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

Report Nos.: 50-335/94-11 and 50-389/94-11

Licensee: Florida Power and Light Company
9250 West Flagler Street
Miami, FL 33102

Docket Nos.: 50-335 and 50-389 License Nos.: DPR-67 and NPF-16

Facility Name: St. Lucie 1 and 2

Inspection Conducted: May 2 - 6, 1994

Lead Inspector: Chris A Casto 4/7/94
for E. Girard Date Signed

Other Inspector: M. Miller

Other Personnel: M. Holbrook, Consultant (EG&G Idaho, Incorporated)

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Test Programs Section
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SUMMARY

Scope:

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

The inspectors conducted interviews with licensee personnel and selectively examined records, procedures, and hardware to evaluate the licensee's implementation of the GL 89-10 program. They also assessed the licensee's actions in response to a related open item and other concerns identified in previous NRC inspections.

Results:

The inspectors concluded that the licensee was in the process of implementing a generally satisfactory GL 89-10 MOV program. However, a violation and two inspector followup items (IFIs) were identified, representing weaknesses in the program implementation. The violation and IFIs are summarized below and described in detail in the indicated report sections:

(Open) Violation 50-335, 389/94-11-01, Inadequate Corrective Action for MOVs Which Stalled During Surveillances. (Section 2.5.b)

In three instances where MOVs stalled during surveillance tests, the licensee failed to document possible damage to and corrective action for the valves and actuators. There were no recorded calculations of the thrust and torque caused by stall to determine if limits prescribed for the actuator by the valve manufacturers were exceeded. NRC inspectors' calculations found the thrust produced by stall was about 230 percent of the actuator thrust rating and 160 percent of its torque rating. The thrust was 125 percent of valve limit. (Note: The licensee did document and address possible damage and corrective actions for motors and overload relays.)

(Open) IFI 50-335, 389/94-11-02, Inadequate Recognition of MOV Test Pressure and Flow. (Section 2.3)

The licensee's design-basis differential pressure test for valve 1-V-3660 did not accurately determine differential pressure at the valve and did not assure representative design-basis flow.

(Open) IFI 50-335, 389/94-11-03, Lack of Instructions or Guidance for Trending and Periodic Evaluation of MOV Failures. (Section 2.5.a)

There was no procedure or instruction specifying who was responsible to perform and evaluate trend reports, when the reports were to performed, who would initiate recommendations and corrective actions, how frequently the reports were to be issued, etc.

The licensee's program implementation was scheduled to be completed 60 days following start-up from Cycle 13 refueling outage (scheduled fall 1994) for Unit 1 and Cycle 9 refueling outage (scheduled fall 1995) for Unit 2. Approximately 2/3 of the gate and globe valves had been set and tested but a methodology had not been established for verifying the capabilities of butterfly valves. These and other important aspects of the program that had not been fully developed and/or implemented will require evaluation in a subsequent NRC inspection. The inspectors specifically identified the following issues for further inspection, together with the violation and followup items described previously:

(1) Completion of the development and implementation of post maintenance test requirements. (Section 2.4)

(2) Establishment and implementation of criteria for determining the capabilities of butterfly valves. (Section 2.6)

(3) Revision of calculations for Direct Current (DC) powered MOVs (pullout efficiency to be used in place of run efficiency). (Section 2.2)

(4) Justification for the adequacy of the method used to extrapolate MOV test results to design-basis conditions. (Section 2.3)

(5) Justification for the MOV stem friction coefficient assumed in thrust/torque calculations. (Section 2.2)

(6) Completion of the development and implementation of criteria for periodic verification. (Section 2.4)

(7) Completion of the remaining setting and testing of valves. (Section 2.6)

(8) Revision of program and test procedures to require that thrust margins be adequate to account for appropriate uncertainties (such as torque switch repeatability). (Section 2.3)

(9) Results of internal inspection of valve 1-V-3660. (Section 2.3)

Previously identified IFI 50-335, 389/92-25-01 was closed by the inspectors based on the review, described in Section 2.10.a, which identified the above violation. Additionally, concerns identified in the previous NRC inspection (50-335, 389/91-18) of the licensee's GL 89-10 program, were either found adequately resolved or will be addressed in the GL 89-10 closeout inspection for St. Lucie performed by Region II.

The inspectors observed that the quality of diagnostic data used by the licensee was particularly good and considered this a strength.

REPORT DETAILS

1. Persons Contacted

*L. Bearror, Quality Assurance/Quality Control
*J. Connor, Technical Staff
*J. Cook, Electrical Maintenance
*W. Dean, Supervisor, Electrical Maintenance
*J. Hallem, Technical Staff Engineer
*G. Madden, Nuclear Reactor Regulation Interface, Licensing
*J. Manso, Engineer, Mechanical Engineering
*L. McLaughlin, Licensing Manager
*K. Mohindroo, Production Engineering Group Manager
*D. Sager, Vice President - Plant St. Lucie
*C. White, Commitment Tracking and Routine Reports, Licensing
*R. Winnard, Juno Licensing
*J. Zudans, Lead Engineer, Mechanical Engineering

NRC Personnel

*S. Elrod, Senior Resident Inspector
*M. Miller, Resident Inspector

*Denotes personnel that attended the exit meeting.

Acronyms and initialisms used throughout this report are listed in the last paragraph.

2.0 GENERIC LETTER (GL) 89-10 "SAFETY-RELATED MOTOR-OPERATED VALVE [MOV] TESTING AND SURVEILLANCE" (2515/109)

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

The current inspection is the initial TI 2515/109 Part 2 program implementation inspection. The TI 2515/109 Part 1 program review for St. Lucie was conducted September 9 through 13, 1991, and was documented in NRC Inspection Report 50-335, 389/91-18, dated November 18, 1991.

The principal focus of this inspection was to evaluate in depth the implementation of GL 89-10 for a sample of MOVs selected from the licensee's program. The MOV sample was chosen from a list of valves that had received differential pressure (DP) testing. The majority of the valves selected were gate valves with high design-basis DP (DBDP) operating requirements. The MOVs in the sample were as follows:

Valve Number	Function	Size	Type
1-V-3480	1A Low Pressure Safety Injection Hot Leg Suction Valve	10 inch	Gate
1-HCV-3617	Auxiliary High Pressure Safety Injection Header Flow Control Valve to Loop 1A2	2 inch	Globe
1-V-3660	High Pressure Safety Injection Pump Recirculation To Refueling Water Tank Isolation Valve	3 inch	Gate
2-V-3480	2A Low Pressure Safety Injection Hot Leg Suction Valve	10 inch	Gate
2-HCV-3615	Loop 2A2 Low Pressure Safety Injection Header Isolation Valve	6 inch	Globe
2-V-3654	High Pressure Safety Injection 2B Isolation Valve	6 inch	Gate
2-V-3658	Shutdown Cooling Heat Exchanger 2B Inlet Isolation Valve	12 inch	Gate
2-V-3664	2A Low Pressure Safety Injection Hot Leg Suction Valve	10 inch	Gate
2-MV-08-13	2C Auxiliary Feedwater Pump Steam Admission Valve	4 inch	Gate
2-MV-09-10	2B Auxiliary Feedwater Discharge Valve	4 inch	Globe

This inspection also evaluated actions which the licensee had taken to correct a related violation and weaknesses identified in previous inspections, as described in Section 2.10 of this report.

Based on this, the inspectors concluded that the licensee was implementing an acceptable MOV program in response to GL 89-10. However, some weaknesses were identified. Additional NRC inspection is planned to complete the evaluation of some areas and to address specific findings identified below.

2.1 Design-Basis Reviews

For the above sample of 10 MOVs, the inspectors reviewed the licensee's Generic Letter 89-10 Design-Basis Differential Pressure (DBDP) Calculations, applicable operational procedures, system flow drawings, pump curves, and the design-basis documents. They verified that the maximum flow and differential pressure were determined for each MOV. Calculations for differential pressure, voltage, flow, and temperature

were reviewed and verified to be complete and correct. Determinations of thrust and torque were verified to use appropriate inputs of the design DP, voltage, and temperature corrected motor torque capabilities. The inspectors verified that the licensee completed the DBDP calculations for all the safety-related systems and addressed flow.

The licensee had been notified of the effects of elevated temperature on motor torque through a Potential 10 CFR Part 21 Notice dated May 13, 1993, and Technical Update 93-03 (March 1993) issued by Limitorque Corporation. The licensee issued Corrective Action Request 070593 dated September 15, 1993, to initiate corrective action for the MOV motors. Engineering Evaluation JPN-SEMP-93-031 was initiated to address the effects of elevated temperature on the MOVs and recommend corrective action. The inspectors verified that the licensee implemented appropriate corrective action by revising the calculations for reduced motor torque of the affected MOVs.

The inspectors concluded the licensee had adequately implemented the design-basis recommendations of GL 89-10 for design-basis reviews.

2.2 MOV Sizing and Switch Setting

The inspectors reviewed the licensee's documentation for determination of design-basis thrust/torque requirements for 5 of their selected sample of 10 valves: 1-HCV-3617, 1-V-3660, 2-V-3654, 2-V-3664, and 2-MV-08-13.

The licensee's calculation of thrust requirements was found to use a standard industry thrust equation with a valve factor assumption of 0.50 for wedge gate valves and 1.10 for globe valves. For determination of actuator output thrust capability, the licensee assumed a stem friction coefficient of 0.20. Further, a margin of approximately 10 percent was incorporated to address MOV load sensitive behavior (also known as "rate of loading"). Minimum thrust requirements for setting of actuator torque switches were adjusted to account for diagnostic equipment inaccuracy and torque switch repeatability.

The inspectors noted that the licensee had calculated stem friction coefficients using static test data for the purpose of justifying their assumed 0.20 stem friction coefficient. The inspectors discussed with licensee personnel the importance of measuring stem friction coefficient under test conditions that are representative of design-basis conditions. Licensee personnel stated this would be considered in developing the justification for their assumed stem friction coefficient. Region II will review the licensee's justification during a future inspection.

The licensee's actuator manufacturer, Limitorque, is understood to have recently recommended that pullout efficiency be used in place of run efficiency for determination of actuator capability in the closing direction for DC powered MOVs. Licensee personnel stated that an informal review of the impact of this information had been completed and that no concerns were identified. They indicated that use of pullout efficiency for the closing direction for DC MOVs will be incorporated by

revising the formal calculations. Region II will review the result of using pullout efficiencies during a future inspection.

2.3 Design-Basis Capability

For their selected sample of 10 valves, the inspectors examined the static test results, dynamic test packages, and post-test review packages. The dynamic test data was evaluated by the licensee using an industry standard equation, the valves' orifice diameters, and the dynamic test conditions. The evaluation indicated closing gate valve factors up to 1.10 and load sensitive behavior as high as 6 percent. Stem friction coefficients for the sampled valves were as high as 0.21 under static test conditions (see Appendix). Based on this data, it did not appear that the licensee's 0.50 valve factor assumption for gate valves was always bounding. However, for those valves with high valve factors, the thrust margins applied to settings had been sufficient to assure satisfactory performance. The capabilities of sister valves had been demonstrated by testing under dynamic conditions.

To determine the operability of an MOV, the licensee linearly extrapolated the thrust necessary to overcome differential pressure to design-basis conditions. Licensee personnel stated that a justification for use of linear extrapolations was under development. Region II will verify the adequacy of the justification in a subsequent GL 89-10 inspection.

The licensee's Calculation PSL-BFJM-93-029, "NRC Generic Letter 89-10 Motor Operated Valve Diagnostic Test Results Evaluation," issued December 9, 1993, documented the method used to extrapolate dynamic test results to design-basis conditions, where necessary. This method stipulated that the closing extrapolated load is compared to the thrust measured at control switch trip (CST) to ensure that the torque switch is set adequately for design-basis conditions. However, the inspectors found that the document did not specify any minimum level of margin that would be necessary to account for uncertainties (e.g., torque switch repeatability or degradation in valve/actuator performance from one test to the next). Licensee personnel stated they would review the guidance on this issue provided in Supplement 6 of GL 89-10, and that their program and differential pressure test procedures would be revised to require that thrust margins be adequate to account for appropriate uncertainties (such as torque switch repeatability). Region II will review the licensee's resolution of this issue during a future inspection.

The licensee's dynamic test evaluation for valve 1-V-3660 determined that this 3 inch Velan flex-wedge gate valve (Low Pressure/High Pressure Safety Injection Pump Recirculation to Refueling Water Tank) had a valve factor of 1.10. The inspectors' review of the diagnostic force trace taken during the dynamic test indicated that flow isolation was marked just prior to the point where the valve appeared to reach hard seat contact. However, they noted that the force trace had the characteristic of a globe valve; there was no closing force plateau just following flow

isolation. Such a plateau is expected because of the uniformity of force when the disc is sliding on the gate valve's seating surface without any change in DP. The seating portion of the static force trace showed the same shape as the dynamic test, which caused the inspectors to question the licensee's choice of flow isolation and determination of valve factor. After review of the static and dynamic traces, licensee personnel agreed that flow isolation was incorrectly marked, leading to an incorrect determination of valve factor. There was no clear indication of flow isolation and the true valve factor was indeterminant. The inspectors' review of the traces for a sister valve, located in series with 1-V-3660 and tested under the same dynamic conditions, showed normal gate valve flow isolation characteristics and a valve factor of 0.51. A possible explanation for the unusual seating characteristic is an offset or deformation of the disc guides. Licensee personnel indicated that, because of the unusual trace, 1-V-3660 was scheduled for inspection of the valve internals at the next outage of adequate duration. The licensee's investigation of 1-V-3660 will be examined in a subsequent GL 89-10 inspection.

The inspectors review of the dynamic test lineup and test results for 1-V-3660 raised two issues:

- 1-V-3660 was located in a recirculation line which had a restricting orifice, check valve, and manual valve between the pumps and the MOV. The licensee used a pump discharge pressure gage to determine the upstream pressure for the dynamic test. Because of the pressure drop caused by the components located between the pump and 1-V-3660, the true pressure at the valve was not measured during testing. Additionally, no assessment for the difference was noted in the test results, such that a satisfactory comparison to design-basis conditions might be made.

- Two pumps would be in operation during the identified design-basis conditions for 1-V-3660. However, the dynamic test was conducted with only one pump running, providing approximately one-half the volumetric flow rate that would be present during the design-basis event. As the effects of flow on valve performance are not readily quantified, test conditions should simulate design-basis flow as near practical to facilitate assessment.

Licensee personnel indicated they would consider the above when evaluating the results of previous dynamic tests and when developing future dynamic test lineups. The licensee's failure to account for test pressure drops and to assure design-basis flow was considered a weakness. It is identified as Inspector Followup Item 50-335, 389/94-11-02, Inadequate Recognition of MOV Test Pressure and flow. Region II will review the licensee's related efforts during a future inspection.

Based on the data examined, the inspectors concluded that the licensee's testing program for the GL 89-10 program MOVs provides the assurance that the tested MOVs will perform their intended safety function.

2.4 Periodic Verification of MOV Capability

Recommended action "d" of Generic Letter (GL) 89-10 requested the preparation or revision of procedures to ensure that adequate MOV switch settings are determined and maintained throughout the life of the plant. Section "j" of GL 89-10 recommends surveillance to confirm the adequacy of the settings. The interval of the surveillance is to be based on the safety importance of the MOV as well as its maintenance and performance history, but was recommended not to exceed five years or three refueling outages. Further, GL 89-10 recommended that the capability of the MOV be verified if the MOV was replaced, modified, or overhauled to an extent that the existing test results are not representative of the MOV.

Licensee personnel informed the inspectors that development of a program for periodic verification of the design-basis capability of GL 89-10 MOVs had not been completed. Electrical Maintenance Motor Operated Valve Program Manual, Section F, indicated that periodic diagnostic testing would be performed on all MOVs included in the scope of the GL 89-10 program on a 5 year schedule and that the schedule would be developed following full implementation of initial baseline testing. The inspectors were informed that static diagnostic testing would be used for the verifications and responded that this was not yet an adequately justified method. Region II will assess the adequacy of the licensee's periodic verification of design-basis capability during a future inspection.

The inspectors found that, in accordance with procedure MP 0950050, "Post Maintenance Testing of Limitorque Motor Operated Valves," the testing criteria for specific maintenance activities were to be determined by the MOV Coordinator. The inspectors questioned whether this provided adequate control. Licensee personnel stated the procedure would be upgraded to include testing criteria for the various maintenance activities. Region II will verify the implementation and adequacy of the post maintenance testing during a future inspection.

2.5 MOV Failures, Corrective Actions, and Trending

Recommended action "h" of the generic letter requests that licensees analyze and justify each MOV failure and corrective action. The documentation should include the results and history of each as-found deteriorated condition, malfunction, test, inspection, analysis, repair, or alteration. All documentation should be retained and reported in accordance with plant requirements. It was also suggested that the material be periodically examined (every two years or after each refueling outage after program implementation) as part of the monitoring and feedback effort to establish trends of MOV operability.

a. Trending and Periodic Examination of Failures and Degradation

The inspectors assessed the following examples of the licensee's trending and periodic examination of MOV degradation and failure data:

- Motor Operated Valve Trending Program Report for valve 2-MV-09-10 (This report contained descriptive information, manufacturers data, dates of testing and preventive maintenance, and trend data on parameters such as stroke time, megger results, stem factor, peak thrust, and thrust at control switch trip. The report contained diagnostic results from 1994; and stroke time, current, and megger data from 1992 and 1994.)

  Nuclear Plant Reliability Data System Component Failure Analysis Report Component Failure Comparison (Unit 2), dated July 2, 1993. (This report compared the St. Lucie and industry failure rate and provided brief descriptions of the valve failures, causes, and corrective actions for the period from October 1, 1991 through March 31, 1993.)

  Maintenance Procedure No. 0940069, Rev. 11, Preventive Maintenance of Non-Environmentally Qualified Limitorque Motor Operated Valve Actuators. (This was provided by licensee personnel as an example to show that trendable data was being collected through preventive maintenance procedures. The inspectors found that it required inspections and recording of various data that could be used to identify degradation and could be trended. Examples of the inspections included stem thread condition, run current, and functioning of position indication lights. The inspectors verified similar data was recorded for environmentally qualified MOV actuators through Procedure 0940072, Rev. 8.)

The inspectors review of the above indicated that trending and examination of MOV failures and degradation had been initiated, except that there were no administrative controls governing the process. There was no procedure or instruction specifying who was responsible to perform and evaluate trend reports, when the reports were to performed, who would initiate recommendations and corrective actions, etc. This was considered a weakness. Licensee personnel indicated that this finding would be evaluated and appropriate action would be taken. The matter was identified as Inspector Followup Item 50-335, 389/94-11-03, Lack of Instructions or Guidance for Trending and Periodic Evaluation of MOV Failures.

b. <u>Documentation, Analysis, and Corrective Actions for MOV Degradation and Failures</u>

The inspectors reviewed and assessed the adequacy of the licensee's documentation, analysis, and corrective actions for MOV degradation and failures through a review of selected licensee maintenance Work Orders (WOs) and Nonconformance Reports (NCRs). The WOs were chosen from the printout of summary information in the licensee's database for 1993 - 94 maintenance. The NCRs, covering significant failures, were chosen from a listing of all NCRs for a like period. Two earlier (1991 and 1992) WOs were added to the review because of their apparent relation to failures in the initial WO and NCR selection.

The WOs reviewed by the inspectors included the following:

WO No.	Description of Maintenance
91035976 01	On November 11, 1991, valve 2-MV-08-12 failed to open (stalled) during testing. The motor insulation exhibited a burnt odor and the overload heater was found to be damaged by overheating. A sustained motor overcurrent condition was indicated. The cause was not established. The motor, overload block, and overload heater were replaced. Static and dynamic diagnostic thrust measurements did not reveal any abnormality.
92001072 01	This was an inspection of the internals of valve 2-MV-08-12 during the refueling outage following the failure documented in the above Work Order. No visible cause of valve binding was observed, except that there were possibly pipe wrench marks on the upper 4 or 5 stem threads and stem runout varied from 4 to 10 mils. The stem was replaced.
92048525 01	On September 15, 1992, valve 2-MV-08-13 showed dual indication and was found to have stalled. Motor, thermal overload, and starter were replaced. (Resulted in NCR 2-514 - described in next table.)
93003402 01	Valve 2-V-3523 showed dual indication when closed. This was corrected by adjusting limit switch rotor points to provide correct indication.
93012842 01	Valve 2-HCV-3647 would not open. No maintenance was required. The reactor operator had forgotten that the switch had to be held in position to continue movement in the desired direction.
94008833 01	Valve 2-MV-09-11 would not operate from the control room switch. Checked limit switch development, control switch, and relay. No problem was identified and, subsequently, the valve operated satisfactorily. It was speculated that the valve did not operate because of dirty contacts.
93014982 01	Valve 1-V-3614 torqued out and would not close (preventing reactor heat-up and pressurization) until forced off back seat. Investigation and repeated testing did not identify a problem.
93030826 01	Valve 1-MV-15-1 would not close. The cause was determined to be dirty torque switch contact points. The points were cleaned and the valve operated satisfactorily.

93017425 01	The position indicating lights for High Pressure Safety Injection System Valve 1-HCV-3616 were behaving abnormally. Investigation found the hypoid gear had several teeth missing. Initiated NCR 1-831 (see below).

The NCRs reviewed by the inspectors included the following:

NCR No.	Condition and Corrective Action
1-820 (5/25/93)	This NCR was used to request an engineering review and approval of a modification that drilled and pinned a key in the stem nut of valve 1-MV-08-3. Engineering approval was provided.
1-831 (9/28/93)	The limit switch cartridge pinion gear shaft had failed on valve 1-HCV-3616, potentially resulting in development of stall in the closing direction. An engineering evaluation determined that the Limitorque actuator one-time thrust rating had been exceeded. The actuator one-time torque rating and the valve thrust limit had not been exceeded. The engineering disposition referred to Limitorque Technical Update 92-01 as requiring an inspection if the rating was exceeded and stated that the actuator would be rebuilt, exceeding the Limitorque inspection requirements. A failure analysis was conducted which identified the probable cause as improper alignment of the hypoid and pinion gears, coupled with porosity found in the hypoid gear. Discussions with the actuator manufacturer indicated that this was an isolated occurrence.
2-600 (4/15/94)	The closing thrust determined at control switch trip during diagnostic testing of valve 2-MV-08-13 exceeded the actuator allowable thrust limit. Engineering evaluated and revised the thrust and torque limits, based on Limitorque Technical Update 92-01. The previously obtained torque and thrust were acceptably within the revised limits. The high closing thrust obtained in the test was attributed to an improvement in stem factor (reduced friction), resulting in a higher thrust for the same torque setting.
2-514 (9/16/92)	On September 16, 1992, valve 2-MV-08-13, the isolation valve for the 2A steam generator supply to the 2C auxiliary feedwater pump turbine, failed to open (stalled) when actuated to provide steam for a surveillance run of the pump. After opening a sister valve (MV-08-12), which increased the downstream pressure and decreased the differential pressure across 2-MV-08-13, valve 2-MV-08-13 was again actuated and successfully opened. Subsequent investigation found the motor and overload relay were damaged by overheating and they were replaced. The valve opened and closed satisfactorily after the replacement.

The licensee's engineering evaluation concluded that the root cause of the failure was indeterminant. NCR 2-514 referred to subsequent NCR 2-536, covering a subsequent failure of the same valve, for additional evaluation and required actions.

2-536 (7/20/93) On July 20, 1993, valve 2-MV-08-13 stalled while attempting to open during a surveillance test. The stall lasted one to two minutes, after which the disc broke free and traveled to full open. No evaluation of the stall thrust and torque was documented. In a subsequent diagnostically monitored full flow differential pressure test, a high unseating load was recorded during opening of the valve. The actuator thrust rating was exceeded by approximately 30 percent. The licensee determined this was acceptable with the following actions recommended: a limit of 50 complete cycles on subsequent valve operation, valve surveillance frequency increased from every 60 days to every 30 days, disassembly and inspection of the valve and actuator at the next Unit 2 refueling outage. Diagnostically monitored surveillance tests in August and October found higher unseating thrusts than previously measured, which were evaluated and found acceptable by the licensee. As a consequence of the October result, the licensee changed from torque to limit switch seating control in an effort to reduce wedging of the disc into the valve seat. During the next refueling outage (February 1994) the valves were replaced with double disc gate valves with larger actuators.

In assessing the above WOs and NCRs, inspectors found that the licensee's documentation, analysis, and corrective actions for MOV degradation and failures was satisfactory except in addressing the mechanical overloads experienced by valves 2-MV-08-12 and -13. These are identical MOVs and perform redundant safety functions. The documented analyses of the stall of valve 2-MV-08-12 on November 11, 1991, and stalls of valve 2-MV-08-13 on September 16, 1992, and July 20, 1993, did not determine the torque and thrust experienced by the actuators and valves (single wedge gate type) for comparison to limits specified by the manufacturers.

Calculations by the NRC inspectors and, subsequently, by the licensee indicated that the thrusts and torques during the above stalls were approximately 18,600 lbs and 143 ft-lbs, respectively. The calculated thrust was about 125 percent of the valve maximum thrust limit described in the licensee's July 26, 1993, engineering evaluation JPN-PSL-93-038, Rev. 0. This deficiency was not identified or evaluated in determining the acceptability of the valves following any of the stall events. Subsequently, the licensee has established a valve thrust limit of 44,000 lbs, indicating the valve would not have been damaged in the stall events. The calculated stall thrust and torque were 230 and 160 percent

of the actuator (Limitorque SMB-00) ratings, respectively. As in the case of valve thrust the actuator stall overthrust and overtorque were not documented or evaluated in assessing valve operability.

In February 1992, Limitorque Technical Update 92-01 was issued to notify licensees and others of recommendations resulting from review of an industry study to establish increased actuator ratings. The Update recommended that the utility: contact Limitorque for an operability assessment if actuator thrust exceeded 140 percent of the rating, quantify any overthrust by conservative calculations or measurements, and ensure housing cover and base fasteners were torqued to specified minimum levels. The Update also indicated that a one-time overthrust of up to 250 percent of the actuator rating was acceptable. Subsequently, in April 1992, Limitorque issued Maintenance Update 92-1. This Update stated that if the 250 percent one-time thrust rating was exceeded, or if the overload occurred more than once, an inspection of the actuator for damage is recommended. For opening overthrust, it recommended inspection of the drive sleeve and lower drive sleeve bearings. The Maintenance Update also stated that a one-time torque overload of up to 200 percent of the actuator rating was acceptable but that, if this limit was exceeded or overtorque occurred more than once, the gearing and particularly the worm should be inspected for cracks.

Valve 2-MV-08-13 had experienced stall twice, as stated above, and may have experienced conditions approaching stall at other times. The licensee did not document the calculations or inspections recommended by the manufacturer to assure the valves would perform their design safety functions. Instead, the licensee relied on diagnostic testing performed following the stall failures.

Licensee personnel agreed that their documented evaluation was insufficient but considered the corrective actions they performed adequate. Their reasons were as follows:

(1) At the time of the 1991 stall event they had no written guidance from Limitorque regarding evaluation of stall.

(2) The one-time allowed actuator thrust and torque specified by Limitorque were not exceeded.

(3) Electrical Maintenance performed a visual inspection of the actuator during motor replacement following the 1992 event.

(4) Diagnostic monitoring performed monthly following the 1993 stall did not indicate any damage to the actuator internals. In addition, visual examination of the actuator did not indicate damage. The use of diagnostics was considered equivalent to vendor recommendations.

(5) The valve manufacturer indicated its thrust limit was 44,000 lbs, which was not exceeded.

The inspectors' assessments of the reasons given to justify the adequacy of the licensee's corrective actions was as follows:

(1) An appropriate engineering evaluation would have included a documented and verified calculation of stall forces which could be compared with the actuator rating. Considering that the stall thrust calculated during this NRC inspection was over twice the actuator rating, it would have been appropriate to seek guidance from the manufacturer or replace the actuator.

(2) The one-time actuator allowed torque and thrust is specified for overloads up to the stated limits. It is only for one (one-time) overload up-to the allowable limits not multiple overloads. The licensee experienced two overloads near the limits and at least three additional lower overloads detected during diagnostic testing. Others, up to stall overload levels, may have occurred undetected.

(3) Discussions with licensee personnel indicated that this visual examination was not the inspection of components that Limitorque recommends. No documented inspection results were provided to the inspectors in support of an adequate visual examination.

(4) While the licensee's diagnostics did increase assurance that the valve would perform its safety function, it would not be expected to detect incipient failures as assuredly as the visual inspection recommended by Limitorque. Based on discussions with licensee personnel, the licensee performed a visual inspection but not the inspection of components that Limitorque recommends. No documented inspection results were provided to the inspectors in support of an adequate visual examination.

(5) The original thrust limit provided by the valve manufacturer was 9910 lbs. As reported in the licensee's 1993 engineering evaluation (JPN-PSL-93-038) performed following the second stall of 2-MV-08-13, informal information from the vendor indicated the limit could be increased to about 15,000 lbs. This was below the stall thrust calculated during this inspection, which is of 18,600 lbs. The licensee was not aware that the limit could be further increased to 44,000 lbs until later.

Based on the above, the inspectors consider the licensee's actions in response to the valve stall failures unsatisfactory. The licensee's failure to document calculation and evaluation of the stall overload conditions, to identify the valve and actuator overload, and to perform the evaluations or inspections recommended by the actuator manufacturer are considered to represent inadequate corrective action. This inadequate corrective action is identified as Violation 50-335, 389/94-11-01, Inadequate Corrective Action for MOVs Which Stalled During Surveillances.

Although the inspectors determined the licensee's valve stall evaluations were deficient, positive aspects were also noted. The application of diagnostics following the failures, particularly the periodic diagnostic monitoring of valve performance instituted after the July 1993 stall, provided increased assurance of valve operability. The licensee replaced MOVs 2-MV-08-12 and -13 at the first refueling outage following the 1993 stall with valves and actuators having improved capabilities. However, it appeared to the inspectors that other actions should have been taken earlier - either improved justifications for the continued operability or valve replacement.

The adequacy of the licensee's documentation, analysis, and corrective actions for MOV degradation and failures was satisfactory with the exception of actions of taken following stall failures.

2.6 Schedule

In GL 89-10, the NRC requested that licensees complete all design-basis reviews, analyses, verifications, tests, and inspections that were initiated in order to satisfy the generic letter recommendations by June 28, 1994, or three refueling outages after December 28, 1989, whichever is later. In a letter dated February 14, 1992, the licensee proposed to change its schedular commitment for completion to 60 days following start-up from Cycle 13 refueling outage (scheduled fall 1994) for Unit 1 and Cycle 9 refueling outage (scheduled fall 1995) for Unit 2. A subsequent NRC acknowledgement letter, dated March 16, 1992, indicated the change was acceptable but requested that the more important valves be tested first, preferably in accordance with the original schedule.

The inspectors reviewed the documented status of testing and determined that the licensee had tested approximately 2/3 of the globe and gate valves in the program for each unit. In accordance with the current commitment, one refueling outage remains for each unit. Licensee personnel stated that some of the remaining valves would be tested during operation.

Licensee personnel had not determined what method that would be used to verify the capabilities of butterfly valves but indicated that they expect to meet the schedule commitment. Appropriate testing of butterfly valves is an industry issue and not unique to St. Lucie.

The inspectors questioned whether the licensee had determined the more important valves to be tested and completed testing of them first, as requested in the March 16, 1992, NRC letter that acknowledged the licensee's schedule change. They were provided copies of related letters (dated January 29 and February 10, 1992) from the licensee's engineering group to the plant, which prioritized the valves for testing. The inspectors reviewed the prioritization against the licensee's list of valves tested and found that in some cases the higher priority valves had not been tested. These were discussed with licensee personnel. Explanations as to why the valves had not tested included: deletions from the program, questions as to whether valves were testable at or near

design-basis conditions, diagnostic sensor problems, maintenance problems, and on-going questions regarding inclusion of certain valves in the program.

Based on the test data reviewed by the inspectors in this inspection and on their discussions with licensee personnel, the inspectors believe the licensee can meet the specified completion schedule. The licensee's completion of the setting and verification of the capabilities of all valves in the GL 89-10 program (including butterfly valves) will be confirmed in a subsequent inspection.

2.7 Pressure Locking and Thermal Binding

The Office for Analysis and Evaluation of Operational Data has completed a study of pressure locking and thermal binding of gate valves. It concluded that licensee's have not taken sufficient action to provide assurance that pressure locking and thermal binding will not prevent a gate valve from performing its safety function. The NRC regulations require that licensees design safety-related systems to provide assurance that those systems can perform their safety functions. In GL 89-10, the staff requested licensees to review the design-basis of their safety-related MOVs.

The inspectors reviewed the licensee's engineering report that addressed pressure locking and thermal binding. Engineering Evaluation JPN-PSL-SEMP-93-036, "St. Lucie Units 1 & 2 Engineering Evaluation of Pressure Locking and Thermal Binding of Motor Operated Gate Valves," Rev. 0, was performed by the licensee to identify safety-related motor operated valves that might be susceptible to pressure locking and/or thermal binding. An initial screening of the 80 MOVs in Unit 1 and the 103 MOVs in Unit 2 was conducted to determine if the MOVs met screening criteria for susceptibility to pressure locking or thermal binding. The screening criteria for pressure locking susceptibility was: (1) flexible-wedge or double disc wedge gate design, (2) used for incompressible fluids, and (3) lacking a design feature for prevention. The screening criteria for susceptibility to thermal binding was (1) flexible-wedge, solid-wedge, or split-wedge gate design; and (2) MOV closed under high temperature conditions. In Unit 1, 14 MOVs met the initial screening criteria for pressure locking and 19 met the initial screening criteria for thermal binding. In Unit 2, 12 MOVs met pressure locking and 15 met thermal binding initial screening criteria. A further evaluation determined that nine MOVs (four in Unit 1 and five in Unit 2) were susceptible to pressure locking. Two MOVs in Unit 1 were determined to be susceptible to thermal binding. The transmittal letter for the above evaluation, JPN-PSLP-94-0132, dated February 28, 1994, identified the MOVs found to be susceptible to pressure locking and thermal binding as follows:

- Pressure Locking

  Valves 1&2-V-3480, 1&2-V-3481, 1&2-V-3651, 1&2-V-3652, and 2-V-3545

- Thermal binding

- Valves 1-V-1403 and 1-V-1405

At this point the inspectors and licensee did not have operability concerns with these valves. The licensee has adequately considered valve operability. However, the letter indicated that a detailed valve specific engineering analysis would be performed for the above valves to determine any required action.

The NRC plans to issue additional recommendations to licensees regarding pressure locking and thermal binding in the future. Subsequently, the NRC will assess licensee actions in this area.

2.8 Motor Brakes

St. Lucie did not have motor brakes on their MOVs.

2.9 Quality Assurance Program Implementation

The inspectors reviewed the licensee's implementation of the quality assurance (QA) function for the GL 89-10 Program MOVs. They found that audits and reviews had been performed by the Nuclear Engineering Department, Independent Safety Evaluation Group (ISEG), Site QA, and Corporate QA. The inspectors reviewed the following examples:

- Nuclear Engineering Department self-assessment letter JPN-ST-92-150, "Design Review/Functional Review MOV - Testing," dated June 12, 1992.

- ISEG Report ISEG-PSL-V-048, "Evaluate Motor Operated Valve Differential Pressure Testing at St. Lucie," dated June 22, 1993.

- Corporate QA audit, QAS-JPN-93-3, "Nuclear Engineering-PSL Design Control," dated October 29, 1993.

- Site QA contractors audits QSL-OPS-92-872 for the MOVATS (MOV) Program and QSL-PS-92-872 for Babcock & Wilcox MOV Testing.

Based on their review of the above, the inspectors concluded the licensee has implemented an effective QA program to address GL 89-10 MOVs.

2.10 Followup of Previous Inspection Findings

The inspectors reviewed the licensee's actions in response to an inspector followup item and other concerns identified in previous NRC inspections. The results of the inspectors' review are described below:

a. Inspector Followup Item

(Closed) IFI 50-335, 389/92-25-01, Review of Operability of Unit 2 MOV MV-08-13 During the Period of July 20 to October 19, 1993.

This item questioned the operability of valve 2-MV-08-13 during the period of July 20 to October 19, 1993. The failures experienced by this valve and the licensee's corrective actions were examined in detail by the inspectors, as described in Section 2.5.b of this report. During the period in question the licensee performed a number of surveillance tests on the subject valve and in each instance the valve opened when actuated to perform its intended safety function. Based on the testing results and evaluations discussed in this report, the inspectors consider the valve to have been operable during that period and this item is closed.

It should be noted that the related review described in Section 2.5.b, identified that the licensee's corrective action for stall failures of this valve was deficient, in that the July 20, and previous related failures were inadequately analyzed. More complete analysis might have led to a licensee conclusion that the MOV's capabilities were significantly degraded and required immediate replacement or further justification for continued operation. Note that valve 2-MV-08-13 and its redundant sister valve were replaced by the licensee during a February 1994 outage.

b. Concerns Identified by Inspection 50-335, 389/91-18 for Which a Written Response was Requested

(1) Schedule

The concern was that the licensee might not meet its generic letter schedule commitment due to delays caused by its recent decision to alter its diagnostic test method. In a response letter to the NRC dated February 14, 1992, the licensee proposed its revised schedule. As discussed in Section 2.6 above, the inspectors examined the licensee's related actions and believes that the current commitment can be met. This resolves the concern.

(2) Valves to be Design-Basis Tested

The concern was that design-basis testing was being omitted on MOVs that were practical to test. Licensee personnel stated that credit might be taken for testing of 56 NRC Bulletin 85-03 valves even though only 23 had been tested. Also, the licensee's status report indicated testing was being omitted for butterfly valves that were practical to test.

In the response letter referenced above, the NRC was informed that the licensee would test all valves practical. The licensee's testing of all valves practical will be assessed when Region II inspects the licensee's completion of GL 89-10 implementation.

c. Concerns Identified by Inspection 50-335, 389/91-18 for Which No Written Response was Requested

(1) Setpoint Window

The concern was that the licensee had no procedure or programmatic guidance for transforming design calculation results into valve setpoint windows. In the current inspection the NRC inspectors determined that adequate setpoint windows had been established for the valves sampled. This resolves the concern.

(2) Use of 0.5 Valve Factor to Account for Uncertainties Such as Rate of Loading

The concern was that the licensee had not adequately accounted for uncertainties such as load sensitive behavior in its thrust setting determinations. The inspectors' review, described in Section 2.2 above, found that load sensitive behavior and other factors originally of concern are being addressed. This resolves the concern.

(3) Justifiable Deviations from Commitment to Test All Valves Practicable

The concern was that the licensee was evaluating deviations from the generic letter recommendation to design-basis DP test all valves practicable for valves with high margins of capabilities to design-basis requirements. The inspectors reconsidered this issue and do not find the deviations of concern, if adequately justified. Such justifications will be subject to evaluation in a subsequent inspection. The original concern is resolved.

(4) Use of Static Diagnostic Testing to Demonstrate Continued MOV Capabilities

The concern was that the licensee planned to use static diagnostic testing for periodic verification of MOV capabilities. The ability of static diagnostic testing to demonstrate continued capabilities has not been justified. In the current inspection the NRC inspectors were informed that the licensee had not completed the determination of the method and criteria to be used for periodic verification. This issue will be inspected during program closeout.

(5) Stem Friction Coefficient and Stem Lubrication Frequency

This concern involved the licensee's use of a low stem friction coefficient and a stem lubrication frequency greater than recommended by the manufacturer. A valve stem friction coefficient of 0.15 was utilized in calculating torque switch settings for St. Lucie GL 89-10 valves located outside containment. The valve actuator manufacturer indicates this stem friction coefficient is to be applied where good stem lubrication is assured and, in practice, the manufacturer normally uses a more conservative 0.20 stem friction coefficient for its own

calculations. Also, the actuator manufacturer recommended an 18 month preventive maintenance frequency for valve stem lubrication, whereas the licensee permitted a 36 month frequency on its non-equipment environmental qualification (EQ) valves.

In the current inspection the NRC inspectors verified that the licensee was now using 0.20 stem friction coefficient. The licensee stated that the valve stem lubrication frequency of 36 months applied only to non EQ GL 89-10 MOVs located inside the buildings. The licensee further stated that the 36 month valve stem lubrication frequency will be adjusted as needed to ensure the stems are properly lubricated. The inspectors concluded the licensee has adequately addressed the valve stem friction coefficient of 0.20 and stem lubrication. This concern is resolved. The licensee's verification that its 0.20 stem friction coefficient assumption and the 36 month lubrication frequency is adequate will be subject to NRC verification in a subsequent inspection.

(6) Torque Seated Butterfly Valves

The concern was that some butterfly valves were being seated using torque switch control, whereas the actuator manufacturer recommended limit switch seating. In the current inspection the NRC inspectors verified that the licensee had implemented a change to limit switch seating for all butterfly valves. The change was identified PCM 284-292 and implementation was verified by the inspectors review of Work Order examples 93027861, 93028660, 93028658, 93028659, and 93028655. This concern is resolved.

(7) Specification of Extrapolation Method and Use of Prototype Testing

The licensee's program document indicated that test results obtained at less than design-basis DP would be extrapolated to design-basis DP and that prototype testing would be used in some cases. The concern was that no criteria were provided for use of either. In the current inspection the NRC inspectors found that the licensee used simple linear extrapolation and that there was no apparent use of prototype testing. Licensee personnel indicated that justification for the adequacy of linear extrapolation was under development (see Section 2.3). Any licensee use of prototype test results will be subject to NRC evaluation in establishing the licensee's completion of GL 89-10 implementation.

(8) Guidance for Documenting and Trending MOV Failures and Degradation

The concern was that the licensee had not provided adequate guidance for performing the trending of MOV failures and degradation recommended by GL 89-10. As discussed in Section 2.5.a above, the current inspection determined there is still concern regarding the adequacy of the guidance provided, particularly with regard to administrative controls.

2.11 Walkdown

The inspectors conducted a walkdown of MOVs to observe the installed yoke thrust sensors and the condition of the valve stems. They observed that the MOVs located inside buildings were in good condition. The valve stem lubrication was satisfactory and the sensors were installed correctly. MOVs located outside, where they were exposed to rain and salt air, were inspected after removing the valve stem covers. On a previous inspection, an NRC inspector had observed that rain water had leaked into similarly located MOVs and corrosion had resulted. The licensee had special "hats" made to cover the valves and initially installed them on two MOVs to determine if they provided protection from the environment. The inspectors found that the two MOVs with "hats" were in good condition with adequate stem lubrication and no corrosion. The other MOVs located outside were observed to have adequate stem lubrication but some minor corrosion. The sensors were satisfactorily attached to the yokes of all the MOVs inspected. The licensee stated "hats" would be installed for all outside GL 89-10 MOVs by the end of 1994. The inspectors considered this to be appropriate corrective action.

The inspectors concluded that the MOVs located inside the buildings were well maintained. However, the MOVs located outside were subject to corrosion from the rain water and the salt air environment and some form of protection appeared appropriate.

3. EXIT INTERVIEW

The inspection scope and findings were summarized on May 6, 1994, with those persons indicated in Section 1. The inspectors described the areas inspected and discussed in detail the inspection results. Three weaknesses were described. The inspectors stated that one of the weaknesses would be discussed with NRC management as a possible violation and that the other two would be identified as followup items. Licensee personnel indicated the reasons they did not consider the one item a violation. Their reasons are described in Section 2.5.b, above. Proprietary information is not contained in this report. The violation and followup items identified by the inspectors are listed in the summary at the beginning of this report.

4. ACRONYMS AND INITIALISMS

CFR	Code of Federal Regulations
CST	Control Switch Trip
DBDP	Design Basis Differential Pressure
DP	Differential Pressure
EQ	Equipment Qualification
GL	Generic Letter
IFI	Inspector Followup Item
ISEG	Independent Safety Evaluation Group
MOV	Motor Operated Valve
NCR	Nonconformance Report
NRC	Nuclear Regulatory Commission

NRR	NRC Office of Nuclear Reactor Regulation
QA	Quality Assurance
TI	Temporary Instruction
VOTES	Valve Operation Test and Evaluation System
WO	Work Order

APPENDIX - ST. LUCIE GATE AND GLOBE VALVE DATA

Diagnostics: VOTES/VTC/LVDT

VALVE NUMBER	VALVE TYPE	TEST CONDITIONS (psid)		% DESIGN BASIS		DYNAMIC VALVE FACTOR [1]		STEM FRICTION COEFFICIENT [2]		LOAD [3] SENSITIVE BEHAVIOR
		Open	Close	Open	Close	Open	Close	Static	Dynamic	
1-V3660	3" Velan 900# Flex Wedge Gate Valve	N/A	1200	N/A	79%	0.21	1.10	N/C [4]	N/C	-5%
1-V3480	10" Velan 1500# Flex Wedge Gate Valve	230	N/A	84%	N/A	1.0	N/A	0.14	N/C	N/A
1-HCV-3617	2" Velan 1500# Globe Valve	1280	1000	52%	76%	N/A	0.34	0.11	N/C	5%
2-V3480	10" Westinghouse 1500# Gate Valve	248	N/A	90%	N/A	0.59	N/A	N/C	N/C	-2%
2-HCV-3615	6" Velan 1500# Globe Valve	417	142	87%	29%	0.95	N/C	0.16	N/C	-20%
2-V3654	6" Westinghouse 900# Gate Valve	740	740	135%	135%	0.72	0.80	0.16	N/C	6%
2-V3658	12" Westinghouse 300# Gate Valve	415	N/A	93%	N/A	0.44	N/A	0.21	N/C	-2%
2-V3664	10" Westinghouse 300# Gate Valve	227	39	80%	14%	0.94	N/C	0.16	N/C	4%
2-MV-09-10	4" WKM 600# Globe Valve	1380	40	100%	3%	N/C	N/C	0.17	N/C	-2%
2-MV-08-13	4" Anchor Darling 600# Parallel Disc Gate Valve	900	10	89%	1%	0.54	0.31	0.19	N/C	3%

1. The dynamic valve factors listed were calculated by the licensee using an orifice diameter.
2. Stem Lubricant: FelPro N5000.
3. 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.
4. N/C = Not Calculated.