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LICENSEE: Public Service Electric & Gas Company
Newark, New Jersey

FACILITIES: Hope Creek and Salem Generating Stations
Hancocks Bridge, New Jersey

DATES: October 17 - November 1, 1994

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## EXECUTIVE SUMMARY

The motor-operated valve (MOV) program commitments identified during the NRC team inspection at Hope Creek in July 1991 (IR 91-80) and MOV Part 2 inspection (IR 93-26) at Salem in 1993 were reviewed for progress. Implementation of the licensee's MOV program at both stations was evaluated, including a detailed review of Hope Creek MOV differential pressure test results.

All dynamic testing intended as part of the Generic Letter 89-10 program at Hope Creek has been completed. The licensee had made substantial progress in evaluating the test data and other industry information. The inspectors performed a detailed review of the dynamic test results for a representative sample of five MOVs. All MOVs in the program had been set up based on static tests using diagnostic equipment. However, the licensee had not completed evaluation of all Hope Creek, EPRI, and other industry test data to assure design-basis capability has been correctly established for all Hope Creek MOVs at their current switch settings. Also, the licensee had not established an acceptable periodic verification program for assessing MOV design-basis capability as requested by Generic Letter 89-10. Consequently, the inspectors concluded that the Hope Creek MOV program was not ready for closure. The licensee was requested to provide additional information for addressing these items at which time the NRC would review the MOV program again for closure.

The inspectors review of the licensee's progress at Salem 1 and 2 concerning the Generic Letter 89-10 program included an update regarding several open items needed for closeout of the MOV program. The inspectors also reviewed licensee actions taken to better familiarize and train Salem maintenance personnel with MOV testing activities so that they can properly assume full responsibility for implementation of the MOV program.

## DETAILS

### 1.0 INTRODUCTION

On June 28, 1989, the NRC issued Generic Letter (GL) 89-10, requesting that licensees establish a program to ensure switch settings for safety-related motor-operated valves (MOVs) were selected, set, and maintained properly. Six supplements to the generic letter have been issued to clarify this request. NRC inspections of licensee actions implementing the provisions of the generic letter and its supplements have been conducted based on guidance provided in Temporary Instruction TI-109, "Inspection Requirements for Generic Letter 89-10, Revision 1," which is divided into Part 1, "Program Review," and Part 2, "Verification of Program Implementation."

The NRC conducted a Part 1 program review inspection at Hope Creek Generating Station in July 1991, as discussed in Inspection Report 50-354/91-80. NRC Inspection 50-354/93-26, conducted in October 1993, reviewed the status of MOV program open items at Hope Creek.

This Part 2 inspection included a review of the MOV program implementation at the Hope Creek. The inspectors also followed up on several issues concerning Salem Units 1 and 2 identified during the 1993 MOV Part 2 Inspection (50-272/93-26 and 50-311/93-26). Prior to the onsite inspection, the licensee was requested to compile a table of the pertinent MOV information obtained for all MOVs tested as part of the GL 89-10 program. The inspectors reviewed this information to select a sample of MOV dynamic test results for detailed review. Five MOVs were selected based on their safety function and the available margin above design requirements. The results of this review together with other MOV issues reviewed are discussed below.

### 2.0 INSPECTION FINDINGS - HOPE CREEK MOV PROGRAM IMPLEMENTATION

#### 2.1 Detailed Review of Selected MOVs

The inspectors evaluated the licensee's design-basis reviews and the design-basis capability determinations for each of the selected MOVs:

1APHV-F011 HPCI/RCIC Return to CST Shutoff Valve
1BCHV-F007C RHR Loop "C" Minimum Flow Valve
1EDHV-2555 Reactor Recirc Pump RACs Return Isolation Valve
1EEHV-4652 Torus Water Cleanup/Suppression Pool Return Isolation Valve
1FCHV-F008 RCIC Steam Outboard Isolation Valve

#### 2.1.1 Design-Basis Reviews

The inspectors reviewed the licensee's "Motor-Operated Valve Program, Programmatic Standard," NC.DE-PS.ZZ-0033(Q), Rev. 3. This document contained several appendices. Appendix 4, Rev. 3, "Operating Conditions Evaluation," identified the appropriate design-basis differential pressures (DPs). The licensee used this procedure for reviewing normal, abnormal, inadvertent, and surveillance operation to determine the maximum DP at which each MOV could be required to operate. System pressure, flow, and temperature were included in the evaluation as required by the GL 89-10. The Final Safety Analysis Report was reviewed to verify maximum design-basis DP and required safety direction

for each MOV (whether the valve was required to open, close, or operate in both directions). The inspectors found the licensee's design-basis reviews for the above valves to be adequate.

**2.1.2 MOV Sizing and Switch Setting**

PSE&G statically set their MOVs using standard industry equations, the valve's mean seat diameter, and an assumed stem friction coefficient of 0.20 at the stem/stem nut interface. The licensee used a valve factor (VF) of 0.30 for gate valves and 1.10 for globe valves. The licensee increased the calculated minimum required thrust by 30% to account for variations in diagnostic error, torque switch repeatability, potential load-sensitive behavior and equipment degradation. During the static test, the diagnostic error and torque switch repeatability tolerances were applied to account for the actual errors for the MOV under test.

To determine the thrust limit for a MOV, the licensee selected the lowest value from either Limitorque's published thrust rating or the valve's weak link analysis. PSE&G then decreased this thrust value to account for an assumed torque switch repeatability and a diagnostic equipment inaccuracy of 13%. The maximum allowable torque was selected as the smallest value among the torque rating of the valve, operator, spring pack, or actuator (capability at full and degraded voltage considered). This torque value was then converted to thrust using a stem friction coefficient of 0.15. The MOV's maximum allowable thrust was then established as the lesser value of either the thrust converted from maximum torque or the comparison of thrust rating limits.

The licensee compared the actual maximum thrust from the VOTES static test with the above calculated maximum thrust. Further, the maximum torque value was compared to the VOTES torque cartridge (VTC) results or a a calculated maximum torque. If the maximum values had been exceeded, the licensee required a deficiency report and an engineering evaluation to reconcile the deficiency.

PSE&G's MOV control circuitry contains a limit switch, LS15, that bypasses the torque switch in the closed direction until the MOV reaches hard seat contact (point C11 on the VOTES diagnostic trace). After hard seat contact, LS15 places the torque switch back in the MOV closing circuitry. This allows full motor capability to be applied until after the valve disk has reached hard seat contact. The LS15 circuitry makes the valve essentially limit switch controlled. With the exception of 16 valves, all GL 89-10 MOVs at Hope Creek contain the LS15 circuitry. Plant operating and emergency procedures provide operator guidance for using this LS15 circuitry when MOVs are required to change position (automatic or manual strokes) for any design basis event. The inspectors noted that during diagnostic testing, and normal surveillance testing, the LS15 circuitry is bypassed and the normal torque switch circuitry controls MOV operation. The inspectors reviewed Procedure HC.MD-GP.ZZ-0224 (Q), Rev. 6, "Valve Operation Test and Evaluation System (VOTES) Data Acquisition For Motor-Operated Valves," which is used for proper setting of LS15 during the MOV static test. The inspectors concluded that the procedures used to set LS15 were appropriate.

### 2.1.3 Design-Basis Capability Determinations

The inspectors reviewed the licensee's Programmatic Standard, Appendix 14, "DP Test Analysis," Rev. 1, the static test results, and the dynamic test packages for the selected MOVs. The test conditions and results (using VOTES diagnostics) were as follows:

| VALVE NUMBER | VALVE TYPE | TEST CONDITIONS (psid) | | % DESIGN BASIS | | DYNAMIC VALVE FACTOR [1.] | | STEM FRICTION COEFFICIENT [4.] | | % LOAD[2.] SENSITIVE BEHAVIOR |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Open | Close | Open | Close | Open | Close | Static | Dynamic | |
| 1APHV-F011 | 10" Anchor Darling 2160# Flex Wedge Gate | 1176 | 1176 | 94 | 94 | 0.48 | 0.48 | N/C | 0.079 | 0.00 |
| 1BCHV-F007C | 4" Anchor Darling 500# Flex Wedge Gate | 324 | 324 | 85 | 85 | 0.78 | 0.78 | N/C | 0.16 | 10.14 |
| 1EDHV-2555 | 4" Anchor Darling 150# Flex Wedge Gate | NSD | 61 | NSD | 59 | NSD | 1.81 | N/C | 0.132 | 6.0 |
| 1EEHV-4652 | 6" Anchor Darling 62# Flex Wedge Gate | NSD | 114 | NSD | 79 | NSD | 0.66 | N/C | 0.071 | 0.0 |
| 1FCHV-F008 | 4" Anchor Darling 1375# Flex Wedge Gate | NSD | 985 | NSD | 88 | NSD | 0.1 | N/C | 0.119 | 0.0 |

1. Valve factor was calculated using mean seat diameter from vendor supplied information.
2. A negative number indicates that the thrust observed at CST during the dynamic test was greater than the thrust observed at CST during the static test.
3. "N/C" = Not Calculated; "NSD" = Nonsafety Direction.
4. Grease used for stem lubrication was Mobil 28.

There were 239 Hope Creek MOVs in licensee's GL 89-10 program. All valves were statically tested using VOTES diagnostic equipment. While the PSE&G had performed 81 dynamic DP tests, six tests were considered inadequate due to low flow conditions.

The inspectors reviewed the licensee's dynamic test data for all MOVs tested and found valve factors as high as 1.81 for gate valves and 2.26 for globe valves. Although these valves had adequate margin, it was apparent to the inspectors that the licensee's assumptions for gate and globe valve factors were not always bounding, especially for MOVs not dynamically tested. The inspectors noted that this assurance was needed for closure of the GL 89-10 program. MOVs which cannot or will not be dynamically tested still need to be

evaluated using a methodology (such as grouping) that ensures their design-basis capability. PSE&G personnel were reviewing site specific and industry data to develop a position on the use of applicable data to Hope Creek MOVs.

The inspectors reviewed some of PSE&G's preliminary engineering work for the "EPRI MOV Performance Prediction Program" and for their "Generic Letter 89-10 Closure Summary for the Motor-Operated Valve Program as Implemented at the Hope Creek Generating Station." In reviewing this preliminary work it appeared to the inspectors that the licensee's intended argument, when completed, may not meet the NRC requirements necessary for GL 89-10 program closure. The argument reviewed relied mainly on the use of the LS15 circuitry in lieu of reviewing each MOV based on design required thrusts (ie., evaluating each MOV's ability operate satisfactorily, considering the thrust requirements associated with "best available" valve factor data). Therefore, the inspectors concluded that the closure summary report's argument may not demonstrate design-basis capability for the 96 MOVs that were not dynamically tested and setup based on static testing (assuming a 0.3 valve factor for gate valves).

Telephone discussions to clarify the issues and requirements were conducted on October 28, 1994, with the lead inspector, the licensee, and cognizant NRR personnel. No immediate operability concerns were identified during this discussion. However, the licensee was requested to continue their internal review of EPRI data, Hope Creek test data, and any other applicable test data, and select the best available data to be used for demonstrating design-basis capability for each MOV in the Hope Creek GL 89-10 program. The results of the completed review and a substantiated method for periodic verification of MOV design-basis capability (discussed in Section 2.3) should be included in the licensee's documentation for program closure.

Thrust margin was determined using two different methods. The first method was for MOVs that were not practicable to dynamically test and were setup using the static test only. Margin was calculated using the control switch trip thrust or the motor capability converted to thrust when the LS15 circuitry was used. However, the design-basis required thrust included the additional 30% margin as discussed earlier. The inspectors noted that the torque switch repeatability and diagnostic equipment inaccuracies could be specified, but the amount of variation in valve factor and load-sensitive behavior could not be specified and may exceed the remainder of the 30% margin. This could affect the accuracy of the stated margins. MOVs setup with this methodology will be reviewed once PSE&G has applied applicable data for each Hope Creek MOV in the GL 89-10 program as discussed earlier.

The second methodology for thrust margin determination was for MOVs that were tested at or near design-basis conditions. Procedure NC.DE-PS.ZZ-0033 (Q), Appendix 14, "DP Test Analysis," Rev. 2, was used to evaluate this test data. For these MOVs, the amount of variation in valve factor and load-sensitive behavior was determined. In the close direction, thrust value at flow cutoff was measured and increased to account for diagnostic equipment and pressure instrumentation inaccuracies. This thrust value was then extrapolated to design-basis DP, if required, and became the extrapolated minimum required thrust. Available closing thrust was determined using thrust at control

switch trip, which had been decreased by the inaccuracies for diagnostic equipment, torque switch repeatability, and pressure instrumentation. The adjusted available closing thrust was then compared to the extrapolated minimum required thrust. The amount of thrust margin determined by this method was required to be greater than zero. The inspectors were concerned that a zero margin provided no allowance for degradation in valve factor or stem lubrication. PSE&G personnel indicated that pressure and diagnostic equipment error had been accounted for twice, and therefore, an approximate 10% margin for degradation in valve factor and stem lubrication was built into the equation even if the thrust margin calculation indicated zero. The inspectors acknowledged the added margin in the licensee's calculation but pointed out that without a specified margin for valve factor and stem lubrication degradation, the procedure could undergo revision and this margin could be inadvertently removed. PSE&G personnel stated they had no intention of revising the procedure in a manner that would remove this built-in margin.

MOVs that were tested at or near design-basis conditions and did not have a thrust margin greater than zero were further evaluated. The full motor thrust capability for the MOV with the LS15 circuitry in effect during the safety valve stroke was compared to the extrapolated minimum required thrust. This type of evaluation was necessary for valve 1APHV-F011, HPCI/RCIC Return to Condensate Storage Tank Shutoff Valve, which initially indicated a margin of -14.7%. The licensee wrote a Discrepancy Report (DR), HMD-94-052, to address this thrust margin being below the normal acceptance criterion of zero. The DR reviewed the LS15 circuitry to ensure it was in the circuit for the closed safety stroke and then compared the full motor thrust capability with the extrapolated minimum required thrust to ensure a margin greater than zero. The result was acceptable, showing a calculated margin of +14%. The licensee recommended inspecting the valve actuator, verifying the gear ratio, and refurbishing the actuator if necessary. The inspector considered these actions appropriate for valve 1APHV-F011.

## 2.2 GL 89-10, Supplement 3 MOVs

The inspectors reviewed the licensee's MOV sizing evaluation and switch settings for the Supplement 3 MOVs. All Supplement 3 MOVs have been statically tested using the VOTES system, and 1FCHV-F008 has been dynamically tested at near design-basis DP. Supplement 3 MOVs are setup to use the unique LS15 circuitry (discussed in Section 2.1.2) during the close stroke to the safety position.

The inspectors independently calculated the margin for the five valves that had not been DP tested. The thrust margin [(Control switch trip - minimum required thrust plus 30%)]/minimum required thrust plus 30%] ranged from 3.4% to 43% for these valves. Available capability, calculated using full motor torque (due to the LS15 circuitry) and assuming a stem friction coefficient of 0.20, ranged from 21% to 57%. Based on these calculations, the inspectors concluded that the valves should have sufficient capability to stroke closed under design basis conditions.

## 2.3 Periodic Verification

Paragraph "j" of GL 89-10 recommended that surveillance intervals be commensurate with the safety function of the MOV, as well as its maintenance and performance history. The surveillance interval in no case should exceed five years or three refueling outages, whichever is longer. Further, the design basis capability of the MOV has to be verified if the MOV is replaced, modified, or overhauled to an extent that the test results are not representative of the MOV performance.

Position Paper #23 in the licensee's MOV Programmatic Standard established the criteria for periodic performance verification activities to be conducted for MOVs at Hope Creek. This position included various preventive maintenance activities for MOVs followed by static testing with diagnostic equipment. These activities would be performed at an interval not to exceed five years or three refueling outages, whichever is longer. No dynamic testing of MOVs was recommended. The inspectors noted that the licensee had not provided adequate technical justification for how these activities would ensure design-basis capability for each MOV over the life of the plant. The licensee was requested to include their justification of this position as part of their closure of the GL 89-10 program (a similar request regarding periodic verification and design basis capability is discussed in Section 2.1.3).

## 2.4 Weak Link Data

PSE&G did not have all their valve "weak link" data for Hope Creek during the Part 1, GL 89-10 inspection. Since then, the licensee has received their "weak link" data and incorporated it into their calculations. Where appropriate, PSE&G reviewed the effected MOVs to determine whether prior maximum thrust values had exceeded the weak link values. Based on this review, the licensee did not find any MOVs had been overthrusted.

## 2.5 Diagnostic Equipment Inaccuracies

The licensee initially used MOVATS diagnostic equipment during MOV testing for the GL 89-10 program, however they have since retested all MOVs using the Liberty Technologies VOTES diagnostic equipment. PSE&G has incorporated the Liberty Technologies 10 CFR 21 report concerning inaccuracies of the VOTES system. Diagnostic equipment inaccuracies are addressed in Procedure HC.MD-GP.ZZ-0224 (Q), "Valve Operation Test and Evaluation System (VOTES) Data Acquisition for Motor-Operated Valves," Rev. 6. Based on review of this procedure, the inspector concluded that the licensee had taken appropriate measures to ensure diagnostic inaccuracies are accounted for.

## 2.6 MOV Failure, Trending, and Corrective Actions

The licensee has developed a MOV tracking and trending program as requested by GL 89-10. The program is described in the MOV Programmatic Standard, Position Paper #24, entitled "MOV Tracking and Trending." This document provides guidance for identifying the basic elements necessary to track MOV performance and establishes criteria for measurement of significant degradation trends as a function of service time. It also defines the basis for assembling and

evaluating performance data from MOV maintenance activities and performance verification from any diagnostic testing. The tracking and trending program was developed so that key MOV parameters could be extracted from work packages documenting MOV maintenance activities. Some of the key parameters monitored are torque switch setting, control switch trip, maximum thrust, maximum and average running load, average running current, and stroke time.

The MOV engineer is responsible for tracking and trending MOV performance to determine trends and to evaluate each MOV from a predictive perspective. This review includes maintenance work history and MOV diagnostic tests and will trend specific performance characteristics to evaluate MOV function and performance over time. The inspector concluded that the licensee had developed an adequate program for tracking and trending MOV performance.

The inspector also reviewed a sample of deficiency reports (DRs) that documented corrective actions taken in response to MOV limitations exceeded during testing. Most of these DRs involved minor overthrust conditions and were found to be acceptable after further evaluation. Based on the sample reviewed, the licensee had taken appropriate corrective actions in response to identified deficiencies.

## 2.7 Globe Valve Efforts

On March 11, 1994, PSE&G submitted a letter to the NRC providing notification of their changes to the GL 89-10 commitments for Hope Creek. The changes involved discontinuing dynamic testing of small globe valves having a low design-basis DP (ie. valves with diameter $\leq$ 2 in. and dp $\leq$ 500 psid). This action was done as a cost beneficial licensing action.

The licensee had evaluated the results of EPRI testing of globe valves and completed an evaluation of their own specific test results. Approximately 20% of the total GL 89-10 globe valve population at Salem and Hope Creek has been tested under DP conditions. In all cases, the target thrust value established by the MOV Programmatic Standard and the resultant static actuator switch settings were sufficient to bound the DP test closing thrust requirements. Based on their evaluation, the licensee concluded that the above referenced valve population demonstrated acceptable performance and, they believed that dynamic testing was not needed to assure the design-basis capability of each of these valves individually. The licensee intends to perform static testing of these valves.

The NRC in a letter, dated July 11, 1994, had accepted the licensee's commitment change to discontinue DP testing of small globe valves, with low design-basis DP, contingent upon the licensee taking appropriate actions to maintain confidence in the design-basis capability of the affected valves. The inspector reviewed the licensee measures taken in this regard, including appropriate implementation of preventive maintenance, leak rate testing, stroke time surveillance, periodic static thrust/torque diagnostic testing and trending of observations and data from these activities. Should performance degradation be noted that may adversely affect MOV design-basis capability, the licensee has controls to initiate the appropriate corrective action.

## 2.8 Schedule for Completion of GL 89-10

PSE&G submitted a letter on July 28, 1994, to the NRC indicating that the committed programmatic actions taken to address items a. through h. of GL 89-10 had been implemented at Hope Creek. As discussed in Sections 2.1.3 and 2.3, the inspectors concluded that additional licensee actions were needed before closure of the GL 89-10 program at Hope Creek. After these actions have been completed, the licensee should contact the NRC to discuss the most effective manner (i.e., meeting at Region I, submittal to NRC, etc.) for accomplishing closure of the GL 89-10 program. These matters were discussed during a telephone call on November 1, 1994.

## 2.9 Evaluation of Pressure Locking and Thermal Binding of Gate Valves

The inspectors reviewed the licensee's evaluation of the potential for pressure locking and thermal binding of gate valves. The licensee, with contractor assistance, conducted a study to evaluate the susceptibility of Hope Creek MOVs to thermal binding and pressure locking conditions. While this study concluded that some valves were susceptible to these conditions, calculations had demonstrated that sufficient motor capability existed to overcome the maximum expected thrusts for these postulated conditions. Notwithstanding the satisfactory conclusions of this study, this issue is unresolved pending a detailed NRC review of the licensee's calculation methodology **(50-354/94-24-01)**.

# 3.0 INSPECTION FINDINGS - SALEM 1&2 MOV PROGRAM IMPLEMENTATION

## 3.1 Review of Open Items from Part 2 Inspection

The inspectors reviewed the licensee's progress in addressing several items that were open at the completion of the Salem 1&2 Part 2 inspection (NRC Inspection Report 93-26). These items included: (1) the performance of AC motors at high temperatures, (2) tolerance for torque switch repeatability, and (3) weak link data. While progress had been made in the past year regarding each item, they were not complete. Additional testing was needed to evaluate the AC motors at high temperature and reduced voltages. The licensee's testing had been completed for evaluating required tolerances for torque switch repeatability. However, this test data had not been fully evaluated. Weak link data had been received from all equipment vendors but, this data had not been fully evaluated for use at Salem.

Salem 2 was shut down for a refueling outage during the inspection, and the licensee was performing its final group of MOV static and dynamic testing. The inspectors discussed activities underway, but were unable to observe any of these activities. The inspectors also discussed how the licensee was planning to come to closure concerning implementation of the GL 89-10 program at both Salem 1 and 2. The licensee indicated that they expected to be in a position to close out Salem 1 shortly after the refueling outage was completed at Unit 2. A similar action would then follow shortly thereafter for the Unit 2 GL 89-10 program closure. The licensee indicated that the lessons learned from the Hope Creek GL 89-10 program review, regarding the needs for closure, would be applied to the Salem reviews.

### 3.2 Independent Assessment of MOV Program Implementation

The inspectors noted that the licensee QA Programs Group had conducted an assessment of the Salem and Hope Creek Station in April through May 1994, regarding their readiness to accept responsibility for the ongoing MOV test program from the GL 89-10 Project Group. This assessment concluded that the Hope Creek technical and maintenance departments were ready for this transition, but the Salem departments were not ready. Specifically, the areas of staffing, experience, training, and administrative controls required strengthening. The licensee responded to this assessment by hiring an experienced MOV engineer into its Salem technical department before the start of the current Unit 2 refueling outage. The licensee also provided additional MOV assistance to Salem by temporary assignment of an experienced Hope Creek MOV engineer for the MOV outage activities at Unit 2. The inspectors considered the licensee actions, in response to this QA assessment, to be appropriate.

## 4.0 MANAGEMENT OVERSIGHT

Overall, the inspectors considered that management oversight regarding MOV activities was good. The mechanical engineering manager and the station technical managers described how they evaluated MOV activities in their departments. These managers rely on the technical experts working directly for them to advise them on technical details concerning MOV issues. The inspectors observed a potential weakness in changing management of the MOV program in that none of the technical departments had requested any independent or self-assessment to evaluate how their MOV activities were being conducted during or subsequent to the MOV station/project transition period. Involvement was noted throughout the inspection regarding these managers and their MOV personnel. The QA Program Group's independent assessment, mentioned previously, was a good licensee initiative.

## 5.0 EXIT MEETING

The inspectors held daily meetings with the licensee's staff to discuss the inspection findings. The inspectors met with the principals listed below on October 21, 1994, to summarize the preliminary inspection findings. A final site visit occurred on October 28, 1994, followed by a final telephone call on November 1, 1994. During the inspection, the licensee indicated that there was no proprietary information involved in the inspection, or expected to be included as part of this report.

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