APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-528/94-11
50-529/94-11
50-530/94-11

Operating Licenses: NPF-41
NPF-51
NPF-74

Licensee: Arizona Public Service Company
P.O. Box 53999, Station 9082
Phoenix, AZ 85072-3999

Facility Name: Palo Verde Nuclear Generating Station
Units 1, 2, and 3

Inspection At: Palo Verde Site, Wintersburg, Arizona

Inspection Conducted: April 4-8 and 20, 1994

Inspectors: C. Myers, Reactor Inspector, Engineering Branch,
Division of Reactor Safety

M. Runyan, Reactor Inspector, Engineering Branch,
Division of Reactor Safety

Approved: ______________________ 5-6-94
T. Westerman, Chief, Engineering Section Date
Division of Reactor Safety, Region IV

Inspection Summary

Areas Inspected (Units 1, 2, and 3): Special, announced inspection of the implementation of the licensee's program to meet commitments to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," and followup of previously identified items.

Results:

- The licensee's program was generally effective in establishing assurance of design basis capability for the sampled motor-operated valves (MOVs) (Section 1).

- The licensee was implementing a program consistent with their commitments to Generic Letter 89-10 (Section 1).

- The use of a nonconservative assumption for stem friction coefficient for calculations of motor/actuator capability under degraded voltage conditions was considered a weakness (Section 1.2.1.2).

- The licensee had not demonstrated the long-term design basis capability of six direct current (dc) MOVs under degraded voltage conditions (Section 1.2.2).

- The licensee had not incorporated margins to account for actuator springpack compression limits or relaxation (Sections 1.2.3 and 1.2.4).

- The licensee's root cause analyses of butterfly valve test anomalies and torque switch roll pin failures were considered program strengths (Sections 1.3.2 and 1.3.3).

- Two concerns were identified with the diagnostic test data evaluation procedure (Section 1.3.4).

- Evaluation of the potential for pressure locking and thermal binding was not complete (Section 3.7).

Summary of Inspection Findings:

- Inspection Followup Item 528/9411-01; 529/9411-01; 530/9411-01 was opened (Section 1.2.2).

- Inspection Followup Item 528/9411-02; 529/9411-02; 530/9411-02 was opened (Section 1.2.3).

- Inspection Followup Item 528/9411-03; 529/9411-03; 530/9411-03 was opened (Section 1.3.4.2).

- Violation 528/9125-02; 529/9125-02; 530/9125-02 was closed (Section 2.1).

- Violation 528/9125-06; 529/9125-06; 530/9125-06 was closed (Section 2.2).

- Inspection Followup Item 528/9332-02; 529/9332-02; 530/9332-02 was closed (Section 3.1).

- Inspection Followup Item 528/9125-05; 529/9125-05; 530/9125-05 was closed (Section 3.2).

- Inspection Followup Item 528/9125-01; 529/9125-01; 530/9125-01 was closed (Section 3.3).

- Inspection Followup Item 528/9125-03; 529/9125-03; 530/9125-03 was closed (Section 3.4).

- Inspection Followup Item 528/9125-10; 529/9125-10; 530/9125-10 was closed (Section 3.5).
- Unresolved Item 528/9332-03; 529/9332-03; 530/9332-03 was closed (Section 3.6).
- Inspection Followup Item 528/9332-01; 529/9332-01; 530/9332-01 was reviewed, but not closed (Section 3.7).
- Inspection Followup Item 528/9125-11; 529/9125-11; 530/9125-11 was reviewed, but not closed (Section 3.8).

Attachments :

Attachment 1 - Persons Contacted and Exit Meeting

Attachment 2 - PVNGS Gate Valve Data

DETAILS

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

On June 28, 1989, the NRC issued Generic Letter (GL) 89-10, which requested licensees to establish a program to ensure that switch settings for safety-related motor-operated valves (MOVs) were selected, set, and maintained properly. Subsequently, six supplements to GL 89-10 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 TI 2515/109, Part 1, program review at Palo Verde Nuclear Generating Station was documented in NRC Inspection Report 528/91-25; 529/91-25; 530/91-25. A subsequent inspection, conducted under Part 2 of TI 2515/109, was documented in NRC Inspection Report 528/93-32; 529/93-32; 530/93-32.

The inspection documented by this report was the second inspection at PVNGS under Part 2 of TI 2515/109. The inspection focused on verification of program implementation for selected valves. Programmatic issues were addressed during this inspection as followup from previous inspection open items and in the context of issues that developed in the course of the inspection.

As an overall assessment, the inspectors concluded that the licensee's MOV program was generally capable of demonstrating the operability of MOVs subject to GL 89-10. The program was thorough and was being implemented in a manner consistent with the licensee's commitments to the generic letter.

For each MOV selected, the inspectors reviewed the design basis calculation of flow, temperature, and the maximum expected differential pressure (MEDP); the sizing and switch setting calculation; the diagnostic test data package; and the diagnostic traces using MOVATS 3000 software.

The licensee's program consisted of 351 MOVs (117 in each Unit). The licensee had tested approximately 214 MOVs at the time of the inspection. The following MOVs were selected for review as representative of recent test activities:

- 1JAFBUV0034 Auxiliary Feedwater System Isolation Valve
- 1JAFCUV0036 Auxiliary Feedwater System Isolation Valve

The selected MOVs were configured as shown below:

Valve ID	Actuator Model	Valve Size and Vendor	Valve Type	Closure Control
1JAFBUV0034	SMB-1	6" Anchor Darling	Gate	Torque
1JAFCUV0036	SMB-1	6" Anchor Darling	Gate	Torque

In addition the inspectors sampled portions of the diagnostic testing for other valves.

1.1 Design-Basis Reviews

The inspectors reviewed licensee Procedure 81DP-4DC10, "Motor Operated Valve Design Basis Review and Thrust/Torque Calculation," Rev. 00.03, dated February 2, 1993. The licensee used this procedure to determine the worst case design basis conditions for each MOV. The inspectors reviewed the design basis calculations for each of the sampled MOVs. The design basis calculations for each of the sampled valves appeared to adequately evaluate the design basis conditions consistent with licensee commitments in response to GL 89-10.

1.2 MOV Sizing and Switch Setting Calculations

The inspectors found that the licensee had established specific procedures for conducting calculations within their GL 89-10 program. The inspectors reviewed licensee Procedure 13-JC-ZZ-201, "MOV Thrust, Torque and Actuator Sizing Calculation," Revision 2, dated September 21, 1992. The licensee used this procedure to determine adequate actuator sizing and required torque switch thrust setpoints. The inspectors reviewed the sizing and setpoint calculations for the sampled valves. The licensee's calculations for the sampled valves appeared to be adequate.

1.2.1 Calculation Method

The inspectors noted the following features of the licensee's method.

1.2.1.1 Valve Factor Assumption

Valve factor was defined as the ratio of the stem thrust to the differential pressure force acting on the valve disk. The licensee had recently revised their generic assumption for valve factor based on their test results that had often exceeded the original assumption of 0.4. The revised valve factors were 0.5 in the open direction and 0.55 in the closed direction. The licensee continued to assume a valve factor of 1.1 for globe valves. The licensee used the mean seat diameter of the valve in their calculation of valve factors.

1.2.1.2 Stem Friction Coefficient Assumption (COF)

A stem friction coefficient of 0.20 was assumed in the licensee's determination of output thrust capability of alternating current MOVs under degraded voltage conditions. A stem friction coefficient of 0.10 was assumed in the licensee's determination that structural limits were not exceeded. The inspectors found these assumed valves to be appropriate in these calculations.

The inspectors identified a potentially nonconservative COF assumption in the licensee's calculation of torque switch trip thrust limits associated with the degraded voltage capability of four dc MOVs. For these MOVs, the licensee used an alternate calculation method which assumed a stem friction coefficient of 0.1. The licensee stated that use of a new stem lubricant, Darina EP-2, justified use of the 0.1 COF assumption. The inspectors noted test data where dynamic stem friction coefficients exceeded this assumption, as high as 0.13, when Darina EP-2 was used. For those cases, the inspectors concluded that the licensee had adequately evaluated the differential pressure test results, indicating higher than assumed stem friction, and had determined that the torque switches were not set beyond the motor's degraded voltage capability. However, it was not clear that MOVs that were tested under static conditions only would receive the same level of analysis. The licensee acknowledged that their assumption may not be bounding in all cases. The licensee stated that modifications were planned for approximately 56 MOVs to address these and other marginal MOVs. The inspectors considered the use of nonconservative values for stem friction coefficient in degraded voltage capability calculations to be a weakness.

1.2.1.3 Load Sensitive Behavior Assumption (LSB)

Load sensitive behavior (LSB) (also known as "rate of loading") was defined as the percentage difference between the valve stem thrust at torque switch trip under static and dynamic conditions for a given torque switch setting.

For untested valves, the licensee did not specifically include a margin for uncertainties such as load sensitive behavior and stem lubricant degradation in their setpoint calculations. Instead, the licensee attempted to set the torque switch "as high as practicable" within the specified setpoint range as a conservative technique to accommodate potential LSB and lubricant degradation.

During their evaluation of the dynamic test data for each valve, the licensee determined if LSB was displayed. If so, the specific LSB value displayed during testing was fed back as a "Dynamic Test Correction Factor," and the minimum required setpoint was revised.

The inspectors reviewed the licensee's justification for their treatment of LSB. The inspectors emphasized that for MOVs that will not be dynamically tested and MOVs that will not be tested under sufficient differential pressure to exhibit LSB, the licensee will need to ensure that their qualitative method

of accounting for these uncertainties adequately incorporates the best available data.

1.2.1.4 Stem Lubrication Degradation

No specific margin was included as a thrust margin in the setpoint calculation to account for stem lubrication degradation between periodic verification testing.

1.2.1.5 Minimum Thrust Setpoint

The minimum required thrust setpoint specified in the licensee's Interim Controlled Motor Operator Data Base (ICMODB) included an allowance for diagnostic equipment inaccuracy and torque switch repeatability.

1.2.1.6 Maximum Allowable Thrust Setpoint

The maximum allowable thrust setpoint was established, based on either degraded voltage considerations or weak link structural limitations.

1.2.2 Design Basis Capability under Degraded Voltage

During review of MOV 1JAFBUV0036, the inspectors noted that the licensee used run efficiency in calculating the actuator closing capability. Run efficiency was the dynamic efficiency identified by Limitorque® for an actuator gear train that was at full rotational speed. Limitorque® recently stated that use of run efficiency is not appropriate for dc motors, in either the open or close direction. This is due to the sensitivity of dc motor speed to load, which makes it difficult to predict when the actuator's efficiency transitions from a run to a lower pullout efficiency.

The inspectors' concern involving the use of run efficiency for this dc MOV was compounded by the fact that the licensee was taking credit for the stall capability of the motor and actuator under degraded voltage conditions. The licensee determined available torque at motor stall by taking 90 percent of the torque at zero RPM from the generic motor curve provided by Limitorque®. For the 40 ft-lb (54.2 N-m) motor for MOV 1JAFBUV0036, the inspectors found that the licensee computed a torque capability of 56.7 ft-lb (76.9 N-m), which corresponds to a motor speed of only 200 rpm. The inspectors noted that the licensee's method resulted in a predicted torque capability which exceeded the manufacturer's rating. Limitorque® has stated that published actuator efficiencies were applicable to motor speeds corresponding to the motor and actuator operating near its rated capacity. The inspectors noted that the rated starting torque for the motor of MOV 1JAFCUV0036 was 40 ft-lb, which corresponded to a motor speed of 700 rpm (from the motor curve). The inspectors were concerned that the predicted motor speed under design basis conditions was less than the motor speed at rated output torque. The inspectors noted that in the case of MOV 1JAFCUV0036, even the use of the

lower pullout efficiency in conjunction with an assumed near-stall operating condition may not be valid.

The inspectors were concerned that even if pullout efficiency could be technically justified for use in the closing capability assessment of MOV 1JAFCUV0036 and similarly configured MOVs (there are two MOVs configured in this manner in each of the three units, six total), the resultant 20 percent loss of degraded voltage torque output capability (caused by substituting the pullout efficiency of 40 percent for the run efficiency of 50 percent) could result in a calculated operability problem. At the inspectors' request, the licensee recalculated the torque capability of MOV 1JAFCUV0036 using various assumptions for starting torque, efficiency, and application factor. Some combinations of assumptions resulted in a calculated inability of the MOV to trip the torque switch at the as-left torque switch setting under degraded voltage conditions. This condition was originally characterized as an unresolved item.

The inspectors did not consider these concerns to constitute an immediate operability problem because the voltage profiles assumed in the degraded voltage calculation assumed end of life battery conditions, whereas the licensee's Class 1E batteries were all newly installed. In the near term, the extra capacity of the new batteries would partially compensate for the effect of a lower assumed operating efficiency. The licensee stated that additional analyses of the six 40 ft-lb dc MOVs would be performed and provided to the NRC for review.

This information was provided prior to a conference call conducted on April 20, 1994, between Mr. T. Westerman and others of the NRC Region IV Staff and Mr. W. Simko and others of the licensee's staff. The inspectors noted that the licensee had recalculated dc motor closing capability, based on motor rated torque, pullout efficiency, and an application factor of 1.1. The inspectors were concerned that the use of an application factor in excess of 1.0 was not supported by industry testing results. The licensee stated that, if current battery conditions were factored into the degraded voltage profile, only one MOV (1AF-37) would require an application factor greater than 1.0 (approximately 1.02). Further, each of the MOVs, including 1AF-37, would be able to close against maximum dynamic pressures. The inspectors determined that the licensee had established sufficient justification for the short-term operability of the six subject dc MOVs, but that additional measures would be necessary for long-term disposition. Accordingly, the unresolved item was downgraded to an inspection followup item (528/9411-01; 529/9411-01; 530/9411-01).

1.2.3 Lack of Consideration of Springpack Deflection Limits

The inspectors noted that the licensee had not incorporated limits associated with actuator springpack deflection in MOV setpoint calculations. These limits are necessary to ensure that the springpack is not taken solid or out of its linear operating range during MOV testing or operation. The springpack deflection limit should be an input to the upper total thrust or torque limit,

along with the actuator rating and weak link component analysis. The lowest of these three values should be identified as the maximum permissible total thrust or torque. The licensee stated that they had identified instances where springpacks had been taken solid by examining diagnostic trace signatures. When this occurred, a heavier springpack was installed. However, no program had been developed to ensure proper springpack operation. The licensee stated that they had recognized this deficiency and had plans to include springpack limits in a future revision to their MOV program. The inspectors considered this situation to have minimal safety significance because the licensee appeared to be identifying springpack problems through its review of diagnostic signature anomalies. This issue was identified as an inspection followup item (528/9411-02; 529/9411-02; 530/9411-02).

1.2.4 Lack of Margin for Springpack Relaxation

The inspectors noted that the licensee had not provided a thrust margin to account for actuator springpack relaxation. Information on this subject was presented in Limitorque® Technical Update 93-02. The licensee stated that they had reviewed this document, but had determined that the observed rates of springpack relaxation were not applicable to their MOVs. In its testing, Limitorque® compressed springpacks for extended periods and then rechecked their force versus deflection characteristics. Limitorque® stated that most of the springpack relaxation was experienced in the first several months of compression. The licensee reasoned that since their springpacks had been in service for several years, practically all of the relaxation that would take place had already occurred. The inspectors concluded that additional information would be needed to determine the validity of the licensee's position. This issue will be addressed further as part of Inspection Followup Items 528/9411-02; 529/9411-02; 530/9411-02 identified above.

1.3 Testing and Data Analysis

The inspectors reviewed licensee Procedure 39DP-9ZZ01, "PVNGS Guidelines For Evaluation of Motor Operated Valve Dynamic Test Data," Revision 3. The licensee used this procedure to evaluate the results of their dynamic testing under differential pressure (DP) conditions. The procedure included the determination of apparent valve factor, stem factor, and LSB for both the opening and closing direction. The inspectors observed that instrument inaccuracies were included in the determination of valve factor and stem factor.

The inspectors found the licensee's data evaluation to be adequate. No significant deficiencies were observed in the licensee's evaluation of the diagnostic signatures for the sampled valves.

1.3.1 Design-Basis Capability

The inspectors reviewed the design basis calculations and test packages for the selected valves. The selected valves were dynamically tested under the

following conditions:

VALVE	CLOSE MAX DP	CLOSE TEST DP	% MAX DP
1JAFBUV0034	1740 psid (12 MPad)	1740 psid (12 MPad)	100%
1JAFAUV0036	1810 psid (12.5 MPad)	615 psid (4.24 MPad)	34%

Because the licensee was not able to achieve at least 80 percent MEDP for 1JAFAUV0036, this valve will be evaluated for capability using the two-stage approach. The two-stage approach will be evaluated by the NRC during the closure of GL 89-10.

1.3.2 Butterfly Valve Diagnostic Testing Anomalies

The inspectors reviewed Condition Report/Disposition Request CRDR 1-3-0217, which evaluated the results of the licensee's DP testing of butterfly valves. There were 24 posi-seal butterfly valves installed at PVNGS. Each Unit had two 10 in (25.4 cm), two 16 in (40.6 cm), and four 24 in (61 cm) posi-seal butterfly valves manufactured by Fisher. PVNGS had removed the elastomer seals for low flow throttling applications without a shutoff function; therefore, the "seating/unseating" torque had no seat resistance component. DP test results had shown higher than expected torque requirements in both the opening and closing directions near the closed position. Static testing did not identify any increased torque requirements near the seat. The licensee considered that throttling service in the 0-20 degree open range had caused accelerated shaft (17-4 PH)/bearing (316 stainless steel) wear or galling, resulting in the higher bearing friction which was DP dependent. The licensee had been in contact with the manufacturer and other utilities experiencing similar problems. The manufacturer had recommended replacement of the bearings with an alternate material to improve its resistance to galling.

According to the licensee, MOVs 1SI-657 and 1SI-658 were their most problematic valves. These valves were used for flow throttling for the shutdown heat exchangers. Both MOVs were determined to be operable, subject to procedural restrictions to minimize the design basis DP.

Although the licensee had determined that the problem was not safety significant for the tested valves, the licensee stated that they were evaluating the apparent generic deficiency for Part 21 reportability. The inspectors found the licensee's action to be adequate at this time. The inspectors found the licensee's root cause analysis of the diagnostic test anomalies to be a program strength.

1.3.3 Torque Switch Roll Pin Failure Analysis

The inspectors found that the licensee had experienced several failures of the roll pins of torque switches. In addition, a failure had occurred due to breaking the torque switch arm. As part of their analysis of these failures, the licensee had installed strain gages on the shaft of a torque switch to measure dynamic torque during operation. The licensee found that excessive inertial shaft torque was developed during rapid acceleration (snapback) of the springpack, immediately following unseating of the valve. Furthermore, the licensee found that for SB model actuators with a lost motion drive sleeve (i.e., hammerblow feature), the compensator spring added to the snapback acceleration. According to the licensee, Limitorque® no longer supplies SB model actuators with lost motion drive sleeves.

Limitorque® notified customers of a Potential Part 21 condition in SMB-00 actuators regarding nuclear torque switch roll pins on December 19, 1990.

- In the notification, Limitorque® identified that the roll pin failures were attributed to the large impact load of the heavy springpack when released by declutching and the rather large mass of the nuclear torque switch that must be actuated.

- The notification stated "It should be noted that unseating an actuator under motor operation does not allow the simultaneous release of the stored energy and, therefore, will not cause failure of the Torque Switch Roll Pins."

The licensee contacted Limitorque® in a letter dated May 26, 1992 requesting technical assistance in addressing failures of torque switch roll pins. In this letter, the licensee stated the following:

- PVNGS has experienced at least 14 failures of pins (roll and groove pins) in torque switches on 10 different actuators (2 SMB-00, 2 SB-0, 8 SMB-1, and 2 SB-3).

    - Only 2 of the actuators were size SMB-00. This was the only size which the Limitorque® Potential Part 21 notification of December 11, 1990, identified as being affected. The two failed torque switches were sent to Limitorque®, who concluded that the actuators must have been declutched while under motor operation to cause the failure. PVNGS did not have any documented evidence of this type of improper operation of the MOV having occurred to cause the failure.

- WNP-2 has experienced 13 failures on 9 different actuators.

- An NPRDS search identified 26 reports of broken roll pins from 15 nuclear sites.

- Many were online failures, not subject to declutching as a cause.

- The failures appeared to be associated with actuators on large gate valves with high speed actuators where the actuator drive train experiences an excessive transient load during unseating.

The licensee conducted a root cause analysis of their torque switch pin failures under Condition Report/Disposition Request CRDR 2-1-0082, dated December 31, 1992. In their evaluation, PVNGS stated the following:

- Limitorque® Corporation qualified their actuator for 2000 lifetime cycles. The failures experienced by PVNGS and other utilities show that torque switch roll pin failures are occurring at a rate that suggests that all operational parameters of the actuators were not considered by Limitorque® in the qualification testing.

- Problems occurring with the SB type actuator indicate that the original design was deficient. The current SB type actuator is being assembled by Limitorque® with a non-hammerblow drive sleeve, which indicates that problems have been occurring; however, Limitorque® has not notified its users.

The licensee has also experienced problems with torque switch contact bar dislocation which also appeared attributable to impact loading of the torque switch. In CRDR 1-4-0036, dated January 27, 1994, the licensee identified the following:

- The contact bar flipped onto its side preventing it from maintaining electrical continuity. This interrupted motor operation as though the torque switch had actuated.

- The torque switch contact bar compression springs were replaced with stiffer springs.

- The root cause was attributed to the recoil force impacting the contact bar during unseating.

The licensee's investigation into torque switch problems was continuing. The inspectors found the licensee's root cause evaluation of torque switch roll pin problems to be a program strength.

1.3.4 Weaknesses in Test Data Evaluation Procedure

In the process of reviewing the MOVs selected for evaluation and as a followup to previously identified issues, the inspector reviewed Procedure 39DP-9ZZ01, "PVNGS Guidelines for Evaluation of Motor Operated Valve Dynamic Test Data," Revision 3. This procedure provides technical guidance for the evaluation of motor-operated valve dynamic test data. Two concerns were identified.

1.3.4.1 Preliminary Operability Reviews

Procedure 39DP-9ZZ01 included a "Preliminary Operability Review" (POR) that functions as an immediate operability determination before the tested MOV was returned to service. The intent of providing an "up front" operability check was to ensure that any obvious MOV deficiencies were detected and corrected before the MOV was afforded Technical Specification operability status and potentially placed in a position other than its safety position. The inspectors questioned the suitability of the POR to meet this objective because: (a) no margins were provided to account for torque switch repeatability or diagnostic system measurement uncertainty (from point to point on the same diagnostic trace), and (b) torque switch trip thrust was taken from the static test, not the dynamic trace, and therefore actual LSB (rate-of-loading) effects were not evaluated in the review. The POR did provide a 15 percent margin applied to the static torque switch trip thrust, but this margin would not in all cases account for the uncertainties of (a) and (b) above.

The licensee acknowledged the inspector's concerns and stated that the POR would be evaluated for possible revision. The inspectors considered the POR to be a weakness in the licensee's MOV program; but, because the existing POR would generally detect gross MOV deficiencies, this issue was not characterized as a safety concern.

1.3.4.2 Design Basis Capability Review

After a POR was satisfactorily completed and the MOV was returned to service, Procedure 39DP-9ZZ01 required the review of a specific set of acceptance criteria within 7 days. The inspectors determined that the acceptance criteria included in the 7-day review were not true acceptance criteria because the failure of an MOV to meet one, or all, of these criteria would never result in an immediate (24-hour, for example) operability determination. The 7-day criteria focused on the verification of design assumptions, such as valve factor, stem friction coefficient, and LSB. When an MOV test indicated one or more design parameters to be in excess of those assumed, a CRDR was initiated to evaluate operability. In most DP tests, the initial design assumptions were not bounding and a CRDR was required. The actual evaluation of MOV operability was performed on the CRDR. The inspectors were concerned that there were no procedures to ensure a timely review or to provide standardized methods to evaluate MOV operability in the CRDR. The inspectors noted that operability assessments in the CRDRs could take over a month to complete. The inspectors sampled several CRDR operability evaluations and found them to differ in method and terminology, depending on the particular engineer who performed the evaluation.

The licensee stated that it would review its MOV test data evaluation process with respect to the guidance recently promulgated in GL 89-10, Supplement 6. This supplement provides suggested criteria for immediate and long-term MOV test data evaluation. This issue was identified as an inspection followup item (528/9411-03; 529/9411-03; 530/9411-03).

1.3.5 Extrapolation of Low DP Test Results

For MOVs that undergo partial DP testing (under conditions less than design DP and flow), the inspectors noted that the licensee had not established criteria to differentiate between one- and two-stage MOVs as defined in GL 89-10. According to their program, the licensee planned to demonstrate design basis capability for all valves within their program, without relying on ongoing EPRI testing. The inspectors were not able to identify MOVs considered complete under the generic letter from those that require additional review. Extrapolation of low DP test data had previously been considered too unreliable to predict MOV performance at design conditions. However, recent test data has indicated that extrapolation of low DP test data is typically conservative because apparent valve factors tend to be higher during lightly loaded than fully loaded strokes. The inspectors observed that the licensee's test data was consistent with this recent industry data. The licensee stated that they were incorporating industry experience in establishing justification for their method of extrapolation of low DP test data. The inspectors found the licensee's actions to be acceptable at this time.

1.4 Periodic Verification of MOV Capability

Every other refueling outage, the licensee conducts static diagnostic testing of each MOV. Each refueling outage, preventive maintenance including stem lubrication and grease inspection is performed. Every fourth refueling outage, each actuator is refurbished and statically tested. The licensee plans to conduct selected periodic DP testing as part of their periodic verification. The inspector found that the licensee had not identified the periodic pressure testing to be performed. The inspectors found that the licensee had implemented preventive maintenance tasks to periodically perform static testing.

2 FOLLOWUP ON CORRECTIVE ACTIONS FOR VIOLATIONS AND DEVIATIONS (92702)

2.1 (Closed) Violation 528/9125-02; 529/9125-02; 530/9125-03: Inadequate Acceptance Criteria

This item identified the failure to incorporate appropriate acceptance criteria in the DP test procedures. During this inspection, the inspector reviewed Procedure 39DP-9ZZ01, "PVNGS Guidelines for Evaluation of Motor Operated Valve Dynamic Test Data," Revision 3. Based on this review, the licensee's corrective actions were considered to be adequate.

2.2 (Closed) Violation 528/9125-06; 529/9125-06; 530/9125-06: Contact Chattering

This item involved a failure to adequately evaluate instances of torque switch chattering for reportability during MOV testing. In their response to the violation, the licensee provided additional information which identified that they had reported torque switch chattering under 10 CFR 21 in 1984. In a

letter dated February 28, 1992, the NRC acknowledged the additional information and withdrew the violation. This item is closed.

3 FOLLOWUP (92701)

3.1 <u>(Closed) Inspection Followup Item 528/9332-02; 529/9332-02; 530/9332-02: Alternating Current Motor Derating Due to Temperature</u>

During the previous MOV inspection, the licensee was evaluating Limitorque®'s notification of a potential 10 CFR Part 21 condition, "Reliance 3 Phase A.C. Actuator Motors (Starting Torque at Elevated Temperature)," dated May 13, 1993. The licensee had committed to complete the evaluation of this notification by April 30, 1994.

During this inspection, the inspectors reviewed the licensee's evaluation. Procedure 13-JC-ZZ-201, "MOV Thrust, Torque, and Actuator Sizing Calculation," Revision 2, incorporated revised voltage levels resulting from a recalculation of the plant's alternating current distribution system and the effect of elevated temperature on Limitorque® actuator motor torque and current. The licensee determined that the reevaluated voltage levels did not result in any operability problems, although a considerable amount of margin in the thrust setpoint band was lost in some cases. The inspectors reviewed the assumptions and equations used in the calculation of design voltage levels and concluded that the licensee had satisfactorily addressed this issue.

3.2 <u>(Closed) Inspection Followup Item 528/9125-05; 529/9125-05; 530/9125-05: Overthrusting</u>

During the TI 2515 Part 1 inspection, the inspectors observed that numerous MOVs had been overthrusted when tested in the open direction. The licensee revised the torque switch setpoint documents for each of the MOVs to include the following considerations to preclude future occurrences of overthrusting:

- During as-found tests, limit-closed MOVs will not be stroked in the open direction into a load cell if the torque switch setting is suspected to be sufficiently high to result in an overthrust situation.

- During baseline tests, the torque switch will be lowered to a setting that is certain to preclude overthrusting, then raised incrementally to the target thrust setpoint.

- Diagnostic signatures will be checked for indications of backseating and referred to engineering for evaluation.

The licensee stated that overthrust events in the open direction were limited to diagnostic testing activities, such that all overthrust events should be identifiable and evaluated as part of the test activity.

The inspector considered the licensee's actions to be sufficient to satisfactorily control the thrust levels experienced by MOVs when tested in the open direction.

3.3 (Closed) Inspection Followup Item 528/9125-01; 529/9125-01; 530/9125-01: MOV Degraded Voltage Calculation

During the TI 2515 Part 1 inspection, the inspectors noted that the Palo Verde Updated Final Safety Analysis Report (UFSAR) stated that Class 1E motors were required to perform their safety functions when subjected to terminal voltages as low as 75 percent of rated voltage. Some safety-related MOVs with Class 1E motors were shown, by calculation, to be inadequate to perform at this voltage level.

The licensee submitted a UFSAR change request to revise UFSAR Section 8.3.1.1.9(D) to exempt certain Class 1E motors from this requirement, such that as-built conditions could be credited in specific degraded voltage evaluations. This change request was approved. The inspectors observed that the licensee had performed a rigorous analysis to estimate the limiting terminal voltage for each GL 89-10 MOV. The inspector concluded that the licensee had satisfactorily addressed the original concern.

3.4 (Closed) Inspection Followup Item 528/9125-03; 529/9125-03; 530/9125-03: Review Test Criteria

This item was identified to review the licensee's DP test acceptance criteria and to review test data. Based on review of Procedure 39DP-9ZZ01, "PVNGS Guidelines for Evaluation of Motor Operated Valve Dynamic Test Data," Revision 3, and review of several MOV test data packages, documented in this report, this item is considered closed.

3.5 (Closed) Inspector Followup Item 528/9125-10; 529/9125-10; 530/9125-10: Vendor Information

This item involved a weakness in the licensee's program for incorporating industry experience and vendor information into their MOV program in a timely manner. The inspectors reviewed the licensee's MOV calculation Procedure 39DP-9ZZ01, Revision 3. The inspectors found that appropriate vendor information had been included in the licensee's procedure. As discussed in Section 1.3 of this report, the inspector found that the licensee had incorporated the experience of other utilities and vendors in their root cause analyses of torque switch roll pin failures and butterfly valve test anomalies. The inspectors found the licensee corrective actions for this previous weakness to be adequate.

3.6 (Closed) Unresolved Item 528/9332-03; 529/9332-03; 530/9332-03: Quality Assurance Involvement

This item involved deficiencies in the conduct of the licensee's MOV program which were identified in a self-assessment conducted by the licensee's

Independent Safety and Quality Engineering Group. The inspectors found that the plant had responded to the seven audit findings and had implemented corrective actions. The Quality Assurance audit had been closed, based on the adequacy of the corrective actions. The inspectors reviewed the plant's response to the Quality Assurance audit deficiencies. The inspectors concluded that the programmatic deficiencies identified in the licensee's self assessment were of low safety significance and had been adequately addressed by the licensee.

3.7 (Open) Inspection Followup Item 528/9332-01; 529/9332-01; 530/9332-01: Pressure Locking and Thermal Binding

This item involved an additional licensee review of the potential for pressure locking and thermal binding. The inspectors found that the licensee had not completed their review which was in progress. This item will remain open, pending review of the licensee's corrective actions resulting from their review of the potential for pressure locking and thermal binding.

3.8 (Open) Inspection Followup Item 528/9125-11; 529/9125-11; 530/9125-11: Evaluation of dc Motor Stroke Time

This item involved the adequacy of licensee's determination of stroke time for dc MOVs. The inspectors found that the licensee had incorporated acceptance criteria for dc MOV stroke time in their DP testing. However, the inspectors found that the licensee had not incorporated allowances for dc motor speed changes under degraded voltage conditions. As discussed in Section 1.2.2 of this report, in some cases under degraded voltage conditions, dc motor speed was expected to decrease from 1700 RPM to as low as 200 RPM for a portion of the valve stroke under design basis DP conditions. The licensee stated that additional evaluation of their acceptance criteria for dc MOV stroke time was in progress. This item will remain open, pending completion of the licensee's evaluation.

ATTACHMENT 1

1 PERSONS CONTACTED

1.1 Licensee Personnel

S. Bauer, Engineer, Nuclear Regulatory Affairs
R. Bernier, Supervisor, Nuclear Regulatory Affairs
S. Coppock, Supervisor, Valve Services Engineering (VSE)
R. Gouge, Director, Plant Support
M. Hooshmand, Engineer, VSE
W. Ide, Plant Manager, Unit 1
A. Krainik, Manager, Regulatory Affairs
J. Kriner, Engineer, Nuclear Engineering
W. Lui, Supervisor, MOV Design Support, Nuclear Engineering
D. Maudlin, Director, Maintenance
R. Prabhakar, Manager, Independent Safety/Quality Engineering (ISQE)
M. Radoccia, Supervisor, ISQE
M. Salazar, Supervisor, Valve Maintenance
S. Scow, Engineer, Technical Quality Engineering, ISQE
W. Simko, Manager, Valve Services, Maintenance
E. Smith Jr., Engineer, Supervisor, MOV Design Support,Nuclear Engineering
F. Swirbul, Manager, Electrical/I&C Design
J. Young, Engineer, ISQE

1.2 Other Organizations

J. Draper, Site Representative, Southern California Edison
R. Henry, Site Representative, Salt River Project
F. Gowers, Site Representative, El Paso Electric

1.3 NRC Personnel

T. Westerman, Chief, Engineering Branch, Division of Reactor Safety, RIV
K. Johnston, Senior Resident Inspector

The personnel listed above attended the exit meeting. In addition to the personnel listed above, the inspectors contacted other personnel during this inspection period.

2 EXIT MEETING

An exit meeting was conducted on April 8, 1994. During this meeting, the inspectors reviewed the scope and findings of the report. The licensee acknowledged the inspection findings documented in this report. The licensee did not identify as proprietary any information provided to, or reviewed by, the inspectors.

ATTACHMENT 2

PALO VERDE GATE VALVE DATA

Diagnostics: MOVATS WITH STEM STRAIN GAGES

VALVE NUMBER	VALVE SIZE & MANUFACTURER	TEST CONDITIONS psid/MPad	DYNAMIC VALVE FACTOR[1]	STEM FRICTION COEFFICIENT[2]	LOAD SENSITIVE BEHAVIOR[3]
1JAFBUV0034	6" Anchor Darling Flex-wedge Gate	1770/12.2 (Open) 1777/12.3 (Close)	0.287 (Open) 0.572 (Close)	0.184 (Open) 0.1 (Close)	-2.9 %
1JAFCUV0036	6" Anchor Darling Flex-wedge Gate	1150/7.9 (Open) 801/5.5 (Close)	0.541 (Open) 0.772 (Close)	0.094 (Open) 0.129 (Close)	+2.5 %

1. The dynamic valve factors listed were calculated by the licensee using a mean seat diameter.

2. The stem lubricant used at the time of testing was Darina EP-2 (previous testing used Nickel Never Seize No. 165).

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.