U.S. NUCLEAR REGULATORY COMMISSION
REGION I

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LICENSEE:	PECO Energy Wayne, PA
FACILITY:	Limerick Generating Station, Units 1 and 2
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AREAS INSPECTED: See Executive Summary

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LIMERICK MOV INSPECTION 95-19
(November 20 - December 1, 1995)

EXECUTIVE SUMMARY

PECO Energy management oversight of the Limerick Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance" program was effective. Well-structured and broadly-based self-assessments of the GL 89-10 program were conducted. A "vertical-slice" program audit performed by an outside consulting firm contributed additional insights regarding program performance, and was a good initiative. Communications were good among site organizations, and between the corporate and LGS engineering staffs regarding motor-operated valve (MOV) issues. Good quality program specifications and procedures, trending of MOV performance, and engineering involvement in work planning related to valve maintenance were all observed to be effective.

Program documentation and test data provided an adequate basis to conclude that safety-related MOVs would perform their intended safety functions under worst-case design-basis conditions. However, the relatively limited amount of meaningful dynamic test data derived from site-specific tests increased the reliance on other industry test information. The licensee's method of applying valve performance information from the Electric Power Research Institute's Performance Prediction Program (for nontestable valves) was found to be inappropriate, and the technical justification for certain valve factor assumptions appeared to be weak. Notwithstanding, the valve factors ultimately applied to the non-testable MOVs appeared to be reasonable, and overall the current switch settings and thrust margins of the MOVs appeared to be adequate. Therefore, closure of GL 89-10 actions at Limerick was reached, subject to additional dynamic testing for MOV Group 19 valves.

Thirteen MOVs were set up such that published actuator torque ratings were exceeded, increasing the potential for excess wear and gear cracking. The Program Position regarding actuator overtorque, which allows that inspections and switch readjustments may be deferred, was inconsistent with Limitorque guidance and recent industry test program information. A followup item (**IFI 95-19-01**) was opened to review this issue at a later time.

The functional capability of MOVs susceptible to pressure locking was reasonably assured. However, the initial operability evaluations contained unjustified assumptions and deviations from vendor technical guidance. Subsequent reanalyses confirmed valve functionality, and modifications have since been initiated.

An unresolved item (**URI 93-09-04**) concerning a control circuit design deficiency involving certain emergency core cooling system valves was closed.

DETAILS

1.0 INTRODUCTION AND PURPOSE

On June 28, 1989, the NRC issued Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," requesting licensees to establish a program to ensure that switch settings for safety-related motor-operated valves (MOVs) were selected, set, and maintained properly. Seven supplements to the generic letter have been issued to provide additional guidance and clarification. NRC inspections of licensee actions, implementing the provisions of the GL and its supplements, have been conducted based on the guidance provided in NRC Temporary Instruction 2515/109, "Inspection Requirements for Generic Letter 89-10," which is divided into Part 1, "Program Review," and Part 2, "Verification of Program Implementation."

The NRC conducted the Part 1 inspection at Limerick Generating Station (LGS) in January 1992, as documented in NRC Inspection Report (IR) 92-80. A Part 2 inspection, conducted in November 1993, was documented in NRC IR 93-28. The purpose of this inspection was to follow-up on the issues identified during the Part 1 and 2 inspections, and to closeout the GL 89-10 program at LGS.

2.0 PROGRAM IMPLEMENTATION

2.1 Program Status and Scope

Generic Letter 89-10 requested licensees to notify the NRC in writing within 30 days after the design-basis reviews, analyses, verifications, tests, and inspections have been completed. In letters, dated July 28, 1994, and June 16, 1995, Philadelphia Electric Company (PECO) notified the NRC that these items were complete for both units.

The GL 89-10 program at LGS included 322 MOVs. One hundred and sixty-one (161) valves within the current program scope were considered to be testable under dynamic conditions and 62 MOVs actually were dynamically tested. However, 18 of these tests were conducted under extremely low design-basis differential pressure conditions, and many other tests did not produce data of sufficient quality to determine valve factors or other performance parameters. Six gate and seven globe valve tests resulted in meaningful information. The inspectors confirmed the licensee's data quality assessments by reviewing diagnostic test traces.

The inspector reviewed PECO Specification NE-145, "Selection of Generic Letter 89-10 Program Valves and Differential Pressure Testable Valves," to assess the licensee's conclusions regarding valve testability. With two exceptions, the inspectors found that PECO adequately justified its determinations.

During a review of MOV capability, the inspector questioned the fact only one MOV in family (group) 19 had been tested dynamically. This did not meet the grouping criteria discussed in GL 89-10, Supplement 6 (nominally 30 percent and no less than two MOVs) for statistical significance. The group consists of twelve risk-significant injection valves in the core spray (CS) and low pressure coolant injection (LPCI) systems. At LGS, the LPCI system injects directly into the reactor core region. The licensee had considered the 8 LPCI valves in the group to be nontestable based on the potential for damage due to

flow-induced vibration. The licensee re-evaluated its position and found that other similarly-configured boiling water reactor licensees tested their LPCI injection valves. PECO reclassified the valves and plans to perform dynamic testing following major maintenance on LPCI injection valve internals. The licensee also committed to continue dynamic testing of the core spray system injection valves during upcoming refueling outages to meet the Supplement 6 criterion. (A second family 19 MOV, core spray valve 1-HV-52-1F037, was tested during the February 1996 refueling outage at Unit 1.) Finally, the licensee initiated a review of the specification to determine if any other MOVs should be recategorized.

The inspectors also questioned the licensee's rationale for not testing valve HV-41-2F021, a main steam line drain valve to the main condenser. Specification NE-145 stated that the main steam discharge could damage the condenser. After additional evaluation, the licensee also reclassified this MOV as testable.

The inspectors reviewed the licensee's reevaluation of MOV testability and found no additional discrepancies. The inspectors concluded that the licensee had attempted to obtain meaningful site-specific test data for a representative sample of testable MOVs at LGS.

2.2 Operator Sizing and Switch Settings

Generic Letter 89-10 requested licensees to establish correct MOV switch settings using the results of the design-basis reviews. This entailed establishing a program to evaluate and revise, as necessary, the methods for selecting and setting switches for each valve operation.

The inspectors reviewed PECO's MOV program closure report, "Limerick Generating Station Generic Letter 89-10 Test Program Completion Report, PECO Energy Company Acceptance," and supporting design specifications concerning grouping methodology, stem friction coefficient, valve factors, and load sensitive behavior. The closure document contained several tables that detailed the program MOVs by valve designator, size, group, available thrust margin, and basis for closure. From the tables, the inspectors selected a valve sample that included several methods of verifying design-basis capability. The verification methods included: (1) valve-specific dynamic test at, or near, design-basis conditions; (2) valve-specific test, linearly extrapolated to design-basis conditions; and (3) plant-specific or industry data applied via grouping to MOVs that were not practical to test, or for which meaningful, quality performance data could not be obtained.

The inspectors evaluated the documentation for the following MOVs:

HV-041-242	Steam line bleed to condenser bypass leakage isolation
HV-051-1F015B	RHR shutdown cooling injection
HV-052-2F005	Core spray loop A outboard injection isolation
HV-55-1F001	HPCI turbine steam admission

PECO's thrust and torque calculations utilized the standard industry equations. Valve mean seat diameter was used to calculate valve seat area. A stem friction coefficient of 0.20 was used to convert thrust to torque. A valve factor of 0.55 was assumed for wedge gate valves greater than or equal to 10 inches in diameter, and a factor of 0.62 was applied to wedge gate valves smaller than 10 inches. For double disk gate valves that do not experience blowdown conditions, a valve factor of 0.40 was assumed, and a valve factor of 1.1 was applied to globe valves. The valve factor assumptions were reduced, where justified, by site-specific dynamic test data or by applying best available data from industry sources. Minimum required thrust was adjusted for diagnostic system uncertainties, torque switch repeatability, load sensitive behavior, and an engineering safety factor.

Valve Factor and Grouping

The limited amount of meaningful plant-specific dynamic test data at LGS increased PECO's reliance on industry data. The licensee divided its MOV population into 70 valve groups based on valve manufacturer, valve type, ANSI pressure class and size, service conditions, materials of construction, and seat/guide stress levels. In descending order of preference, PECO attempted first to use in-plant data, followed by the Electric Power Research Institute's (EPRI) prototype data, to justify the valve factors applied to non-dynamically tested MOVs. However, much of the in-plant dynamic test data were not considered by the licensee to be useful to justify valve factors. The licensee reviewed EPRI prototype data for valves that matched those at Limerick (Anchor-Darling and Velan) based on valve manufacturer, type, size, and ANSI pressure class rating. The valve factor data for these "typical" valves were plotted on graphs; one for valves greater than 10 inches in diameter, and one for valves less than 10 inches in diameter. A 95% probability line was superimposed on the graphs, resulting in the wedge gate valve factors cited above.

The inspectors did not agree with the licensee's method of using the EPRI information. For example, the prototype data was in the form of disc friction factors vice valve factors; the angle of the disc seating surface normally is used to convert a disc friction factor to a valve factor. The licensee acknowledged this difference, but stated that the difference was small enough to be discounted. Second, the inspectors noted that EPRI valve friction factors were developed by removing parasitic or valve conditioning loads, further reducing the friction factors published by EPRI as compared to valve factor. The EPRI Performance Prediction Model (PPM) adds back the parasitic or valve conditioning loads when calculating total required thrust, but LGS does not utilize the PPM. Third, EPRI tested a small sample of various valves of different manufacture, type, size, design, and rating that is not sufficient to establish a reliable statistical database for each valve category. The inspectors reviewed several MOV groups to assess the impact of the licensee's method on valve operability.

Valve group 15 consisted of eight, 8-inch, 150 psi, Anchor-Darling gate valves. Two valves were tested dynamically, but the data was not of acceptable quality to validate valve factor or load-sensitive behavior. The licensee used a valve factor of 0.62 based on its use of the EPRI data. The inspectors noted that the valves in this group had relatively low thrust margins. For example, valve HV-87-222 (drywell cooling containment isolation) had only a 2.0 percent (%) margin. Because of other margins used in the required thrust calculations, such as 15% for load sensitive behavior, a stem friction coefficient of 0.2, and an engineering factor of up to 5%, the inspectors had no immediate concerns regarding the functionality of the valves in this group. However, the low overall margin available illustrated the need for further justification of valve factor assumptions.

Valve group 19 contained 12-inch, 900 psi, Anchor-Darling (Hayward) gate valves. Of the 12 MOVs in the group, four were considered to be testable under dynamic conditions. However, the licensee tested only one valve, HV-52-2F005 (core spray loop "A" outboard injection), and applied its performance parameters to the remainder of the group. During the inspection, PECO obtained and evaluated additional test data for similar valves at other nuclear plants and adjusted upward the assumed opening and closing valve factors from 0.26 and 0.35, respectively, to 0.3 and 0.43. Additional margin for closing the CS injection valves in the group was provided by changing system operating procedures to trip the pumps prior to closing the valves. In all cases, the new, lower thrust margins for the MOVs in this group remained acceptable. To be more consistent with the intent of GL 89-10, Supplement 6, the licensee is revising its program to caution against applying data from only one valve to other nontestable MOVs.

Valve group 35 consisted of eight, 8-inch, 150 psi, Crane gate valves. PECO used a valve factor of 0.62 derived from its use of the EPRI data. However, the EPRI prototype data did not include test results for Crane gate valves. LGS will be expected to justify further the valve factor applied to this group.

The inspectors considered the licensee's valve factor justifications to be weak. However, the inspectors acknowledged that the assumed valve factors were reasonably conservative, and noted that the MOVs reviewed had sufficient thrust margins. Thus, while the licensee should continue to seek further industry and site-specific information to refine its valve factor justifications, the current switch setup of the MOVs was adequate for GL 89-10 program closure.

Load Sensitive Behavior

PECO originally assumed a 10% margin for load-sensitive behavior, but re-evaluated the assumption during the inspection using statistical analysis. The data indicated an average value of 2.97% with a mean plus two standard deviations of 17.23%. When these values were combined with other errors and uncertainties in a square root, sum-of-the-squares methodology, the load-sensitive behavior equated to a 13.5% margin. PECO adopted a 15% margin for load-sensitive behavior and reevaluated its nontestable MOVs. While all of the MOVs retained an acceptable margin, some required a reduction in the assumed

5% engineering safety factor to do so. The licensee stated that it intended to track and improve the margin on these MOVs. The inspectors concluded that the licensee's analysis of load-sensitive behavior was adequate for program closure.

Stem Friction Coefficient

The licensee's VOTES testing procedures derive and compare static and dynamic stem friction coefficients. The inspectors reviewed PECO's stem friction coefficient evaluation. The licensee performed a statistical analysis using 91 data points, and concluded that the stem friction coefficient of 0.185 bounded its data with a 95% confidence level. In addition, PECO assumed a coefficient of 0.2 to set up its MOVs. The inspectors considered the evaluations of stem friction coefficient to be adequate for program closure.

Stem Lubricant Degradation

PECO included a 5% engineering safety factor in its MOV set-up methodology to account for stem lubricant degradation and spring pack relaxation. The licensee's program provides for monitoring of lubricant performance as part of its tracking and trending program, and for adjustment of margins as appropriate. The inspectors found this position adequate for program closure.

Linear Extrapolation

The inspectors reviewed PECO Position Paper 22, "Linear Extrapolation Method Justification." The licensee based its extrapolations on site-specific test data and the boiling water reactor owners' group position that requires a differential test pressure of at least 80% of the design-basis value. Engineering evaluations were required for each case involving extrapolation from below 80%. In those cases, PECO reviewed the test conditions, running load (as a percentage of differential pressure load) and other factors (such as the absolute value of the test differential pressure) to determine the validity of the extrapolation. The inspectors considered the licensee's approach to be conservative and adequate for program closure.

Actuator Overtorque

Limitorque Corporation maintenance and technical updates provide guidelines in the event that published actuator torque ratings are exceeded. The guidance recommends disassembly and inspection of actuators subjected to 120% or greater of published ratings, and correction of the condition prior to returning a valve to service.

During the course of MOV testing, LGS found 29 actuators in the overtorqued condition. The licensee identified three types of conditions: (1) cases in which the torque switch was set above the actuator's capability under degraded voltage conditions; (2) cases in which the torque switch was set above the spring pack's rated capability; and (3) cases in which measured peak torque exceeded the published actuator rating. PECO Position Paper 23, "Actuator Structural Over Torque Position," dealt with the latter case. PECO's policy is to correct an overtorque condition prior to returning an MOV to service.

However, on a case-by-case basis (documented by a nonconformance report), the licensee deviates from Limitorque's guidance by deferring inspections and corrective action to a later date. The licensee deferred inspection and readjustment of 13 MOVs at LGS Units 1 (4 MOVs) and 2 (9 MOVs), justified by the results of gear train inspections performed on 22 previously overtorqued actuators at LGS. No gear train wear or cracks were found in actuators that were overtorqued from 121% to 202% of the published ratings.

The inspectors noted that an industry testing program found that valve actuators are more susceptible to damage from excessive torque than previously considered in Limitorque's guidelines. The licensee stated that it had considered current industry test information in its evaluations, but concluded that the test conditions were significantly more severe than those experienced by the actuators at LGS. In addition, the number of cycles anticipated for the LGS valves was far less than the number of cycles experienced by the test valves. The licensee has scheduled corrective action for the 13 nonconforming MOVs for the next refueling outages at LGS Units 1 and 2. The inspectors concluded that the affected MOVs were functional. However, the adequacy of PECO's overtorque policy, in light of current industry test results, is a followup item pending further NRC review of the licensee's inspection criteria and methods, findings, and technical evaluations. **(IFI 95-19-01)**

MOV Operability Checks

PECO performed preliminary operability reviews prior to returning MOVs to service after dynamic testing. The review consisted of assuring that a valve completed its stroke to the required position, and that no abnormalities were present in the diagnostic trace. For the closed direction, flow cutoff and hard seat contact were verified to occur prior to torque switch trip. In the open direction, the torque switch bypass was verified to allow torque switch operation after maximum disk pullout forces had occurred. Licensee personnel were required by maintenance guidelines to perform the complete dynamic test acceptance criteria review within 1 week of the dynamic test. The complete review determined valve factor, stem friction coefficient, linear extrapolation to design-basis conditions (if required), and other MOV parameters. The inspectors randomly selected several MOVs for review and found that the dynamic test reviews had been performed within the 7-day requirement. However, the inspectors concluded that the preliminary operability checks did not assess the margin available at design-basis conditions, raising the possibility that an inoperable MOV could remain in service for up to 7 days. The licensee addressed this concern by revising its operability check procedure prior to the end of the inspection.

Material Conditions

The inspectors performed a walkdown of GL 89-10 MOVs at LGS. The valves inspected were well-lubricated with Mobilux EP-1 grease, and appeared to be in excellent condition. All of the areas entered by the inspectors were very clean and general material conditions were good.

2.3 Periodic Verification of Design-Basis Capability

Generic Letter 89-10 requested licensees to develop methods to verify periodically that MOV degradation or control switch misadjustment has not occurred. The LGS program established periodic verification test intervals based on a "graded approach" that ranked MOVs by safety (risk) significance and high performance margin criteria. The licensee categorized approximately 70% of the MOVs in its program as "nonsafety-significant," and plans to test these valves only on a post-maintenance basis.

The inspectors did not determine the acceptability of PECO's periodic verification plans at this time. The NRC ultimately will review this aspect of the MOV program following issuance of a generic letter. However, the inspectors informed the licensee that its current approach to periodic verification of "nonsafety-significant" valves was not consistent with the intent of GL 89-10. PECO should review its program in light of the new GL and consider any appropriate adjustments. For example, the licensee should consider the benefits (such as identification of decreased thrust output and increased thrust requirements) and potential adverse effects (such as accelerated aging or valve damage) when establishing periodic tests for each GL 89-10 MOV.

2.4 Post-Maintenance/Modification Testing

The inspectors reviewed the post-maintenance/modification testing program, including static and dynamic testing requirements, and concluded that testing had been performed as required by LGS procedures and was consistent with GL 89-10 recommendations.

As described in Procedure AG-CG-26.6, "Post-Maintenance/Modification Testing (PMT)," work planners primarily are responsible for assigning appropriate PMT requirements based on the scope of the work performed. Exhibits in the procedure provide specific guidance concerning static diagnostic tests, but defer to component engineers to evaluate the need for a dynamic test. The determination whether or not to perform a dynamic test is documented in an action request evaluation. The inspectors reviewed twenty completed work orders, verified that static diagnostic tests had been assigned properly, and that exceptions to dynamic testing had been documented appropriately. The inspectors also found that engineering was closely involved in the PMT process, and considered this to be a program strength.

2.5 Performance Trending

Procedure PG-12, "MOV Performance Evaluation and Trending," describes PECO's program for tracking and trending safety-related MOV performance at LGS. The goal of the program is to monitor MOV performance and the overall effectiveness of the MOV maintenance program. Upon closure of a work order, the MOV component engineer enters quantitative and qualitative information into a computerized MOV data base. An "Actions and Investigations" field lists typical preventive and corrective maintenance activities (i.e., lubricated stem, torqued packing, adjusted limit switch), and an "Actuator Trending/Analysis Parameter" review field covers problems associated with

major MOV components, such as the torque switch, motor, gear train, spring pack, and limit switches. In addition, "as found" grease conditions are recorded. The inspectors observed a demonstration of the computer software's capabilities. For every MOV part number, the program contained numerical criteria for various test parameters. The data can be tabulated and sent as an external file, allowing other software to be used to perform statistical analyses.

At the time of the inspection, the program contained 502 records, mostly from baseline VOTES tests and preventive maintenance work orders. The MOV component engineer looks for performance trends each time a work order is entered into the system. For example, the licensee identified an adverse trend involving overtorqueing of residual heat removal system heat exchanger service water inlet valves. The issue was resolved by changing the valve actuation logic to eliminate closure against pump shutoff head. The trending program also requires an overall plant MOV performance review to be performed semiannually. The inspectors concluded that the licensee's provisions for tracking and trending MOV performance were effective and acceptable for GL 89-10 program closure.

2.6 Operating Experience Assessment Program

The inspectors reviewed PECO's Operating Experience Assessment Program (OEAP) to assess the licensee's integration of vendor information into the GL 89-10 program. The inspectors reviewed a sample of Liberty Technologies Customer Service Bulletins (LTCSB), VOTES "Hot Tips" (VHT), and a Limitorque Technical Update (LTU) to determine if they had been processed through the OEAP appropriately, and in a timely fashion.

The inspectors found that all of the vendor notices had been processed through the OEAP, and that the technical issues had been evaluated and resolved. The LGS OEAP coordinator tracked the technical evaluations on a weekly basis and reported to management the opening of new evaluations, and whether any items were overdue. At the time of the inspection, there were no overdue MOV vendor issues. The inspectors concluded that PECO maintained an effective vendor information program for MOVs.

3.0 (CLOSED) MOV CONTROL LOGIC DESIGN DISCREPANCIES (URI 93-09-04)

This item concerned a potential MOV control circuit design discrepancy concerning emergency core cooling system valves that may not close automatically when in a throttled (mid-stroke) position. The condition was a result of the limit switch development scheme, in which the automatic actuation contact in series with the close permissive contact, was located on the same limit switch rotor as the open torque switch bypass (OTSB); with the open torque switch bypass contact closed, the close permissive contact remained open, blocking automatic closure. In addition, the valve position indication switches were set up such that the valves would indicate closed in the control room while actually throttled open.

The licensee initially corrected the condition by adjusting the OTSB limit switch to provide dual indication in the control room when the valves were throttled open, and training operators to be aware of the condition. PECO also performed a 50.59 safety evaluation that determined that the switch development was consistent with the original plant design basis. The inspectors noted that the LGS Updated Final Safety Analysis Report permitted operator intervention to align systems to perform their safety functions in accordance with procedures, and that the report was revised to describe the control scheme. Notwithstanding, PECO subsequently implemented a modification to the limit switch development that moved the OTSB function to a spare limit switch rotor, thus permitting independent setting of the OTSB, close permissive, and valve position indication contacts. The modification eliminated the "discrepancy," and improved the accuracy of the valve position indication in the control room.

The inspector attended a pre-job briefing and witnessed the implementation of the modification on one of the affected MOVs. The briefing was detailed and complete. During the work, the inspector questioned the maintenance technicians and found them to be well-versed in the job requirements. The technicians were professional, attentive to detail, and safety conscious.

The inspector concluded that the control logic change provided additional assurance that the MOVs would function automatically when called upon, and that PECO took a conservative approach to safety by implementing the modification.

4.0 PRESSURE LOCKING OF GATE VALVES

In October 1993, PECO completed a scoping study that identified as susceptible to pressure locking 14 safety-related gate valves at LGS. In January 1994, PECO completed its engineering evaluation of the valves, and concluded that all were capable of overcoming the pressure locking forces expected under postulated accident conditions. For both LGS units, the susceptible valves were:

- HV-49-1(2)F013 — Reactor core isolation cooling (RCIC) injection
- HV-51-1(2)F017A-D — Low pressure cooling injection (LPCI) loops A,B,C,D
- HV-52-1(2)F005 — Core spray (CS) loop A injection
- HV-52-1(2)F037 — Core spray (CS) loop B injection

As a result of additional reviews in July 1995, PECO also determined that high pressure cooling injection (HPCI) system valves HV-55-1(2)F006 and HV-55-1(2)F105 were susceptible to pressure locking during certain loss of feedwater transients. PECO concluded that these valves were operable.

The inspector reviewed licensee pressure locking evaluations at the PECO corporate engineering offices on July 12-13, 1995, and discussed preliminary findings and conclusions with the licensee in early August. Based on the inspector's performance of independent calculations using a method developed by Grand Gulf (Entergy) and standard industry actuator sizing equations, the inspector questioned the operability of the loop B CS and loop D LPCI

injection valves at Unit 1. Subsequently, PECO modified the two questionable valves during a planned outage in late August 1995. During the current inspection, the inspectors reviewed the licensee's operability justifications for the HPCI injection valves. The inspector noted that the remaining valves are scheduled to be modified during next refueling outages at Units 1 and 2 in February 1996 and February 1997, respectively.

The inspector found that PECO's assumptions regarding the pressures exerted on the valve disks were reasonable, but that the methodology and other assumptions utilized by the licensee underestimated required stem thrust and actuator torque and overestimated motor-actuator capability. The licensee calculated an "equivalent differential pressure" force using a set of upstream, downstream, and bonnet pressure assumptions, and applied that force in the standard industry (Limitorque) actuator sizing equation to derive required thrust and torque. This method was similar to that contained in NUREG-5807, "Improvements in Motor-Operated Gate Valve Design and Prediction Models for Nuclear Power Plant Systems." However, PECO's calculation did not account for disk unwedging force, and the inspector did not agree with the licensee that under static conditions this force was inherent in the valve factor term of the standard equation. In addition, to convert thrust to torque PECO utilized a stem factor based on a coefficient of friction of 0.15. The inspector considered this value to be unjustified, noting that the coefficient of friction calculated by the licensee (bounded at a 95% confidence level) using site-specific test data was 0.185. Finally, PECO utilized motor stall torque from generic motor performance curves to calculate actuator output capability. The inspector did not consider the application of unvalidated generic motor curves to be justified, and noted that use of motor stall torque to estimate actuator output was contrary to Limitorque guidance.

PECO refined certain of its assumptions and reperformed the operability evaluations to address the inspector's observations. The licensee estimated unwedging force by correlating peak pullout motor current to the motor current recorded during valve wedging. The inspector considered the approach to be reasonable in the interim, since the unwedging force recorded on the VOTES traces had been outside the calibration range of the diagnostic equipment. The licensee also calculated a higher stem coefficient of friction that was more consistent with site-specific test data. Concerning motor output capability, PECO confirmed that the generic motor performance curves had been validated by tests of similar motors at another nuclear facility. The tests indicated motor torque capacity in excess of the nameplate value. To account for uncertainties, PECO also "derated" the curves by ten percent. In addition, the licensee performed valve-specific calculations of motor terminal voltage under degraded grid conditions that resulted in additional output torque capability. Based on the licensee's revised assumptions, the inspector concluded that PECO's reanalysis provided reasonable assurance that the valves would be functional through the end of the current operating cycle.

During this inspection, the inspector reviewed PECO's operability assessment of the HPCI injection valves. The inspector found that the licensee's calculation of motor output torque capability was consistent with the approach endorsed in Limitorque Maintenance Update 88-01 for direct current motors. To estimate required thrust, PECO utilized its "equivalent differential pressure" approach, and assumed a stem coefficient of friction of 0.2 and a valve factor of 0.3. The inspector considered the stem friction coefficient assumption to be adequately justified by PECO's MOV test results, and conservative. However, the valve factor applied by the licensee did not appear to be justified either by industry (EPRI) tests of similar Velan gate valves, or by the licensee's GL 89-10 test program. PECO revised its calculations and reconfirmed its conclusion regarding HPCI valve operability. Again, the licensee did not include unwedging forces in its evaluation. The inspector performed calculations using PECOs design-basis valve factors and the unwedging forces measured during diagnostic testing. The calculations indicated that the MOVs had sufficient capability to overcome postulated pressure locking forces.

The inspector concluded that the susceptible MOVs identified by PECO were functional, and verified that the licensee had scheduled the valve modifications for the upcoming refueling outages. However, the inspector found that PECO's initial operability evaluations contained inadequately justified assumptions and deviations from vendor guidelines. The NRC will reevaluate the licensee's treatment of susceptible MOVs at LGS during its review of the response to GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves."

5.0 MANAGEMENT SUPPORT AND SELF-ASSESSMENT

The licensee provided effective management oversight and support of the MOV program at LGS. This was evidenced by good quality program specifications and procedures, staff participation in industry users' groups, and utilization of expertise provided by vendors and engineering consultants. The inspectors found that program goals and management expectations were communicated clearly to corporate and site organizations, and reinforced by regularly scheduled team meetings and senior management presentations. Communication among site organizations involved in MOV work and between the LGS and corporate engineering staffs was excellent.

Periodic self-assessments are performed at LGS pursuant to procedure AG-CG-19, "Self-Assessment Guideline." PECOs process was formal and well-structured, requiring evaluation of performance against clearly established and measurable success criteria. The inspector reviewed the results of a GL 89-10 program self-assessment that was performed during the second quarter of 1995. The assessment included findings from audits and surveillances performed by the licensee's quality assurance organization and offsite consultants. The assessment was broadly-based and self-critical.

PECO also commissioned a consultant to perform a "vertical slice" audit of the MOV program. The inspectors found that the responsibilities for resolving the audit findings were clearly established and that the status of open items was monitored closely by program management.

6.0 MANAGEMENT MEETINGS

Licensee representatives were informed of the purpose and scope of the inspection at an entrance meeting conducted on November 20, 1995. Findings were discussed periodically with the licensee throughout the course of the inspection.

The inspectors met with the principals listed below to summarize preliminary findings on December 1, 1995. The licensee acknowledged the preliminary findings and conclusions with no exceptions taken. The bases for the inspection conclusions did not involve proprietary information, and none was included in this inspection report.

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J. Cotton	Director, Nuclear Quality Assurance
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