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

Report Nos.: 50-424/88-10 and 50-425/88-09

Licensee: Georgia Power Company
P. O. Box 4545
Atlanta, GA 30302

Docket Nos.: 50-424 and 50-425 License Nos.: NPF-68 and CPPR-109

Facility Name: Vogtle 1 and 2

Inspection Conducted: February 9-11, 1988

Inspector: _____ 3/4/88
E. H. Girard Date Signed

Approved by: _____ 3/4/88
J. J. Blake, Section Chief Date Signed
Division of Reactor Safety

SUMMARY

Scope: This routine, announced inspection of the licensee investigation and correction of the failures experienced in residual heat removal (RHR) system valves 1-HV-8716A and B.

Results: No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*J. Aufdenkampe, Engineering Support Superintendent - Plant Support, Nuclear Operations (NO)
*G. Bockhold, General Manager, NO
E. Burns, Inservice Inspection Coordinator, NO
*G. Frederick, Quality Assurance Site Manager, NO
*W. Gabbard, Senior Regulatory Specialist, NO
K. Glandon, Senior Plant Engineer - Maintenance, NO
*T. Greene, Plant Support Manager, NO
K. Heaton, Work Planning Engineer, NO
*M. Hobbs, Instruments and Controls Superintendent - Maintenance, NO
H. Jaynes, Plant Engineering Supervisor - Maintenance, NO
*W. Kitchens, Operations Manager, NO
*W. Marsh, Deputy Operations Manager, NO
*G. McCarley, Project Compliance Coordinator, Construction
*W. Nicklin, Regulatory Compliance Supervisor, NO
*R. Spinnato, Independent Safety Engineering Group Supervisor, NO
*J. Swartzwelder, Nuclear Safety and Compliance Manager, NO
J. Trawber, Systems Engineer - Engineering Support, NO

Other Organization

H. Abshil, Test Engineer, MOVATS Incorporated

NRC Resident Inspector

*J. Rogge

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on February 11, 1988, with those persons indicated in paragraph 1. The inspector described the area inspected and discussed in detail the inspection finding listed below. Dissenting comments were not received from the licensee.

Item Number	Status	Title/Reference Paragraph
424/88-10-01	Open	INSPECTOR FOLLOWUP ITEM - Torque Switch Pin Failure Concern, Paragraph 4.d.

The licensee did not identify as proprietary any of the materials provided to or reviewed by the inspectors during this inspection.

3. Licensee Action on Previous Enforcement Matters

This area was not inspected.

4. Licensee Investigation and Correction of Failures Experienced in Residual Heat Removal System Valves 1-HV-8716A and B

On January 28, 1988, the licensee experienced a common-mode failure of two RHR system gate valves during stroke time testing. The licensee has attributed the failure to "pressure locking," a condition in which water is trapped in the bonnet above the gate and exerts a pressure that may prevent opening. All licensees had been previously alerted of this condition through the Institute for Nuclear Power Operations (INPO) Significant Operating Event Report (SOER) 84-7.

Based on the pressure locking failures of the two Vogtle plant valves, the NRC became concerned that the warning expressed in INPO SOER 84-7 might not have been sufficient and that additional actions might be needed. The inspection described herein was conducted primarily to obtain sufficient information regarding the Vogtle valve failures to aid in assessing the need for additional NRC action. Secondarily, the inspector examined the adequacy of the licensee's plant specific corrective actions.

The inspector conducted his examination of this matter through discussions with licensee personnel, review of related documentation and observation of the involved valves and operators (including a failed torque switch).

The following individuals were the principal sources of information provided in discussions:

- Engineering Support Superintendent
- Senior Plant Engineer - Maintenance
- Systems Engineer
- Pump and Valve Testing Coordinator

The following documentation provided information for this inspection:

- Westinghouse Drawing 8376D55, Revision 2, Motor Op Gate Valve Mod 08002GM84FEB000
- Bechtel Drawing 1X4DB122, Revision 24, P&I Diagram, Residual Heat Removal System No. 1205
- Deficiency Card #1-88-286 (1/28/88)
- Deficiency Card #1-87-2750 (10/28/87)
- Interoffice Correspondence from R. Lide to T. Green, dated 12/10/87, RHR Cross Tie Valve (1-HV-8716B) Motor Failure on 10/28/87
- Design Change Request (DCR) 88-V1N0017, Revision 0, Initiate Design Change to Enable Valves to Open Against High DP and DT which may be

Causing Pressure Locking/Thermal Binding

- INPO SOER 84-7, Pressure Locking and Thermal Binding of Gate Valves
- NRC Office for Analysis and Evaluation of Operational Data (AEOD) Report AEOD/S402 dated July 1984, Pressure Locking of Flexible - Disk Wedge-Type Gate Valves, prepared by S. D. Rubin
- Vogtle Electric Generating Plant (VEGP) NO Procedure 13011-2, Revision 1, Residual Heat Removal System
- NRC Inspection and Enforcement Circular (IEC) 77-05, Fluid Entrapment in Valve Bonnets, dated March 9, 1977
- Undated 1987 document described as Engineering Response to AI87-0235/SOER 84-007.

a. Past Industry Experience and Recommended Actions to Avoid Valve Pressure Locking

Past industry experience with valve pressure locking was summarized in NRC AEOD Report AEOD/S402. This report concluded that, based on a review of reported failures involving pressure locking, the condition could be a potentially significant contributor to common mode failure of safety-related gate valves during accidents. The report recommended that the NRC consider issuing a Bulletin on the subject.

Rather than issuing a Bulletin or other NRC notification regarding the subject, the NRC elected to allow INPO to address the matter. INPO responded through issuance of SOER 84-7. This document described the conditions that cause pressure locking and another potential source of valve failure thermal binding. The SOER also provided recommended actions to avoid pressure locking and thermal binding. The SOER generally referred to pressure locking as "bonnet pressurization" resulting when water became entrapped in the valve bonnet and exerted a downward pressure that (in some instances) would prevent any upward opening movement of the disc into the bonnet. The SOER stated that bonnet pressurization had been found in both flexible-wedge and double disc gate valves and that other types of wedge gate valves were also subject to the condition. The SOER described two potential causes of bonnet pressurization:

Cause of Bonnet Pressurization

- Differential Pressure Locking -- One condition that can result in bonnet pressurization occurs when the valve has a differential pressure across the disc in the closed position. The pressurized side of the flexible disc can move away slightly from its seat, allowing high pressure liquid to enter the bonnet cavity. With time, the bonnet pressure will tend to equalize with the pressure in the body cavity. If pressure in the body is subsequently decreased, the bonnet pressure will force the disc against its seat. If no internal or external pressure equalizing path for the bonnet is provided, pressure locking may occur, i.e., the pressure differential can cause the disc forces

on the valve seats to become sufficiently high that the valve cannot be opened.

- Liquid Entrapment -- A second condition of bonnet pressurization can occur when the system, including the valve bonnet, is full of cold liquid with the valve closed. As the system temperature increases, the bonnet liquid temperature eventually increases, resulting in potentially high pressure. The valve does not have to be in a high temperature system but only in close proximity where heat conduction through the pipe or via the surrounding air will heat the bonnet liquid. Theoretically, a one degree Fahrenheit rise in temperature of a trapped fluid would result in approximately a 100-psia rise in pressure (assuming a constant bonnet volume and that no air is trapped in the bonnet). Should this pressure exceed the yield strength of the body/bonnet materials, the results could be excessive leakage or, under extreme conditions, ruptured valves.

Actions recommended by the SOER to address bonnet pressurization concerns were as follows:

Recommended Licensee Actions to Address Bonnet Pressurization

- Identify all gate valves in safety-related systems that are required to open for system operation and are potentially susceptible to the pressure locking phenomenon.

- For the valves identified in the above recommendation, take appropriate actions to ensure that these gate valves will open when required.

NOTE: The SOER provided various examples of actions to be taken. These generally involved providing a path for liquid in the bonnet to relieve any pressure buildup into the system piping.

- Operations and maintenance personnel training should include instructions on the valve failure mechanisms discussed in the SOER, including how to diagnose the failure mechanism and the action necessary to recover from the failure.

b. Description of Vogtle Failure Occurrence

A description of the valves, their location and function, and the circumstances of their January 28, 1988, failure is given in the following paragraphs.

Valves 1-HV-8716A and B are eight inch motor operated flexible wedge gate valves manufactured by Westinghouse Electric Corporation (Electro Mechanical Division). Their operators were manufactured by limitorque and are size SMB 00. The valves are located in the cross-tie which connects RHR Trains A and B.

They are normally open valves that close for cold leg injection at the beginning of a Loss of Coolant Accident (LOCA) and open later to provide for hot leg injection. Prior to their failure, they had been closed for heat up from Mode 3. In Mode 4 at about 320°F and 350 psig, a Reactor Operator attempted to open the valves in performance of a routine surveillance (stroke timing). Indication was lost and fire alarms in the vicinity of the valves actuated. Investigation shortly thereafter found that the valve motors were burned out.

Following failure, the valves were unseated manually, the motors were replaced and the 8716A valve was tested with a MOVATS test system in attempting to establish the cause of the failure. The test which was conducted with the plant at cold shutdown, found that the opening thrust for the valve was not excessive. In a subsequent test of the valve, a roll pin securing the torque switch shaft failed disabling the torque switch. The switch was replaced. The licensee believes the roll pin was damaged when the switch experienced rapid movement to a position associated with the high unseating torque experienced during the motor failure (and possibly during past actuations).

When valve A did not experience a high opening thrust during testing, licensee personnel initially thought that a differential pressure across the disc was needed to cause the high thrust requirement. Additional MOVATS testing proved this hypothesis incorrect as opening against a differential pressure resulted in no valve lock-up and only about 8000 lbs of thrust was required for opening

The licensee next tested the hypothesis that the failure had been due to pressure locking. A valve was closed cold (such that water might be trapped in the bonnet). The valve was then heated up and MOVATS tested for opening thrust. Unseating thrust was found to be in excess of 18,700 lbs (the limit of the test system) confirming a pressure locking condition.

c. Previous Failure of Valve 1-HV-8716B

On October 28, 1987, a Reactor Operator attempted to actuate valve 8716B open during a normal operation pursuant to entering Mode 3. About 20-30 seconds after actuation, valve indication failed. Several additional attempts to actuate the valve proved unsuccessful. About 15 minutes after the first attempt, fire alarms annunciated in the vicinity of the valve. Observation of the valve at its location found that its motor appeared to have burned out. The valve was manually opened about 75 minutes after the initial actuation without any undue force. The motor was replaced and MOVATS testing revealed a torque switch roll pin failure. (Note: This is not the same roll pin as that referred to in 4.b above but it is similar in size and function). The licensee hypothesized that the roll pin had failed during or prior to the last valve closure, allowing the disc to be driven into the seat, jamming it there and precluding re-opening without excessive force. The valve had been closed on October 26,

1987 at a temperature of less than 100°F and at the time of its failure on October 28, 1987, it was at a temperature in excess of 200°F. The licensee's investigation stated that they could not totally discount the possibility that the valve failure had been caused by pressure locking, but that it was considered unlikely, as the valve had soft packing with a valve steam leak-off connection that would aid in relieving any bonnet pressure build up.

In view of their findings with regard to the January 28, 1988, failure of this valve, the licensee now considers that both failures were the result of pressure locking.

d. Licensee Corrective Actions

The NRC inspector reviewed the actions that had been taken by the licensee to address the pressure locking failure of valves 8716A and B. These actions are described below:

(1) After replacing the motors of these two Unit 1 valves, the licensee drilled holes into their discs to provide a path to the bonnets that would preclude pressure buildup in the bonnets. The inspector found that the applicable Design Change Request 88-VIN001 indicated that a similar modification would be performed on the identical Unit 2 valves. MOVATS testing confirmed that the relief holes in the discs resulted in acceptable unseating thrust values for conditions simulating those that previously required excessive thrusts.

(2) The licensee's original evaluation of their valves for susceptibility to failure producing phenomena described in SOER 84-7 addressed only their possible occurrence for functioning under design accident conditions. Further, the NRC inspector was informed that the contractor who performed the valve evaluation failed to consider some design accident conditions and that a re-review for pressure locking had been performed separately by the licensee and another contractor following the January 28 failure of valves 8716A and B.

This re-review was stated to have confirmed that there were no design accident conditions in which the SOER 84-7 pressure locking would occur. The thermal binding concerns a SOER 84-7 were not addressed in the re-review.

A previous licensee review (Engineering Response to AI 87-023/ SOER 84-007) identified 13 valves that were potentially susceptible to pressure locking. However, as the licensee determined that these valves would not experience pressure locking during their functioning for a design accident, there was no hardware correction or further analysis to assure against pressure locking during normal operation or testing. Valves 8716A and B had not been included in the 13 valve list.

The NRC inspector expressed concern to the licensee that they had not taken all normal valve operating and test conditions into consideration in the evaluation for susceptibility to pressure locking and thermal binding. The inspector was informed that it was the licensee's position that any susceptibility to the phenomena in normal operation and test conditions would already have been identified in their past operating experience. The inspector noted that pressure locking was only recently identified for valves 8716A and B and that damage short of total valve failure might have resulted and remained undetected.

(3) Although the licensee replaced the torque switch in valve 8716A because of a failed roll pin, they did not check the roll pins in 8716B for possible damage. The inspector found that the cognizant Systems Engineer and Engineering Support Superintendent had not even been aware of the recent torque switch roll pin failure. The inspector informed the licensee that his concern regarding possible damage to the roll pin in the 8716B valve torque switch would be identified as Inspector Followup Item 424/88-10-01, Torque Switch Pin Failure Concern.

(4) Noting the licensee's failure to check for damage to the torque switch roll pins as described in (3), the inspector asked if the licensee had checked other valve actuator components for damage. The inspector was informed that the components most likely to have received damage were the motor pinion gear and interfacing gear and that these would have been checked.

(5) The RHR Systems Engineer informed the inspector that, as a step to assure against pressure locking for some valves during surveillance testing, they were considering manually unseating some valves prior to the testing. The inspector expressed concern that this might partially invalidate the associated testing.