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

Report Nos.: 50-259/94-03, 50-260/94-03, and 50-296/94-03

Licensee: Tennessee Valley Authority
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1101 Market Street
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Docket Nos.: 50-259, 50-260 and 50-296

License Nos.: DPR-33, DPR-52, and DPR-68

Facility Name: Browns Ferry 1, 2, and 3

Inspection Conducted: February 7 - 11, 1994

Inspector: M D Hunt — 3/11/94
M. D. Hunt — Date Signed

Accompanying Personnel: M. Miller, Reactor Inspector
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Approved by: C. Julian for — 3/11/94
C. Casto, Chief — Date Signed
Test Programs Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This special, announced inspection was performed at the Browns Ferry Nuclear Plant to examine the implementation of the licensee's motor-operated valve (MOV) program to meet commitments in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." The inspectors utilized the guidance provided in Temporary Instruction (TI) 2515/109 (Part 2), "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance." As delineated in Part 2 of TI 2515/109, this inspection was the initial review of the Licensee's MOV program implementation in response to GL 89-10.

The inspectors reviewed selected portions of design calculations, test packages, and diagnostic signature traces for ten MOVs. The inspectors also reviewed followup issues from the previous NRC inspection of the MOV program (TI 2515/109, Part 1) conducted February 24-28, 1992, and documented in NRC Inspection Report No. 50-259, 260, 296/92-04.

Results:

The licensee identified 56 MOVs that were in the program. The licensee had conducted only 11 differential pressure (DP) tests to date, the highest being at approximately 370 psig differential. While there were MOVs in the program which must operate under higher differentials, none had been tested. Of the tests completed, the licensee had performed adequate reviews to verify that the MOV was capable of performing the intended function before returning it to service. The licensee has scheduled 12 valves for DP testing during the next outage and does not plan further tests.

Concerns:

The licensee had not completely developed the list of non-testable valves that will be in the program. (Section 2.3)

The signature traces have not been marked to identify the various points at which data was taken to evaluate valve performance. (Section 2.2)

The MOV program documentation has not been completely revised per the issued Engineering Change Notice to present complete comprehensive program results. (Section 2.1)

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*C. Crane, Maintenance Manager
J. Davenport, Licensing Engineer
J. Elmerick, Design Engineer
C. Galuska, Design Engineer
*B. Endsley, Maintenance Engineer
*J. Kurtz, Project Management
*R. Machon, Plant Manager
*R. Mundy, Principal Mechanical Engineer
*W. Pratt, Corporate Maintenance
*R. Wells, Compliance Licensing Manager

Other licensee employees contacted during this inspection included engineers, security force members, technicians, and administrative personnel.

NRC Resident Inspectors

*J. Munday, Resident Inspector
*R. Musser, Resident Inspector

2. GENERIC LETTER (GL) 89-10 "SAFETY-RELATED MOTOR-OPERATED VALVE TESTING AND SURVEILLANCE" (TI-2515/109)

On June 28, 1989, the NRC issued GL 89-10, which requested licensees and construction permit holders to establish a program to ensure that switch settings for safety-related MOVs were selected, set, and maintained properly. Subsequently, five supplements to the GL have been issued and one issued for comment. NRC inspections of licensee actions implementing commitments to GL 89-10 and its supplements have been conducted based on guidance provided in Temporary Instruction (TI) 2515/109, "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance." TI 2515/109 is divided into Part 1, "Program Review," and Part 2, "Verification of Program Implementation."

The purpose of this inspection was to:

1. Review the licensee's corrective actions for the concerns identified in NRC Inspection Report 50-259/260/296/92-04.

2. Select and review the design-basis and test documentation for several safety related MOVs from a list of tested MOVs within the GL 89-10 program.

Follow-up reviews were performed to determine if changes were implemented to address concerns identified during the previous Part 1 GL 89-10 inspection. That inspection identified several concerns related to MOV program documentation and procedures that were in the approval stage. Since then, this documentation has been approved and issued.

2.1 Design-Basis Reviews

The inspectors examined the licensee's implementation of their GL-89-10 Motor Operated Valve Plant Program for diagnostic testing of MOVs. This examination included review of piping and instrumentation drawings; design-basis calculation results of the expected differential pressures; the sizing and switch setting calculations; and diagnostic test data. The inspectors also conducted a walkdown of selected MOVs.

The inspectors reviewed the licensee's design-basis documentation (DBD) to determine and verify its adequacy in general for all MOVs in the program and specifically for the ten sampled MOVs examined during this inspection. In addition, the recommended action "a" of GL 89-10 that requested licensees determine the maximum differential pressure and flow expected for both normal and abnormal (accident) conditions was examined to verify that maximum parameters were used.

The licensee had one MOV calculation package for each valve which included both design-basis and engineering calculations. The MOV packages included the calculations for differential pressure, electrical degraded grid voltage, flow, temperature, design thrust, and torque. The documents and calculations were reviewed to determine if the design-basis differential pressure and flow conditions, design temperature, and other design parameters for each MOV selected met the recommendations of GL 89-10. The inspectors verified that degraded grid calculations were included to ensure that the lowest motor terminal voltage commensurate with design-bases conditions was factored into the determination of maximum thrust ratings. The inspectors also verified that the licensee satisfactorily addressed the Limitorque Part 21 high temperature motor concern. The MOV documentation was reviewed for the selected valves identified below:

Valve No.	Function, Size, Type and MOV DBD and Engineering Thrust Calculations
2-FCV-23-34	Residual Heat Removal Heat Exchanger A Service Water Discharge Valve, 12 inch globe, Calculation MD-Q2023-910067
2-FCV-23-40	Residual Heat Removal Heat Exchanger C Service Water Discharge Valve, 12 inch globe, Calculation MD-Q2023-910068

2-FCV-23-46	Residual Heat Removal Heat Exchanger B Service Water Discharge Valve, 12 inch globe, Calculation MD-Q2023-910069
2-FCV-23-52	Residual Heat Removal Heat Exchanger D Service Water Discharge Valve, 12 inch globe, Calculation MD-Q2023-910070
2-FCV-70-47	Reactor Building Closed Cooling Water Primary Containment Outlet Valve, 8 inch flex wedge gate, Calculation MD-Q2023-910079
2-FCV-74-07	Residual Heat Removal Loop I Minimum Flow Bypass Isolation Valve, 4 inch solid wedge gate, Calculation MD-Q2023-910107
2-FCV-74-30	Residual Heat Removal Loop II Minimum Flow Bypass Isolation Valve, 4 inch solid wedge gate, Calculation MD-Q2023-910112
2-FCV-74-57	Residual Heat Removal Loop I Isolation Valve (To Suppression Pool Header), 18 inch solid wedge gate, Calculation MD-Q2023-910119
2-FCV-74-59	Residual heat Removal Loop I Test Isolation Valve, 12 inch globe, Calculation MD-Q2023-910121
2-FCV-74-71	Residual Heat Removal Loop II Isolation Valve (To Suppression Pool Header), 18 inch solid wedge gate, Calculation MD-Q2023-910126

The inspectors normally review the DP test results for valves that operate at higher differential pressures and require higher thrust values. To date, the licensee had not tested any of the MOVs in the program that operate at higher differential pressures. Another intent of the inspection was to review the documentation and testing for both gate and globe valves. Five gate valves and five globe valves were inspected.

The system documentation review included the "System Design Criteria" for the Residual Heat Removal System (RHR), Residual Heat Removal Service Water System (RHRSW), and the Reactor Building Closed Cooling Water System (RBCCW). The "System Design Criteria" included the system description, operation, and design-basis documentation. The Process and Instrumentation (P&ID) drawings and the system Flow Sheet Drawings were also examined. The system flow (P&ID) drawings were used to verify the location of the MOVs in the piping systems and the design safety function. These documents were examined to verify that the MOV design-basis calculations included all necessary parameters.

The MOV design-basis documentation (DBD) included calculations, drawings, engineering reports, and engineering standards. The MOV documentation package for each valve included both the "design-basis" calculations and the "engineering thrust" calculations. The DBD documents reviewed are listed as follows:

1. System Design Criteria BFN-50-7023 (RHRSW), BFN-50-7070 (RBCCW), BFN-50-7074 (RHR)

2. Mechanical Design Standard, DS-MIS.2.22 Motor Operated Valve Design Basis Review Methodology

3. TVA Program Plan "Implementation of Generic Letter 89-10"

4. Evaluation of the EPRI Motor Operated Valve Performance Prediction Program to the TVA Generic Letter 89-10 Program

5. ED-Q-2999-870027 "480V Class 1E Motors And Equipment Voltage Drop Calculation"

In the areas inspected the inspectors concluded the licensee had adequately addressed the design-basis as recommended in GL 89-10.

2.2 MOV Sizing and Switch Setting

The MOV DBD and Engineering Thrust Calculations listed in Section 2.1 computed the thrust setting and torque values for the selected MOVs at the design-basis differential pressure conditions. The inspectors found that the licensee used industry accepted equations and application factors in these calculations. The gate valve thrust equation incorporated a valve factor of 0.4. However, the licensee also incorporated a 1.2 safety factor that effectively made the gate valve factor 0.48.

The inspectors reviewed the licensee's methodology and thrust calculations for each of the selected MOVs to determine if the requirements in Mechanical Design Standard DS-M18.2.21, "Motor Operated Valve Thrust and Torque Calculations" were met. The inspectors reviewed each part of the MOV package that included calculations or data for 1) valve design, 2) operator size, 3) electrical motor rating, 4) motor starting torque, 5) degraded voltage conditions, 6) control circuit logic, 7) thrust/torque determination, 8) valve requirements, 9) piston loading effects, 10) DP load, 11) packing friction load, 12) seating load, 13) stem thrust closing, 14) stem thrust opening, 15) actuator torque, 16) actuator capabilities, 17) spring pack rating, 18) valve weak link, and 19) thrust band.

The engineering department has a program for comparison of test data with design data identified as the "MOV Differential Pressure Test Evaluation Reconciliation With Design Methodology". The purpose of the "reconciliation" was to compare the test data with the design calculations to determine that the proper design assumptions had been

used and if MOV adjustments were needed. The inspectors reviewed "draft" reconciliation packages for all the valves tested and concluded the program was complete and quite acceptable. The inspectors noted that the MOV test (signature) traces had not been marked to signify the various events that occur during MOV operation. The test engineers make a determination of various points on the signature traces to determine operability before returning the MOV to service. The points selected by the design engineers for reconciliation may not be determined in the same manner and therefore different values could be used causing discrepancies among the engineering groups. The inspectors informed the licensee that identification of events on the signature traces would improve coordination of the MOV data.

The inspectors concluded the licensee's methods for MOV sizing and switch settings met the recommendations for GL 89-10.

2.3 Design-Basis Capability

The inspectors reviewed maintenance procedure ECI-0-000-MOV008, "Testing of Motor Operated Valves Using 3000 MOVATS Signature Analysis System" and the individual test procedures 2-TI-284, 2-TI-290, and 2-TI-291 for the selected MOVs. These procedures were reviewed to verify that proper testing instructions were provided to ensure that the MOV DP testing was performed to meet design-basis requirements.

The inspectors reviewed the DP test results and post test analysis for each of the MOVs. These examinations were conducted to ensure design-basis capabilities were demonstrated. The review included diagnostic test data, line pressure, differential pressure and flow measurements, and documentation and analysis of the test data.

A review of the test data against the design calculation for each MOV indicated there was adequate torque, thrust and thrust margin in excess of 10 percent. The licensee used the MOVATS torque thrust cell (TTC) to obtain the torque and thrust measurements.

The inspectors reviewed the licensee's list of testable MOVs. One of the determining factors for valve testability is the availability of space to permit the installation of the TTC. The licensee advised the inspectors that TTC and the Thrust Monitoring Device (TMD) are the only MOV mounted test devices that will be used. They only plan to use the TMD where there is sufficient margin to allow for the accuracy deficiencies. Presently the licensee has identified only 12 additional MOVs for DP testing.

The inspector conducted a walkdown inspection of the MOVs to observe their location for the installation of the TTC. In addition, the stem lubrication and stem threads were examined and found in satisfactory condition. The inspectors concluded that the testing and analysis demonstrated adequate design-basis capabilities for the MOVs tested. However, the licensee had not tested any of the MOVs that operate at higher DPs.

2.4 MOV Failures, Corrective Actions, and Trending

The inspectors questioned the number of valves with electric brakes in the program. The licensee presented the inspectors with drawing number 2-47E408-1, Mechanical Valve Actuator (EMO) Modifications which contained a list of all program valve modifications. Four of these valves had the existing motor brakes disabled by removing the brake internal components and electrical leads. Late in the inspection, the licensee informed the inspectors that there were 3 valves; 73-34, 73-40, and 73-44, that were not on the above drawing and still had functioning brakes installed. Following the inspection, the licensee informed the inspectors that they propose to remove the brake assemblies during the next outage. In the interim, the licensee contacted the vendor for brake drag values and determined that there is sufficient margin to overcome the brake affects during the stroking of the valve. This matter will be reviewed during a future inspection.

The inspectors reviewed the corrective actions for the MOV program. The inspectors reviewed the following reports:

Problem Evaluation Reports:

BFPER920071	Condition: Some calculation deficiencies were found which required additional engineering justification of numerical techniques of calculating unseating forces. (None of the information had been used to implement valve settings.) Corrective Action: Revised Calculations where calculations were effected.
BFPER940016	Condition: (OPEN) Calculated torque required to operate the valve exceeds the torque rating of the actuator by ≈ 10%. Corrective Action: Replace the stem nut with roller screw. (Scheduled for next Unit 2 outage.)
BFPER940017	Condition: (OPEN) A run efficiency was used on valves that can be and are throttled. (Closed direction only). Corrective Action: Revise calculations - No impact on thrust requirements or operability of any valves.

Significant Corrective Action Report:

BFSCAR920005 Condition: Calculations showed RHR containment cooling valves would be unable to perform their design function.

Corrective action: Calculation was issued to demonstrate valves are capable of performing their design function in the open direction. Note: In the open direction the DP force is added directly to the wedge unseating force. Subsequent Field Engineering analysis was performed and validated the corrective action calculation.

The root cause analysis performed by design engineering for the described conditions in the aforementioned reports and the corrective actions taken appeared to be adequate.

For the documents reviewed no concerns were identified in the licensee's corrective actions program.

2.5 Quality Assurance

The inspectors reviewed Browns Ferry Quality Assurance Record R92 940131 805, "Generic Letter 89-10 Motor Operated Valve Program Self Assessment," dated January 26, 1994. Eight MOVs were selected to evaluate the adequacy of the MOV program at BFN. The licensee's auditors performed a critical review of the program and generated their findings as recommendations. A sample of these were: the program needs to establish controls for operating procedures where the changes to the system could invalidate a specific MOV calculation; the program should use 20% margin as a rule where possible; and all differential test procedures should record flows throughout all phases of the test where possible. The audit included a list of follow up items as Attachment 4. Nine of 21 listed items had been completed. The most notable was the issuance of SSP-6.51, "Program Plan for Generic Letter 89-10," dated February 2, 1994, while another, the Unit 2 Differential Pressure Test Reconciliations, were currently in draft. The inspectors concluded a sufficient amount of attention has been given to the program and considerable progress has been made as a follow up to the self assessment. However, the self assessment has just been issued and while credit is given to their actions, the inspectors note that some of these items should have been completed earlier in the program.

3. EXIT INTERVIEW

The inspection scope and findings were summarized on February 11, 1994, with those persons indicated in Section 1. The inspectors described the areas inspected and discussed in detail the inspection results. Proprietary information is not contained in this report. No dissenting comments were received from the licensee.

4. ACRONYMS AND INITIALISMS

AEOD	Office for Analysis & Evaluation of Operational Data
BFN	Browns Ferry Nuclear
CST	Control Switch Trip
DBD	Design-Basis Document
DP	Differential Pressure
EOP	Emergency Operating Procedure
EPRI	Electric Power Research Institute
FCV	Flow Control Valve
GL	Generic Letter
HPCI	High Pressure Coolant Injection
IST	Inservice Test
IVA	Isolation Valve Analysis
LPCI	Low Pressure Coolant Injection
MOV	Motor Operated Valve
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
RBCCW	Reactor Building Closed Cooling Water
RCIC	Reactor Core Isolation Cooling
RFO	Refueling Outage
RHR	Residual Heat Removal System
RHRSW	Residual Heat Removal Service Water
ROL	Rate of Loading
TI	Temporary Instruction
TMD	Thrust Monitoring Device
TTC	Torque-Thrust Cell