MAR 3 1994

Docket Nos. 50-272
50-311

Mr. Steven E. Miltenberger
Vice President and Chief Nuclear Officer
Public Service Electric and Gas Company
P. O. Box 236
Hancocks Bridge, New Jersey 08038

Dear Mr. Miltenberger:

SUBJECT: MOTOR-OPERATED VALVE INSPECTION AT SALEM UNITS 1 AND 2, INSPECTION REPORT NOS. 50-272/93-26 and 50-311/93-26

This letter refers to an announced NRC safety inspection conducted by Mr. Leonard J. Prividy and others from this office on November 29 - December 3, 1993, at the Salem Power Station. The inspectors reviewed the programs being implemented in response to NRC Generic Letter 89-10, "Safety-Related Motor-Operated Valve (MOV) Testing and Surveillance." The results of t s inspection were discussed with Mr. J. Ranalli, Nuclear Mechanical Engineering Manager, and other members of your staff on December 3, 1993. The inspection concluded with a final closeout meeting at the site between the lead inspector and Mr. J. Ranalli on January 5, 1994.

The areas covered in this inspection are important to public health and safety and are described in the enclosed report. The inspection included reviews of selected documents, interviews with your personnel, direct observations of plant equipment during MOV testing at Unit 1, and a review of test results from past MOV dynamic testing conducted at Units 1 and 2.

Our inspectors concluded that satisfactory progress was being made toward completing your MOV program activities in accordance with your commitments to Generic Letter 89-10.

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No response to this letter is required. We appreciate your cooperation in this regard.

Sincerely,

Original Signed By
Kenneth Blount for

Dr. Plackeel K. Eapen
Systems Section
Engineering Branch
Division of Reactor Safety

Enclosure: NRC Region I Inspection Report Nos. 50-272/93-26 and 50-311/93-26

cc w/encl:
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S. LaBruna, Vice President - Engineering and Plant Betterment
C. Schaefer, External Operations - Nuclear, Delmarva Power & Light Co.
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RI:DRS	RI:DRS	HQ:NRR	RI:DRS
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2/16/94	2/16/94	2/25/94	2/ /94 3/3/94

U. S. NUCLEAR REGULATORY COMMISSION
REGION I

REPORT/DOCKET NOS: 50-272/93-26
50-311/93-26

LICENSE NOS: DPR-70
DPR-75

LICENSEE: Public Service Electric & Gas Company
80 Park Plaza - 17C
Newark, New Jersey

FACILITY: Salem 1 & 2 Generating Stations

INSPECTION AT: Hancocks Bridge, New Jersey

INSPECTION DATES: November 29 - December 3, 1993, at Hancocks Bridge
December 13, 16, and 22, 1993, at King of Prussia, Pa.
January 5, 1994, at Hancocks Bridge

INSPECTORS: F. Bower, Reactor Engineer
M. Holbrook, Contractor, INEL
R. Cain, Contractor, INEL
T. Kenny, Senior Reactor Engineer
L. Prividy, Senior Reactor Engineer

LEAD INSPECTOR: Leonard J Prividy — 2/16/94
Leonard Prividy, Sr. Reactor Engineer — Date
Systems Section, EB, DRS

APPROVED BY: Thomas G. Scarbrough — 2/17/94
for Dr. Plackeel K. Eapen, Chief — Date
Systems Section, EB, DRS

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Areas Inspected: An announced safety inspection was conducted of the licensee's program, developed in response to NRC Generic Letter 89-10 and related activities at Salem Units 1 & 2. The motor-operated valve (MOV) program commitments identified during the team inspection of May 1992 were reviewed for progress. Implementation of the licensee's MOV program, including a detailed review of MOV test results, was evaluated.

Inspection Results: The MOV program for both units was being implemented in accordance with current commitments made per Generic Letter 89-10, previous NRC inspections, and existing regulatory requirements. The licensee was making satisfactory progress in completing its MOV activities as scheduled. Four MOVs were selected for detailed review of their dynamic test results. A concern was identified for one (22RH19) of these MOVs concerning the evaluation of its original dynamic test results and this concern was resolved by the results of a retest performed on December 15, 1993. An unresolved item was opened to follow the resolution of the MOV pressure locking and thermal binding issue.

DETAILS

1.0 INTRODUCTION

On June 28, 1989, the NRC issued Generic Letter (GL) 89-10, requesting licensees to establish a program to ensure that switch settings for safety-related motor-operated valves (MOVs) were selected, set, and maintained properly. Five supplements to the generic letter have been issued to clarify the NRC 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 Salem, Units 1 and 2 in May 1992, as discussed in Inspection Report 50-272/92-80 and 50-311/92-80. NRC Inspection Report 50-272/93-24 and 50-311/93-24 conducted in October 1993, reviewed the status of MOV program open items, including an update to the program review conducted during the initial Part 1 inspection.

This inspection included a review of the Part 2 program implementation at both units. Prior to the onsite inspection, the licensee was requested to compile a table of the pertinent MOV information obtained for all MOVs that had been tested as part of the GL 89-10 program. The inspectors reviewed this information at the beginning of the onsite inspection to select a sample of MOV dynamic test results for detailed review. The MOVs selected were 1RH26, 2CC117, 22RH19, and 2SJ5. The results of this review together with other MOV issues reviewed are discussed below.

2.0 INSPECTION FINDINGS - 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:

1RH26	RHR RCS Hot Leg Recirculation Isolation
2CC117	RCP Component Cooling Inlet Outboard Containment Isolation
22RH19	22 RHR Heat Exchanger Discharge Cross Connect Valve
2SJ5	SI BIT Inlet Isolation

2.1.1 Design-Basis Reviews

The electrical distribution system for the Salem plant supplies a nominal 230 Vac to several MOVs in the generic letter program. The inspectors noted that an elevated Motor Control Center (MCC) bus voltage of 242V was used as the starting point for the degraded voltage calculation for 2CC117. This elevated bus voltage may not represent the worst case voltage that this MOV would experience when called upon to fulfill its containment isolation safety

function. The original degraded voltage analysis provided vital MCC voltages for 0 seconds and 30 seconds after the initiation of a loss of coolant accident (LOCA). MOV 2CC117 receives an automatic signal for valve closure within 5 seconds of the LOCA event, and has a stroke time of approximately 8 seconds. Therefore, the degraded voltage present at approximately 10 seconds into the design basis accident should have been used for 2CC117. However, the licensee applied an MCC voltage from the "T = 0 SEC." column of the study that did not represent the voltage available when the actuator motor would have to develop its maximum output for completion of its safety function. The licensee agreed to review their calculations for rapid-acting MOVs to ensure that appropriate voltages had been chosen for the MOVs to perform their safety functions at current torque switch settings. The licensee developed, in July 1993, a more detailed degraded voltage study for the 0-30 second accident scenario to include recent upgrades in the switchyard configuration and reflect a more accurate degraded voltage model. The licensee intends to use this study to review MOVs with a safety function to close. The licensee also plans to perform a similar review for MOVs with a safety function to open. The licensee expects to complete reviews within their existing MOV program schedule.

Of the MOVs chosen for detailed review, 1RH26, 22RH19, and 2SJ5 utilized degraded voltage values that were less than 70% of the motor's nominal voltage rating. The inspector noted that NRC Vendor Inspection Report No. 99900100/93-01, which included a review of Limitorque's activities associated with the supply of valve actuators to the nuclear industry, stated that Limitorque does not have a specific correlation based on data or testing for MOVs operated below 70% of the rated voltage. The licensee considered that their electrical capability calculations were conservative and demonstrate that the MOV motors will start at below 70% of the nameplate voltages. However, based on the Salem 230 volt distribution system and potentially more severe voltage drops than a 480 volt system,the licensee considered it prudent to perform certain MOV testing at lower than 70% rated voltage to confirm their calculations. The licensee has successfully tested at least two MOVs in situ at lower than 70% rated voltage with the use of a variac transformer. These tests were also performed under some percentage of the design basis differential pressure. The licensee indicated that they will use an outside contractor to perform further tests of MOVs at less than 70% rated voltage.

2.1.2 Design-Basis Capability Determinations

The inspectors reviewed the licensee's programmatic standard Appendix 14, "DP Test Analysis," Rev. 1, dated December 18, 1992, static test results, and dynamic test packages for the selected valves. The test conditions were as follows:

VALVE	CLOSE D/P (psid)	% DESIGN BASIS	OPEN D/P (psid)	% DESIGN BASIS
1RH26	178	97.6%	178	97.6%
2CC117	104	84.5%	104	84.5%
22RH19	189	77.0%	189	77.0%
2SJ5	2522	116.8%	2522	N/A

The inspectors reviewed the licensee's dynamic test data for the sample valves which used the industry standard equation, the valves' orifice diameters, and the dynamic test conditions. This review indicated a double disk gate valve factor for the closing direction of 0.77, flex wedge valve factors up to 0.52, and a ball-and-socket gate valve factor of 0.71 (See Appendix A). The licensee's data identified load sensitive behavior as high as 28%. Stem friction coefficients for the sample valves (determined at control switch trip) were as high as 0.17 under dynamic conditions. The licensee has not justified the use of those stem friction coefficients as determined at control switch trip are appropriate for flow isolation, as recommended in GL 89-10.

To determine the operability of an MOV, the licensee linearly extrapolated the thrust necessary to overcome differential pressure to design-basis conditions. The licensee expects to utilize information from the Electric Power Research Institute's (EPRI) Performance Prediction Program as part of a justification for their extrapolation methods. Until the licensee completes this justification, the extrapolation of such DP test is considered to be the first stage of a two stage approach, where the MOVs are setup using the best available data, as discussed in GL 89-10. The licensee recognized the need to justify its method of extrapolation by the schedule commitment date for the completion of their GL 89-10 program.

Based on the review of the selected MOVs, it appeared that the licensee's valve factor assumption for gate valves was not always bounding. The inspectors reviewed other MOVs dynamically tested and noted that 13 out of 20 (65%) double disk gate valves had valve factors that were higher then the assumed 0.20 valve factor. Further, 20 out of 27 (74%) of the wedge gate valves had valve factors in excess of the assumed 0.30 valve factor. The inspectors noted the following examples of licensee testing where valve factors were higher than assumptions in prior calculations.

Valves	Size/Vendor	Valve Factor Range
2 CV40/41	4" A/D FW Gate	.48 - .61
11/12 SJ134	4" Velan FW Gate	.31 - .52
1/2 RH26	12" Velan FW Gate	.35 - .50

The licensee recognized the need to thoroughly evaluate this test data and feed it back into their MOV setup methodology for application to other similar MOVs not yet dynamically tested. They also indicated the need to thoroughly review the EPRI MOV test data for impact. The licensee noted several examples where Salem test experience had been used to adjust thrust values for MOVs not yet tested. Examples cited were CC117, 118, 187, and 136. When these component cooling system MOVs demonstrated high valve factors during DP testing in Unit 2 (Note: MOVs were reviewed for operability and considered to be operable), the valves were refurbished and the MOVs were satisfactorily retested. Based on this experience, the identical valves in Unit 1 were refurbished and satisfactorily retested during the next outage. However, the licensee had not yet evaluated the existing dynamic test data for applicability to all other MOVs which can not be dynamically tested. The licensee is currently evaluating their test data for adjusting their valve factor assumptions to ensure that all GL 89-10 MOVs have their torque switches set in accordance with the best available data within the MOV program schedule requirements.

During the dynamic testing of 22RH19 on April 28, 1993, the actual valve factor was determined to be 0.71 versus an assumed value of 0.30 used in the required thrust calculation. Further, the load sensitive behavior experienced by this valve was 28%. The dynamic test was conducted at 77% of design basis conditions. The initial MOV thrust value set-up was unsatisfactory, requiring the licensee to revise their minimum target thrust value by increasing the torque switch setting, and retesting the MOV. The inspectors reviewed the VOTES diagnostic traces for the 22RH19 dynamic test and noted that significant force increases occurred well after the point of the force trace (but prior to hard seat contact) that the licensee identified as flow isolation (VOTES mark C10). The forces increased approximately 4000 lbf (53%) above the 7793 lbf measured at C10. The licensee could not fully explain why the forces would increase, and then decrease rapidly prior to hard seat contact if flow was truly isolated where marked on the force trace. The licensee reperformed the dynamic test for 22RH19 on December 15, 1993. For this retest, the licensee installed additional instrumentation with the output connected to the VOTES equipment to provide a more distinct indication of flow isolation as follows:

1. A differential pressure transmitter was installed across 22RH19 with the output signal fed into the VOTES equipment attached to the MOV.

2. An accelerometer was placed on the body of the valve where insulation had been removed.

Comparison of the April and December 1993 DP tests indicated that they were performed at basically the same flow and DP conditions. The thrust determined at flow isolation during the December 1993 test was slightly higher. Although the anomaly in the April 1993 test concerning the significant force increase observed between flow isolation and hard seat contact could not be explained, the inspector noted that this phenomenon did not occur in the December 1993 test. The retest of 22RH19 appeared to be a satisfactory test with no question where flow isolation occurred.

The licensee identified 12 MOVs that had experienced dynamic test failures for a variety of reasons. Two of the selected MOVs, 2CC117 and 22RH19, failed due to actual valve factors that were much higher than the originally assumed 0.30 valve factor which resulted in torque switches that were set too low. The licensee indicated that the dynamic test failures were not considered reportable because: 1) as-found testing was not performed, and 2) maintenance and refurbishment activities had taken place prior to the conduct of the dynamic tests. The licensee considered that the combination of these two conditions prevented the determination of MOV inoperability during the previous operating period.

The licensee's dynamic testing of 2CC117 indicated a higher than assumed valve factor. Sufficient margin existed to account for this higher valve factor, aided in part by the low stem friction coefficient associated with this valve. The low stem friction coefficient allowed the valve thrust to be increased without exceeding the actuator torque limits. The licensee has confidence that valve operability due to lubrication degradation will not be an issue for 2CC117 since MOVs are maintained on an 18-month lubrication cycle. However, the licensee plans to confirm the appropriate lubrication frequency by conducting as-found testing in the future to determine the extent of lubrication degradation. 2CC117 will be included in this testing. The inspector had no further comments regarding the 2CC117 and 22RH19 testing.

2.2 Evaluation of Pressure Locking and Thermal Binding of Gate Valves

The inspectors reviewed the licensee's evaluations of the potential for pressure locking and thermal binding of gate valves at the Salem plant. An existing study had been conducted in response to Significant Operating Event Report 84-07 and it concluded that all susceptible valves were equipped with internal or external protection devices to prevent the occurrence of pressure locking or thermal binding. However, due to GL 89-10, the licensee was reassessing the susceptible MOVs identified in this original study to capture any new valves that should have been included since the original response. From this recent review, the licensee noted that 12 additional valves have been identified of which four appear to require additional evaluation to determine susceptibility and any recommendations. Pending completion of this licensee evaluation, this is an unresolved item (50-272/93-26-01 and 50-311/93-26-01).

2.3 Inadvertent MOV Operation

The licensee considers inadvertent MOV operation as not applicable for the design basis of their plants. The licensee has documented the differential pressure due to valve mispositioning. They were waiting for the outcome of the NRC review of the core melt frequency resulting from inadvertent MOV operation in pressurized water reactor plants at the time of this inspection.

2.4 Performance of AC Motors at High Temperatures:

The licensee had initiated an effort to address Limitorque's Potential 10 CFR 21 condition, "Reliance 3⊕ L. C. Actuator Motors (Starting Torque at Elevated Temperatures)," dated May 13, 1993, which dealt with the effect of elevated temperature on the output of AC motors. Due to uncertainties in this Part 21, the licensee indicated that their efforts to address this issue were delayed in 1993 until Limitorque provided further guidance in Technical Update 93-03 regarding the evaluation of MOV performance at high temperatures. The licensee indicated that calculations have been performed to confirm operability and corroborate information received from Limitorque. Additionally, the licensee plans to perform testing to confirm their calculations of motor performance. This testing will be performed by an outside contractor in conjunction with the reduced (less than 70%) voltage testing for MOVs (Section 2.1.1) and is expected to be completed by the spring of 1994.

2.5 Tolerance for Torque Switch (TS) Repeatability

The licensee had not fully implemented the torque switch repeatability values provided by Limitorque in Maintenance Update 92-02. The licensee had commenced a test program in an effort to justify less conservative values for MOVs which have a torque switch dial setting of "1" and a torque output of $\leq$ 50 ft-lb. This testing consisted of stroking a Limitorque SMB-000 and a SMB-00 actuator on a test stand for a nominal 25 strokes. Separate test runs were conducted using a low speed and a high speed motor with the SMB-00 actuator. Preliminary results indicated that none of the test runs resulted in a deviation of greater than 10%. The inspectors noted that the licensee's study did not address the second condition identified by Maintenance Update 92-02, where the torque switch repeatability value would change from 5% to 10% where the torque switch was set at "1" and the torque output was $\geq$ 50 ft-lb. Licensee personnel stated that they will extend the current study to address this condition. The licensee stated that this testing was expected to be done by March 31, 1994.

2.6 Weak Link Data

The Salem plant did not have all the valve "weak link" data from the valve manufacturers. This data is necessary for the determination of the maximum allowable thrust. In the interim, the Salem plant is using the actuator thrust rating as the weak link for the determination of the maximum allowable thrust. The licensee stated that all valve weak link data is expected by March 31, 1994. For those MOVs where weak link data had been received, the inspector verified that the licensee had evaluated acceptably the affected MOVs to determine that prior maximum thrust values were not exceeded due to the new weak link data.

2.7 Diagnostic Equipment Inaccuracies

The licensee responded on October 8, 1993, to the reporting requirements of GL 89-10, Supplement 5 concerning diagnostic equipment inaccuracies. The licensee had used MOVATS diagnostic equipment prior to implementing the GL 89-10 and was in the process of retesting these MOVs with the VOTES diagnostic equipment. The response also documented that the licensee was completing the implementation of information provided by Liberty Technologies concerning application of torque correction factors and effective diameters. Engineering evaluation A-O-ZZ-MEE-0849 was developed and several action items had been initiated to resolve potential overthrust conditions as a result of this information. The licensee expects that required actions will be completed by Spring 1994.

2.8 Horizontally Installed MOVs

NRC Information Notice 92-59 was issued to alert licensees regarding industry experience that horizontally-installed gate valves may be susceptible to increased friction or binding. The inspector reviewed the licensee's response to this issue. The licensee stated that no direct MOV failures had been attributed to this issue, but they were calling attention to it in their MOV tracking and trending program. A list of MOVs which may be affected had been identified for inclusion and referenced in this program for analysis of problems. The inspector considered these actions to be appropriate.

2.9 Schedule for Completion of GL 89-10

In a letter NLR-N92184, dated February 11, 1993, the licensee requested a schedule extension for the completion of their GL 89-10 activities, primarily attributed to an increased scope of effort at Salem to implement an MOV refurbishment program. The inspector discussed the status of the licensee's GL 89-10 program and the licensee indicated that their GL 89-10 MOV efforts were expected to be completed as follows:

1. Salem 1: All tests were completed this outage and the schedule extension requested for completion by Spring 1995 probably will not be necessary.

2. Salem 2: Expected to be completed by Fall 1994.

The licensee also noted that the Hope Creek MOV efforts are expected to be completed by the Spring of 1994.

3.0 EXIT MEETING

The inspectors met with licensee personnel, denoted in Attachment 1 of this report, at the conclusion of the onsite inspection on December 3, 1993. At that time, the scope of the inspection and the inspection results were summarized. Follow-up telephone conference calls between the licensee, NRR, and Region I were conducted on December 13, 16, and 22, 1993, to clarify certain aspects of the licensee's MOV program activities, including the evaluation of the differential pressure testing results for MOV 22RH19. A final closeout meeting was conducted at the site between the lead inspector and the licensee on January 5, 1994. The licensee acknowledged the inspection findings as detailed in this report and had no additional comments regarding the inspection results.

ATTACHMENT 1

Persons Contacted

Public Service Electric and Gas Company Personnel

* T. Carrier, Maintenance Engineer
* P. Cusick, MOV System Engineer
* M. Davidson, Project Manager, General Physics
* C. diGirolamo, MOV System Engineer
* M. Hoskins, Engineer, Bechtel
* S. Ketcham, Nuclear Mechanical Principal Engineer
* R. Lewis, MOV Project Lead Technical Engineer
* C. Manges, Licensing Engineer
* S. Maginnis, MOV Project Manager
* J. Ranalli, Nuclear Mechanical Engineering Manager

F. Thomson, Licensing Manager

* Denotes those present at the exit meeting held December 3, 1993.

APPENDIX A

SALEM GATE VALVE DATA

Diagnostics: VOTES/VOTES Torque Cartridge (VTC) System

VALVE NUMBER	VALVE SIZE & MANUFACTURER	TEST CONDITIONS (psid)	DYNAMIC VALVE FACTOR [1]	STEM FRICTION COEFFICIENT	LOAD SENSITIVE BEHAVIOR
1RH26	12" Velan Flex Wedge Gate	1178 (Close) 178 (Open)	0.50 (Close)	0.09 (Dynamic) 0.15 (Static) Grease: EP-1	0.0%
2CC117	6" Anchor Darling Double Disk Gate	1104 (Close) 104 (Open)	0.77 (Close)	0.08 (Static) Grease: EP-1	0.0%
22RH19	8" Crane Alloyco Ball and Socket Gate	189 (Close) 189 (Open)	0.71 (Close)	0.17 (Dynamic) 0.10 (Static) Grease: EP-1	28.10%
2SJ5	4" Velan Flex Wedge Gate	2522 (Close) 2522 (Open)	0.52 (Close)	0.08 (Dynamic) 0.12 (Static) Grease: EP-1	Unknown

[1] The dynamic valve factors listed were calculated by the licensee using an orifice diameter.