the valves might have failed due to pressure locking and had ruled this out. The inspector informed the engineer that, although the valves did not appear to be susceptible to pressure locking during surveillance test conditions, they did appear susceptible under design accident conditions. They are flexible wedge gate valves and reactor pressure might leak into their bonnets and result in pressure locking. In a subsequent telephone conversation with Region II, licensee personnel acknowledged that previous evaluations for potential pressure locking of Hatch gate valves failed to recognize that check valve leakage would occur and result in reactor pressure against the discs of the LPCI inboard injection valves. This could cause the discs to flex and allow pressurization of the valve bonnets. Region II requested the licensee to perform an operability evaluation for potential pressure locking of the LPCI and similar Core Spray Injection (CSI) gate valves. This is discussed in section 2.3.3 of this report.

(6) From their investigation, the licensee concluded that all of their valves had been operable for design-basis accident conditions.

2.3.3 Pressure Locking

Pressure locking may occur in a closed flexible-wedge gate valve when pressurized fluid is trapped in the valve bonnet and increases the required unseating force to above the capability of the actuator (or motor). In the case of the licensee's LPCI and CSI inboard injection valves, this could occur if reactor coolant pressure flexes the gates and leaks into the valve bonnets. Pressure locking that occurred in a valve arrangement similar to the licensee's was described in NRC Information Notice 92-26, Pressure Locking of Motor-Operated Flexible Wedge Gate Valves, dated April 2, 1992.

As noted in section 2.3.2(5), the licensee was requested to determine whether their LPCI and CSI inboard injection gate valves were operable, considering the potential for pressure locking due to the reactor pressure imposed on their discs. The licensee's initial calculation of operability found all of the subject valves were operable. However, NRC review identified that it was in error. Subsequently, the licensee revised the calculation (Ref. 4) and determined that one LPCI valve (2E11F015B) might not be capable of opening due to pressure locking. The valves were considered operable if the thrust required to overcome pressure locking was within the capability of the motors (acting through the actuators). The licensee informed Region II that, to ensure operability, they installed a larger motor and different gearing in this valve. The same modification was reportedly made to the similar LPCI MOV located in the other train (2E11F015A).

In performing their operability evaluation calculation, the licensee (in part) used a methodology developed by Entergy Operations Incorporated to predict the thrust required to overcome pressure locking of flexible-wedge gate valves. This methodology is based on limited pressure-lock testing and the NRC staff currently considers it acceptable only for past and short term future operability evaluations. The NRC found the licensee's calculations were sufficient to demonstrate adequate short term future capabilities for the LPCI valves after their stated modifications of 2E11F015A and B. Additionally, the calculation was considered satisfactorily to demonstrate the past and short term future operability of the CSI valves. As already mentioned, the calculation indicated inadequate past operability for 2E11F015B. The NRC found that the past operability of valves 1E11F015B and 2E11F015A remained questionable. 1E11F015B may have been inoperable during the quarter prior to the surveillance test that evidenced the motor shaft failure, as the force required to overcome pressure locking might have propagated the pre-existing fatigue crack in the motor shaft to failure. Regarding valve 2E11F015A, the licensee's method of establishing the adequacy of the motor output (unrelated to the Entergy Operations Incorporated methodology) was considered unsatisfactory and previous licensee determinations of motor torque provided in the licensee's trend sheets (Ref. 5) implied the motor output torque would be inadequate.

2.4 Summary and Conclusions

The licensee did not provide prompt corrective action for conditions adverse to quality:

(1) On June 6, 1994, the licensee reported that the LPCI inboard injection valve motor ratings were being exceeded in surveillance tests performed during plant operation. On May 19, 1995, LPCI inboard injection valve 2E11F015B failed during a surveillance test. This failure was presumed to be the result of repeatedly operating the motor above its rating. As corrective action, the licensee determined that the test procedures for all four F015 (LPCI inboard injection) valves should be revised before the next test in order to preclude further failures. The revision was to

provide manual unseating of the valves before testing, in order to reduce the load placed on the motors to within their ratings. The procedure revision was not promptly implemented and on June 18, 1995, valve 2E11F015B failed again during functional test conditions like those of the surveillance test. Further, the procedural changes necessary to assure reduction of the load to within the motor ratings had not been adequately accomplished when, on July 2, 1995, LPCI inboard injection valve 1E11F015B failed during a surveillance test.

(2) Following failures of the valve 2E11F015B actuator motors on May 19 and June 18, 1995, the licensee did not promptly inspect the other LPCI inboard injection valves to determine if they were experiencing degradation. After valve 1E11F015B failed its surveillance test on July 2, 1995, due to a pre-existing fatigue crack, the A train valves were inspected and degradation was noted.

(3) In reviewing the LPCI inboard injection valve failures, the licensee observed that the reactor side of the discs in these flexible wedge gate valves had likely received full reactor pressure due to leakage through the reactor-side check valves. Also, the licensee's design-basis differential pressure calculation (Ref. 2) recognized the need to assume this leakage. Industry information available to the licensee for some years, such as NRC Information Notice 92-26 (dated April 2, 1992), had shown that such leakage could occur and result in pressure locking during a LOCA. The licensee failed to promptly consider this information and initiate corrective actions to ensure their LPCI and CSI valves, which had similar designs and system arrangement, would not pressure lock when called on to operate in a LOCA. The licensee did not complete corrective actions to ensure the operability of these valves until after mid-July 1995.

The licensee's failure to take prompt corrective action described above was considered an apparent violation of the requirements of 10 CFR 50, Appendix B, Criterion XVI. It was identified as apparent violation 50-321, 366/95-17-01, Failure to Provide Prompt Corrective Action to Preclude MOV Failures.

The past operability of LPCI inboard injection MOVs 1E11F015B, 2E11F015A, and 2E11F015B was not demonstrated. The past operability of 1E11F015A and the CSI valves was adequately demonstrated.

Based on information provided by the licensee, the LPCI and CSI valves addressed in this inspection are now considered operable until the next refueling outage.

3.0 Exit Interview

The inspection scope and findings were summarized on August 15, 1995, in a telephone call with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results and findings. Proprietary information is not contained in this report. Dissenting comments were not received from the licensee. The following apparent violation was identified:

Apparent Violation, Failure to Provide Prompt Corrective Action to Preclude MOV Failures. (paragraph 2.4)

4.0 Acronyms and Initialisms

CFR	-	Code of Federal Regulations
CSI	-	Core Spray Injection
ERT	-	Event Review Team
LOCA	-	Loss of Coolant Accident
LPCI	-	Low Pressure Coolant Injection
MOV	-	Motor-Operated Valve
NRC	-	Nuclear Regulatory Commission
psid	-	pounds per square inch differential
RHR	-	Residual Heat Removal
VOTES	-	Valve Operation Test and Evaluation System

APPENDIX A
REFERENCE LIST OF DOCUMENTS REVIEWED

1. Southern Company Services memorandum dated June 8, 1994, Engineering Evaluation for 1E11F015A&B, 2E11F015A&B, 1E21F005A&B, 2E21F005A&B

2. Differential pressure calculations SMNH-93-004, Rev. 2 (November 1994) and SMNH-93-005, Rev. 2 (November 1994), for Residual Heat Removal System valves (Note: These calculations identified the maximum normal operation and accident differential pressures for the Unit 1 and 2 LPCI injection F015 MOVs)

3. Investigation Report for 2E11F015B Motor Failures, Root Cause Summary, Significant Occurrence Report No. CO 9501927 (undated and unsigned)

4. Calculation SMNH 95020, Rev. 1, dated July 21, 1995, Evaluation of Pressure Locking Phenomena - 1/2E11F015A/B and 1/2E21F005A/B (Region II reviewed this calculation with the assistance of NRC Office of Nuclear Reactor Regulation personnel)

5. Computer database MOV Testing and Trending Sheets (containing diagnostic data back to 1991)

6. Maintenance database summary for LPCI injection valves, with entries back to 1986 (sampled by the inspector for consistency with data being tabulated in the licensee's failure investigation)

7. Informal calculation of stem factor for valve 2E11F015A, transmitted to M. Shymlock (Region II) by D. Crowe on July 25, 1995

8. Diagnostic test results from diagnostic tests performed after replacements of the failed LPCI valve motors

9. May, June, and July 1995 maintenance database entries for LPCI inboard injection valves 1E11F015A, 1E11F015B, 2E11F015A, and 2E11F015B

10. Surveillance Procedure 34SV-E11-002-2S, Rev. 3, dated May 22, 1995, with Temporary Change 95-140, RHR Valve Operability

11. Results of diagnostic tests performed following the failures