U. S. REGULATORY COMMISSION

Region V

Report Nos. 50-528/91-25, 50-529/91-25, 50-530/91-25

Docket Nos. 50-528, 50-529, 50-530

License Nos. NPF-41, NPF-51, NPF-74

Licensee: Arizona Public Service Company
P. O. Box 53999, Sta. 9012
Phoenix, Arizona 85072-3999

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

Inspection Conducted: July 8 through August 13, 1991

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Inspection Summary:

Inspection on July 8 through August 13, 1991 (Report Nos. 50-528/91-25, 50-529/91-25, 50-530/91-25)

Areas Inspected: This inspection reviewed the licensee's Generic Letter 89-10 program for safety-related motor operated valves. (SIMS Issue GL 89-10)

Temporary Instruction 2515/109 was used as guidance for the inspection.

Results:

General Conclusions and Specific Findings

In general, the inspection findings indicated that the licensee was developing an aggressive program for assuring MOV reliability. Program strengths were found in the areas of scope and test scheduling. Weaknesses were identified in the areas of program implementing procedures, overall program integration, test acceptance criteria, review of vendor information notices, corrective actions and trending.

Summary of Violations

Two violations were identified. One violation involved a failure to adequately review a test deficiency of torque switch chattering for potential reportability under 10 Part CFR 21. (Enforcement Item 50-528/91-25-06; refer

to Section 4.6.) A second violation was identified involving a failure to establish appropriate acceptance criteria for MOV testing. (Enforcement Item 50-528/91-25-02; refer to Section 4.4.)

Open Items Summary:

Nine new followup items were identified:

- 91-25-01 Motor Sizing for 75% degraded voltage (p.5)
- 91-25-03 Test acceptance criteria (p.8)
- 91-25-04 Periodic verification (p.9)
- 91-25-05 Adequacy of test procedure notes to preclude actuator over-thrusting (p.10)
- 91-25-07 CAR 91-0021 (p.15)
- 91-25-08 Vendor services and software (p.15)
- 91-25-09 Margin for accuracy and rate-of-loading (p.17)
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- 91-25-11 NRR evaluation of DC MOV stroke time (p.19)

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DETAILS

1. PERSONS CONTACTED

* J. Levine, Vice President, Nuclear Production
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* J. Hesser, Manager, Nuclear ICE
* J. LoCicero, Manager, ISE
* A. Ogurek, Manager, NS&L
* P. Prandjes, Manager, CAG
* C. Russo, Manager, QC
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  D. Blackson, Manager, Central Maintenance
  B. Webster, Manager, Component Engineering
  T. Bradish, Compliance Manager
* R. Badsgard, Assistant Manager of Nuclear Projects, SNE
  T. Weber, Supervisor, Component & Speciality
* S. Coppock, Supervisor, Component Engineering (MOV Coordinator)
* R. Rogalski, Audit Supervisor, QA
* A. Khanpour, Engineering Supervisor, Site Nuclear
* N. Eidsmoe, Procurement Engineering Supervisor
* W. Weems, Elec/HVAC Supervisor, CMPO
* E. Smith, MOV Supervisor, Nuclear ICE
* R. Rouse, Compliance Supervisor
* R. Ebann, MOV Foreman, Central Maintenance
* J. Baxter, Compliance Engineer
* T. Phillips, I&C Senior Engineer, SNED
* J. Zaghloul, Senior Electrical Engineer, SNED
* S. Schroeder, Senior Electrical Engineer, NED
* S. Kanter, Senior Coordinator, Owner Services
* R. Henry, Salt River Project Site Representative
* J. Draper, SCE Site Representative
* B. Druin, Consultant, CMPO

The inspectors also interviewed other licensee and contractor personnel during the course of the inspection.

*Attended Exit Meeting

2. BACKGROUND

Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," dated June 28, 1989 requested that licensees establish a program to ensure that switch settings for safety-related motor-operated valves (MOVs) and certain other MOVs in safety-related systems are selected, set and maintained properly. Supplement 1 to GL 89-10 provided the results of public workshops on the implementation of the Generic Letter. Supplement 2 to GL 89-10, dated August 3, 1990, stated that inspections of programs developed in response to GL 89-10 would begin January 1, 1991.

In response to concerns raised by the results of NRC sponsored MOV tests, Supplement 3 to GL 89-10, dated October 25, 1990, requested all licensees to consider the applicability of the information obtained from the NRC-sponsored tests to MOVs within the scope of GL 89-10 and to consider this information in the development of priorities for implementing the Generic Letter program.

GL 89-10 requested that licensees submit a response to the Generic Letter by December 28, 1989. In a letter on that date, the licensee committed to implement the recommendations of GL 89-10 and stated that a schedule would be provided by June 28, 1990. The licensee indicated, however, that their commitment might be revised if experience showed that testing every MOV was unnecessary. In a letter dated July 2, 1990, the NRC staff acknowledged the licensee's response.

3. INSPECTION PLAN

The inspection was performed in accordance with Temporary Instruction (TI) 2515/109, "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance," dated January 14, 1991. The inspection focused on Part 1 of the Temporary Instruction (TI), which involves a review of the program being established by the licensee in response to GL 89-10. The inspectors did not address Part 2 of the TI, which involves a review of program implementation, except to assist in evaluating the licensee's GL 89-10 program.

The inspectors reviewed the licensee's program commitments as established in their December 28, 1989 response and the Palo Verde Nuclear Generating Station NRC Generic Letter 89-10 Program document (Rev. 1, July 5, 1991) and supporting documentation. In addition, the inspectors discussed program details with licensee personnel.

4. MOV PROGRAM REVIEW

4.1 Scope

GL 89-10 Recommendations and Licensee Commitments

GL 89-10 recommended that all safety-related MOVs and other MOVs that are position-changeable in safety-related piping systems be included within the scope of the licensee's GL 89-10 program. Supplement 1 to the Generic Letter defined "position-changeable" as any MOV in a safety-related piping system that is not blocked from inadvertent operation from the control room. The licensee response to GL 89-10, committed to the scope of the program as recommended in GL 89-10.

Observations

A review of the licensee's GL 89-10 program scope was conducted using the licensee's "Implementation Plan for NRC Generic Letter 89-10," Revision 1, dated July 5, 1991, and other available documents. The licensee's GL 89-10 program included 117 MOVs per unit. Most of these MOVs have

Limitorque actuators. However, the inspectors noted some Rotork and EIM actuators in the licensee's GL 89-10 scope.

The inspectors noted that the scope of the licensee's program included safety related MOVs, MOVs in safety related systems that could be inadvertently mispositioned from the control room, and MOVs for which credit was taken in the Emergency Operating Procedures (EOPs).

The inspectors also noted that the licensee had planned to extend many of the recommendations advocated in GL 89-10 to MOVs outside of the GL 89-10 scope.

Conclusion

The inspectors determined that the scope of the licensee's program appeared to be adequately established.

4.2 Design Basis Reviews

GL 89-10 Recommendations and Licensee Commitments

Recommended Action "a" of GL 89-10 requested the review and documentation of the design basis for the operation of each MOV to determine the maximum differential pressure and flow (and other factors) expected for both normal operations and abnormal conditions. The licensee committed to follow the recommendations of GL 89-10.

Observations

The inspectors discussed the performance of design basis reviews with licensee personnel. The licensee had contracted with Combustion Engineering (CE) to provide worst case pressure, flow, and differential pressure for each of the valves in the GL 89-10 scope. The licensee used the CE design data as input to their initial MOV sizing and switch setting calculations.

The inspectors noted that the licensee had only recently developed a procedure for conducting design basis reviews. The inspectors reviewed procedure 81DP-4DC10, Revision 0, "Motor Operated Valve Design Basis Review and Thrust/Torque Calculation," and found that it appeared to adequately address the guidelines set forth in GL 89-10. The inspectors found that no similar specific guidance had been established by the licensee for the original design basis review performed by CE. According to the licensee, the initial CE review established conservative bounding values for the worst case conditions for cases where the specific design basis conditions had not been determined. The licensee committed to review the CE pressure, flow, and differential pressure design input to verify compliance with their procedure by December 31, 1991. This schedule commitment date was reflected in their business plan.

The inspectors cautioned the licensee that if the approved design basis review reveals a different differential pressure than the previously used CE value, the licensee may need to repeat MOV sizing and torque switch setpoint calculations, reset the affected MOV torque switches, and repeat

the design basis testing. This could impact the licensee's program schedule. The licensee's design basis reviews will be examined in a future inspection.

Conclusion

The inspectors determined that the licensee appeared to have developed adequate plans and procedures for the performance of design basis reviews.

4.3 MOV Sizing and Switch Setting Calculations

GL 89-10 Recommendations and Licensee Commitments

Recommended action "b" of Generic Letter 89-10 requested licensees to review, and revise as necessary, the methods for selecting and setting all MOV switches. The licensee committed to follow the recommendations of GL 89-10.

Observations

a. The inspectors reviewed selected calculations and licensee procedure 13-JC-ZZ-201, "MOV Thrust, Torque and Actuator Sizing Calculation," Revision 0, dated 1991, which the licensee initially utilized for sizing MOVs and calculating their switch settings. The inspectors found that the licensee's calculations and procedure did not consider the effects of elevated temperature on motor performance and cable losses for degraded voltage calculations. Furthermore, the licensee did not consider motor ambient temperature in sizing their thermal overload protection devices (TOLs). The licensee had not included margin to account for rate-of-loading effects, nor had any margin been established to account for seismic/dynamic loading.

   The inspectors found that many of these concerns and other programmatic weaknesses were addressed in Revision 1 of the Palo Verde "Implementation Plan for NRC Generic Letter 89-10" which was issued during the inspection. In particular, the revised plan committed to consider the following:

   * Physical valve orientation, piping configuration and fluid type

   * Component weak link analysis based on ASME Code allowable stresses (Seismic and stem thrust/torque values to be considered)

   * Control circuit logic for the purpose of determining proper torque/limit switch settings and thermal overload configurations

   * Degraded voltage effects due to power supply and cable sizing, cable impedances accounting for in-rush or locked rotor currents, and temperature effects under normal and abnormal conditions and thermal overload sizes

   * Evaluation of motor capabilities with respect to operating temperature requirements

The implementation plan also committed to consider rate-of-loading effects as more data became available.

b. The inspectors observed that licensee calculations were not consistent in their use of an assumed valve stem friction coefficient in establishing stem factors. The values varied from 0.2 to as low as 0.1. These values would correspond to assumed lubrication quality ranging from poor to ideal. The licensee was cautioned that use of non-conservative valve stem friction coefficients lower than 0.2 would require specific justification.

The inspectors found that the licensee had not included any margin in their calculation of the minimum required target thrust setting to account for potential degradation of valve stem lubrication between maintenance/lubrication intervals. Furthermore, the inspectors found that the licensee adjusts the torque switch setting using MOVATS diagnostic equipment after cleaning and lubricating the valve stem. Since the licensee could set the torque switch at the minimum required thrust under these ideal lubrication conditions, the inspectors were concerned that any subsequent degradation of the lubricant quality over time would result in inadequate thrust capability. (Refer to Section 4.8.4 for further discussion)

In response to the inspectors' concern, the licensee identified that general procedural guidance had been established to set torque switch settings to the high end of the specified target window to establish a margin for degradation.

The inspectors found no instances of torque switch settings at the minimum value. However, the inspectors recommended that the licensee consider the need to more formally account for lubrication degradation within their setpoint methodology and controls. In addition, the inspectors emphasized the need for justification of the assumed consistency of lubrication based on feedback from the licensee's ongoing preventative maintenance activities. (Refer to Section 4.8.4 for further discussion.)

c. The inspectors noted that the Palo Verde FSAR stated that Class 1E motors were specified to perform under 75% degraded voltage. However, the inspectors observed that certain GL 89-10 MOVs with Class 1E motors were shown by calculation to be inadequate to perform under worst case design conditions at 75% degraded voltage. The inspectors noted that the current equations for demonstrating MOV operability under degraded voltage conditions were more conservative than those used in the original design (e.g. valve factors for most flex wedge gate valves had been increased from 0.3 to 0.4). The inspectors also noted that Palo Verde degraded voltage protective relays would typically limit maximum degraded voltage to far less severe conditions than 75% degraded voltage. Further, the inspectors expressed concerns that established design margins were being reduced. This is a followup item (Followup Item 50-528/91-25-01).

d. The inspectors observed that the licensee had incorporated recent industry experience into their calculational methodology. The licensee's calculations for flex wedge gate valves used a valve factor of 0.4 which was more conservative than the standard industry valve factor of 0.3.

Furthermore, the inspectors observed that, on a case-by-case basis, valve factors had been increased from 0.4 to 0.5 as a result of test failures. The licensee had performed several differential pressure tests to demonstrate MOV operability under design basis conditions. The tests for auxiliary feedwater (AFW) valves 13AFBUV0034 and 13AFBUV0035 failed on the first attempts. The subsequent increase in torque switch setting and thrust was sufficient to achieve valve operability when the subject AFW MOVs were retested at design basis differential pressure. The inspectors were concerned, however, that the licensee had increased the valve factor as a corrective action only for the test failures without evaluating the generic applicability to other flex wedge gate valves which had not yet been tested. The licensee responded that evaluation of the adequacy of their calculational methodology would be addressed at the conclusion of their test program when the failure data could be statistically assessed. However, the inspectors emphasized the need for a more timely evaluation of the generic applicability of the test results to ensure that the licensee's interim program was conservatively established. The licensee acknowledged the need to evaluate their DP test data in a more timely manner.

The inspectors considered the licensee's use of an increased valve factor as corrective action on a case-by-case basis in lieu of an identifiable root cause to be a weakness in the development of the licensee's program.

Conclusion

The inspectors determined that the licensee had not yet adequately established procedures for performing calculations to verify proper sizing of MOVs and setting of their switches.

4.4 Design Basis Differential Pressure and Flow Testing

GL 89-10 Recommendations and Licensee Commitments

Recommended action "c" of the Generic Letter requested licensees to test MOVs within the Generic Letter program in-situ under their design basis differential pressure and flow conditions. If testing in-situ under those conditions is not practicable, alternate methods may be used to demonstrate the capability of the MOV. A two-stage approach was suggested for situations when design basis testing in-situ was not practicable and when an alternate method of demonstrating MOV capability could not be justified at the time. With the two-stage approach, a licensee would evaluate the capability of the MOV using the best data available and then would work to obtain applicable test data within the schedule of the generic letter. The licensee committed to follow the recommendations of GL 89-10, except that with regard to testing all MOVs

where practicable, the licensee requested to reserve the option to reduce the scope of their design basis testing program if subsequent industry developments and results of the licensee's testing program could provide justifiable alternatives.

Observations

a. The licensee uses MOVATS diagnostic equipment during testing. The parameters measured as part of the licensee's testing program appeared consistent with current industry recommendations. The licensee had an aggressive plan for full flow differential pressure testing and had completed 31 differential pressure tests by the time of the inspection. The licensee was in the process of prioritizing the MOV test schedule by MOV safety significance based on input from the licensee's Probability Risk Assessment Group. The inspectors considered these aspects of the testing program to be strengths.

b. The inspectors reviewed licensee test procedures, 73TI-9ZZ43 and 73TI-9ZZ44, Rev. 0, which were used for design basis testing of MOVs in the AFW and SI systems in Unit 3 during April, 1991. The inspectors noted that the procedures had no acceptance criteria for the design basis test data, nor did they use the test data as feedback into their calculations. However, when a valve failed to operate, the licensee would modify valve factors to accommodate the increased torque/thrust requirements for the failed MOV.

Failure to incorporate appropriate acceptance criteria in the DP test procedures is an apparent violation of 10 CFR Part 50, Appendix B. (Enforcement Item 50-528/91-25-02)

The inspectors emphasized the intended twofold purpose of design basis differential pressure (DP) and flow testing: first, to demonstrate MOV capability to perform under design basis conditions; and second, to provide input for validating or refining the licensee's design methodology. Without acceptance criteria, the DP testing cannot satisfy these goals.

Of the 31 MOVs which underwent DP testing, 6 failed to perform their design function. The failures involved AFW valves. Subsequently, the valve factors for these valves were adjusted from 0.4 to 0.5 and calculations for required thrust were revised. However, as pointed out in the previous section, the licensee had not attempted to determine applicability of the observed phenomena to other similar valves.

The inspectors reviewed other DP tests which had demonstrated MOVs to perform their design function. For Unit 3 Safety Injection Valves SI-V-666 and SI-V-667, the inspectors found that the DP test results indicated a lower available margin than predicted by the licensee's design calculations. The inspectors stressed the importance of verifying available margin as part of the test acceptance criteria. Available margin is important, because the DP tests do not simulate all design conditions. For example, DP tests

are not conducted under degraded voltage or seismic/dynamic conditions.

Despite completion of 31 DP tests at the time of the inspection, none of the MOVs were considered by the licensee to have completed their GL 89-10 program. The licensee considered their program to be developing and acknowledged the need for specific acceptance criteria which was being prepared for future testing.

The inspectors will review the licensee's DP test acceptance criteria and their review of test data in a future inspection. (Followup Item 50-528/91-25-02)

Conclusion

The inspectors considered the licensee's design basis measured test parameters, number of MOVs presently scheduled for testing, and the fact that 31 DP tests had already been conducted to be a program strength. However, due to the lack of test acceptance criteria and timely review of test results, the inspectors concluded that the licensee had not yet adequately established their program for demonstrating the capability of MOVs through design basis differential pressure and flow testing.

4.5 Periodic Verification of MOV Capability

GL 89-10 Recommendations and Licensee Commitments

Recommended action "d" of the Generic Letter requested that licensees prepare or revise procedures to ensure that adequate MOV switch settings are determined and maintained throughout the life of the plant. Paragraph "j" of the Generic Letter recommended that the surveillance interval be based on the safety importance of the MOV as well as its maintenance and performance history, but the interval should not exceed 5 years or 3 refueling outages. Further, the capability of the MOV should be verified, if the MOV is replaced, modified, or overhauled to an extent that the existing test results are not representative of the MOV. The licensee committed to follow the recommendations of GL 89-10.

Observations

a. The inspectors reviewed the licensee's procedures for post maintenance testing, including Nuclear Administrative and Technical Manual 30AC-9WP04 (Rev. 1, November 1, 1988), "Retest," and 73PR-9ZZ04 (Rev. 2, July 28, 1989), "Valve Motor Operator Monitoring and Test Program." The licensee indicated that they intended to use MOVATS static tests to measure thrust before and after packing adjustments in conjunction with stroke time tests. The inspectors noted that the licensee's post-maintenance test procedures did not clarify when the use of diagnostic thrust tests were required to verify MOV capability for other types of maintenance activities. The licensee acknowledged the concern and committed to revise their procedures. The inspectors also recommended that the licensee review their procedures to identify where thrust diagnostics would be needed to verify MOV operability for other MOV maintenance items.

b. The inspectors noted that the licensee was in the process of formulating their periodic verification and testing program for MOVs. The inspectors noted that the results of NRC sponsored testing had shown that current static testing methods were not capable of detecting certain MOV performance deficiencies which dynamic testing had been able to detect. The inspectors emphasized to the licensee that the use of static testing alone for periodic verification would require justification.

The inspectors will review the licensee's plans and procedures for periodic verification of MOV capability during a future inspection. (Followup Item 50-528/91-25-04)

Conclusion

Since the licensee had not yet finalized this area of their GL 89-10 program, the inspectors determined that the licensee had not yet adequately developed plans and procedures for periodic verification of the capability of MOVs.

4.6 MOV Failures, Corrective Actions, and Trending

GL 89-10 Recommendations and Licensee Commitments

Recommended action "h" of the Generic Letter requested that licensees analyze or 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. This data should be periodically examined (every 2 years or after each refueling outage after program implementation) as part of the monitoring and feedback effort to establish trends of MOV operability. These trends could provide the basis for a licensee revision of the testing frequency established to periodically verify adequate MOV capability. The Generic Letter indicated that a well-structured and component-oriented system is necessary to track, capture, and share equipment history data. The licensee committed to follow the recommendations of GL 89-10.

Observations

a. The inspectors reviewed the over-thrusting event of auxiliary feedwater MOV 3JSGAUV134, as described by Engineering Evaluation Report EER-MO-033. The inspectors noted that in evaluating the adequacy of the motor sizing, the EER credited the dc motor as capable of operating at 110% torque rating without justification. The licensee did not consider elevated ambient temperature effects in this evaluation. In addition, the licensee used a stem friction coefficient of 0.12 (as compared to the more conservative value of 0.20) without justification. Based on standard sizing calculations, the inspectors concluded that it appeared that the motor would have been inadequately sized to provide the required torque under degraded voltage conditions. Hence, it did not appear that an adequate margin was established to ensure that the subject motor would not have stalled before the point of torque switch trip. Since

the thermal overload protection is bypassed during safety features actuation, stalling or jamming of this valve could have resulted in burn-out of the motor.

Subsequent modifications made by the licensee resulted in the actuator thrust exceeding the Limitorque rating in the opening direction. In attempting to justify the acceptability of this as-left condition, the licensee used an industry study which had not been reviewed or approved by Limitorque. Further, the licensee did not have a documented evaluation of the study. While encouraging the licensee to incorporate current industry experience and the best available data into their program, the inspectors cautioned the licensee to ensure that design input data and references were properly reviewed and approved within established design control measures.

The inspectors noted that over-thrusting would occur principally during valve testing under static conditions rather than under design basis conditions. The licensee recognized this fact and the need to limit the thrust experienced by the actuator during testing. The licensee had prepared notes to inform test personnel to lower the torque switch setting prior to static testing to avoid over-thrusting the actuator. In a future inspection, the inspectors plan on reviewing the adequacy of these test procedures notes to preclude over-thrusting the actuator in the opening direction. (Followup Item 50-528/91-25-05)

b. The inspectors reviewed selected tests which had been conducted under maximum DP conditions by the licensee during the recently completed Unit 3 refueling outage. The inspectors found that in two of seven tests conducted on high pressure safety injection (SI) valves, the valves had failed to close completely under maximum dp conditions. The safety injection valves are normally closed, 2" Borg-Warner wye-globe throttle valves, with SMC-04 actuators. The valves have an active safety function to open on a safety injection signal for cold leg injection. The valves also perform a passive safety function of containment isolation in the normally closed position. The licensee had determined that the electrical contacts in the torque switch had chattered under flow induced vibration causing the actuator to intermittently interrupt operations prior to completely closing. The licensee installed a stiffer contact spring which maintains contact closure until intended actuation of the torque switch. Subsequent repeat testing was successful with no further incidence of chattering.

The licensee modified the two affected valves to incorporate the stiffer contact spring. In addition, as a precaution, the licensee initiated work orders to modify the remaining six safety injection valves and two mini-recirculation valves for the safety injection pumps in all three units. The licensee had considered the flow induced vibration to be unique to the test conditions and not representative of either normal or design basis conditions. As such the test deficiency was not considered to affect the operability of

the MOV or its capability to perform its safety function under design basis conditions.

The inspectors reviewed prior tests conducted on the safety injection valves under similar conditions during startup of Unit 3 in 1984. The inspectors found that the licensee had previously encountered the same problem on two other safety injection valves. At that time, a stiffer contact spring had also been installed on all 30 SMC-04 safety injection MOVs, along with other system modifications to reduce the flow induced vibration. Successful repeat testing at that time demonstrated that the problem had apparently been eliminated. (For all 30 SI MOVs with SMC-04 actuators, the replacement of the standard contact springs with stiffer contact springs in the 1984 time period constituted the first set of contact spring stiffness increases. The changeout of contact springs during and subsequent to the recent Unit 3 refueling outage constitutes a second contact spring stiffness increase.)

The inspectors found that the licensee had not evaluated Part 21 reportability at the time they became aware of the problem of flow induced vibration causing torque switch chattering either in November 1984 or in April 1991. No MNCR had been initiated as a result of the findings in either case. The inspectors noted that NMCR No. 91-SI-1057 had been initiated in July, 1991, addressing the previous incidents. However, the inspectors found that the disposition of this MNCR appeared to discredit its validity, stating that it was written based on an misinterpretation of requirements for operability. At that time, the licensee had determined that the problem did not constitute a defect as defined under Part 21 and was not reportable. The licensee determination was based on their conclusion that the instances of the problem were isolated to non-representative flow conditions and that the problem did not affect the ability of the affected component to perform its active safety related function.

The inspectors found that the licensee had not adequately evaluated the torque switch chattering problem. This conclusion was based on the following observations:

1. The two mini-flow safety injection pump valves which the licensee modified to install stiffer contact springs did have a close safety function which could be affected by the deficiency. Although these MOVs had not demonstrated the problem during testing, they were identical to the affected valves.

2. The deficiency could directly affect the ability of SMC-04 Limitorque actuators to perform an active safety related close function due to flow induced vibration under high differential pressure. DCP 3CM-SI-150, dated November 1984, identified all 30 SI valves with SMC-04 actuators (10 in each unit) as having the potential for torque switch chatter. Two of the MOVs in each unit are located on minimum recirculation lines and have an active safety function to close.

3. The Limitorque actuators were procured as seismically qualified. The seismic qualification report for the safety injection valve actuators (N001-1.01-828-1) identified that torque switch chattering was an analyzed failure mode which was not expected to be encountered in operation of the actuator under any expected vibration frequencies.

4. Repeat occurrences of the deficiency in different valves indicated that past corrective actions had not been sufficient to eliminate the problem. For example, 40% (4 of 10) of the safety injection valves in Unit 3 had experienced the problem.

5. The licensee evaluation for Part 21 reportability appeared to restrict consideration of the deficiency to the safety function of only the component on which the problem was encountered. There appeared to be no evaluation of the safety related functions of other applications of the component. This appeared to be a programmatic weakness.

6. The licensee had not evaluated the effect of the torque switch chattering on the actuator motor. Although the thermal overload devices were bypassed during the opening stroke, they were relied on to provide motor protection during the closing stroke. The inspectors were concerned that previous repetitive cycling of inrush current to the motor while the torque switch chatters may have resulted in motor degradation which may go undetected and subsequently preclude safety function operation. The licensee initiated a review to determine if the thermal overload device settings were adequate to protect the actuator motor when subjected to chattering conditions.

The inspectors considered this issue of torque switch chatter may be potentially reportable under Part 21. This issue will be forwarded to NRR for further evaluation.

The inspectors reviewed Palo Verde Nuclear Administrative and Technical Manual Procedure 94AC-OLC02, Review of Conditions Adverse to Quality for 10 CFR 21. The procedure requires, in part, that a finding be evaluated and a Reportability Evaluation Report initiated if it is determined to be a deviation. Paragraph 4.2 defines a "deviation," in part, as a departure from the technical requirements included in a procurement document (an engineering or design document). However, a Reportability Evaluation Report was not initiated for the reported problem of contact chattering due to vibration in Limitorque SMC-04 actuation under MNCR 91-SI-1057. This failure to adequately evaluate conditions for Part 21 reportability is an apparent violation. (Enforcement Item 50-528/91-25-06)

c. The inspectors noted that the licensee had reported 124 MOV failures to the Nuclear Plant Reliability Data System (NPRDS) since 1986. Of the 124 MOV failures, 37 were identified as limit switches out of adjustment, with normal or cyclic wear identified as a contributor

for 12 of these failures. The inspectors noted that normal/cyclic wear did not appear to be a parameter used in the design.

The inspectors found that 28 of the 124 failures were identified as miscellaneous breakdowns, which the licensee identified as seen only once or twice since the three units went on line. While the licensee had established a data base, it did not appear that the program was trending failures by valve, operator and component type (gate, globe and/or butterfly), as well as service application.

Discussions with the licensee identified the following:

- A review of the last three years of MOV Work Order (WO) activity was in progress or would be performed to ensure that all MOV failures had been captured by the Failure Data Trending (FDT) system.

- A review of all the identified MOV failure data generated over the last three years would be performed to ensure the actual root cause for each failure was clearly identified.

The inspectors also emphasized the importance of trending accelerated wear and degradation of MOV components in addition to failures.

Conclusion

The inspectors considered MOV failure corrective actions and trending to be an area of weakness in the licensee's GL 89-10 program. The inspectors determined that the licensee had not yet adequately developed plans and procedures for analyzing MOV failures, justifying corrective actions, and trending.

4.7 Schedule

GL 89-10 Recommendations and Licensee Commitments

GL 89-10 requested that licensees complete all design-basis reviews, analyses, verifications, tests, and inspections that were initiated in order to satisfy the Generic Letter recommended actions by June 18, 1994, or 3 refueling outages after December 28, 1989, whichever is later. The licensee committed to follow the recommendations of GL 89-10.

Observations

The inspectors reviewed the licensee's schedule for implementation of their GL 89-10 program. The licensee had organized their program into a detailed set of tasks, each of which had a schedule and was included in the licensee's business plan. In general, the program schedule appeared reasonable and well organized.

The inspectors expressed concern, however, over certain aspects of the licensee's program. For example, the licensee's reliance on unverified design input (refer to section 4.2 of this report) and performance of

testing without acceptance criteria and without review of test results (refer to section 4.4) left the licensee's program vulnerable to reiterations and schedule slippage, if current assumptions establishing adequate margin could not be substantiated.

In order to keep on schedule, the inspectors emphasized the importance of verifying design input, implementing an MOV sizing and switch setting calculation methodology which includes conservative design margin to assure adequate performance under subsequent design basis testing, and evaluating current DP test data on a timely basis.

Conclusion

The inspectors determined that the licensee had apparently established an adequate schedule for the completion of the recommended actions of GL 89-10.

4.8 Other MOV Program Areas Addressed

4.8.1 Control of MOV Switch Settings

a. The inspectors were concerned that the licensee was no longer controlling torque switch settings on the ZZI-004 drawings per their established procedure, but instead were using Engineering Evaluation Requests (EERs). The EER process was adapted to provide an expeditious means for Engineering to specify switch settings without the encumbering delays associated with the drawing change process.

An open ended EER was utilized by Nuclear Engineering Division (NED) to specify and change required torque switch settings, which were determined either by analysis or testing. The licensee referred to this information as the Interim Controlled Motor Operator Data Base which was administered through the EER process. The MOV monitoring and test procedure (73-J-ZZI-004) which directs the use of Drawing 12-J-ZZI-004, had been changed to refer to either the ZZI-004 drawing or an EER for the required switch setting information. In practice, the EER was the only document which specified switch settings during the implementation of the GL 89-10 program.

While it appeared that some adaptation of the existing licensee program was appropriate during the GL 89-10 program, the inspectors emphasized the importance of ensuring that program controls embodied quality assurance measures equivalent to those within established plant procedures.

The inspectors noted that the licensee's QA department Corrective Action Report (CAR) 91-0021 identified potential problems associated with keeping torque switch (TS) settings in an interim data base via EERs. The licensee's Component and Specialty Engineering group, which had primary responsibility for the MOV program, had committed to respond to the CAR within

the next few months. The inspectors intend to review this in a future inspection. (Followup Item 50-528/91-25-07)

b. The licensee was questioned on the controls for torque switch limiter plate removal. The licensee indicated that limiter plates could be removed if required to achieve the specified target thrust. No special or procedural controls were in place for the removal of torque switch limiter plates. The licensee was cautioned that setting torque switch setpoints above the maximum recommended by Limitorque constituted a design change of that actuator and required appropriate review prior to implementation. The inspectors acknowledged that the licensee's GL 89-10 program procedures incorporated design review measures when they removed torque switch limiter plates.

4.8.2 Training

a. The inspectors discussed the training program with licensee management, reviewed general training requirements, outlines and records, and toured the training facility.

The inspectors noted that, as part of the licensee's indoctrination program, technical personnel were required to complete an orientation package. The orientation package was tailored to specifically address the necessary requirements for the applicable duties. The packages included requirements for the licensee's administrative procedures, goals and objectives, NRC rules and regulations, and quality assurance procedures; as well as industry codes, technical specifications and procedures applicable to the employee's duties. The orientation package required signatures by the employee and the employee's supervisor to acknowledge completion.

Training and requirements for MOV personnel appeared adequate. However, the need for refresher training courses for maintenance and testing technicians was identified by the inspectors as a potential weakness in the licensee's program.

b. The inspectors observed that the licensee relied heavily on contract personnel in their MOV program. The inspectors checked the licensee's certification of MOVATS personnel. Although the licensee verified that MOVATS personnel had been certified to comply with MOVATS standards, the licensee had not verified the MOVATS certification to be in compliance with the licensee's requirements. The inspectors also noted that MOVATS had also issued updated software for their test equipment and that the licensee was apparently using the updated MOVATS software without verifying compliance of the software to PVNGS standards. The inspectors emphasized the licensee's responsibility to adequately control vendor services and software. Review of vendor services and software will be addressed in a future inspection. (Followup Item 50-528/91-25-08)

4.8.3 Diagnostics

a. The inspectors found that the licensee used MOVATS diagnositc test equipment to establish required torque switch settings during static baseline testing. Diagnostic signatures were also obtained during DP testing.

b. In addition, the licensee has recently utilized stem strain gaging (Teledyne technique) for thrust determination during DP testing in Unit 3. This technique involves attaching strain gauges to the valve stem and analytically correlating output to thrust. Currently, the licensee considers the use of stem strain gaging to provide supplemental data, acquired for information only, in developing the utility of the technique. The inspectors noted that no procedures currently exist controlling stem strain gaging nor is load cell calibration performed as a check against the analytically derived thrust values. The inspectors cautioned the licensee against subsequent use of informal data to verify required torque switch settings until the accuracy of the data had been determined and the data obtained under appropriate test control measures. The licensee acknowledged the inspectors' concerns.

c. The inspectors informed the licensee of a recent Notice of Nonconformance issued to MOVATS for inadequate verification of equipment accuracy. The licensee noted that the results of industry sponsored testing of MOVATS accuracy would be presented at the upcoming MUG meeting scheduled for the following week. The inspectors stressed that consideration and implementation of these results were necessary in order to comply with the recommendations of GL 89-10.

At the subsequent MUG meeting, MUG released a preliminary report on its testing program for MOVATS and other diagnostic equipment. MUG intends to release a final report in January 1992. During the period when results of the diagnostic testing are being finalized by MUG, the licensee is encouraged to take inventory of all MOVs for which diagnostic equipment has been used to establish switch settings. This would provide the licensee with some advance information about the number of operability evaluations and potential switch setting changes or modifications that might be required when the results of the final report are released.

d. The inspectors noted that the licensee had not addressed MOVATS Engineering Report 5.0, Revision 0, January 1991, "Equipment Accuracy Summary," which provided guidance for the consideration of rate-of-loading effects that might reduce the available thrust delivered by the motor operator under high differential pressure conditions. The inspectors recommended that the licensee consider this information when they develop their margin to account for rate-of-loading effects.

The licensee's consideration and implementation of MOVATS accuracy and rate-of-loading effects will be reviewed in a future inspection. (Followup Item 50-528/91-25-09)

4.8.4 Maintenance

a. The inspectors reviewed detailed assembly/disassembly maintenance procedures for the licensee's Limitorque, Rotork, and EIM motor operated valve actuators. The Limitorque procedures had recently been issued for use; however, the Rotork and EIM procedures were still in draft form. The inspectors found that these procedures appeared to be adequately detailed, including requirements for maintenance and testing and special tools.

b. The inspectors observed that the licensee had an 18 month preventative maintenance (PM) program for their MOVs. The inspectors observed that several of the maintenance procedures were lacking in details for identifying and recording excessive wear and degredation. For example, the licensee's preventative maintenance procedure 32MT-9ZZ48 did not require specific observation or evaluation of the as found condition of the stem thread lubricant. The inspectors noted that such observations were required for the quantity and quality of the actuator housing lubricant and the limit switch lubricant. The inspectors emphasized that since there was no established frequency for actuator overhaul, the PM observations of degradation constituted the only established opportunity to thoroughly assess the actuator for unexpected degradation.

The inspectors observed that the licensee's program did not include provisions for confirming assumptions embodied in the calculational methodology. As described above, as-found stem lubricant quality was not observed during PM activities. However, stem friction coefficients assumed in engineering calculations credited ideal lubricant quality in some cases.

The inspectors found these assumptions to be unrealistic and non-conservative without justification from PM observations. The inspectors pointed out that stem wear and lubricant degradation were common deficiencies as identified in Attachment A of GL 89-10. Furthermore, such a deficiency would directly reduce the actual thrust delivered to the valve, potentially causing the actuator to torque out early before the valve could complete its required safety function.

The inspectors found this lack of coordination of PM activities in verifying engineering assumptions to be a weakness in the licensee's program.

The inspectors observed that the licensee did not have a specific refurbishment schedule for MOVs. Preventative maintenance and diagnostic testing, alone, have been found at some facilities to be insufficient for detecting all aspects of

MOV degredation (e.g. stem nut wear). The inspectors note that, recently, at another facility which did not have an MOV refurbishment program, an MOV failed because of excessive wear of an actuator component. The solution to the problem was refurbishment of the MOV, but other similar MOVs at the facility had to undergo operability evaluations and, in some cases, refurbishment before the facility was restarted.

4.8.5 Industry Experience and Vendor Information

The inspectors observed that the licensee's technical data group controlled NRC, EPRI, and INPO information. This portion of the program appeared adequate.

The inspectors also reviewed the licensee's receipt, review, and control of vendor information. Vendor information was controlled by the licensee's Site Nuclear and Construction Procurement Engineering Department.

The inspectors selected the Limitorque Maintenance Update as a means of sampling the licensee's handling of vendor information; because they contained important information about actuator assignment adjustments, operating experience, and maintenance which could potentially affect valve operability.

The inspectors noted that the review of the Limitorque Maintenance Updates had been initiated in September of 1990, but had not been completed until June 28, 1991. The inspectors noted that the licensee's Maintenance Standards Review group had reviewed the Limitorque updates and incorporated pertinent information into affected draft maintenance procedures. However, the inspectors also noted a number of significant omissions in the licensee's review process. The review package document had specifically waived electrical and engineering reviews, as well as review by nuclear training. The inspectors were especially concerned that information notices had been allowed to bypass the review of the licensee's motor operated valve group. Furthermore, these notices dated as far back as August of 1988.

The inspectors emphasized the importance of timely review and implementation of vendor documents (where applicable) in light of the safety significant information they often contain. The inspectors considered the licensee's lack of control of vendor information to be a significant weakness in their MOV program. The licensee acknowledged the need to evaluate vendor information and provided their detailed plans for responding to Generic Letter 90-03 on vendor interface. The inspectors plan on reviewing this response and the licensee's evaluation and implementation of pertinent information contained in these documents during a future inspection. (Followup Item 50-528/91-25-10)

4.8.6 Inservice Testing

Palo Verde valve stroke time acceptance criteria did not initially consider motor speed changes under load or degraded voltage conditions. In the case of DC MOVs this will significantly affect motor speed and, hence, stroke time. The inspectors observed a case where actual MOV stroke time was within 1/2 second of the acceptance criteria and questioned if the licensee had considered whether the valve would be able to satisfy stroke time under load and degraded voltage conditions. The licensee had not evaluated this case. However, the licensee's revised GL 89-10 program plan, dated July 1991, committed to include this area of concern. The inspectors emphasized that if the design basis DC MOV safety function was time critical and credited operations of the MOV under maximum DP and degraded voltage conditions, the acceptance criteria for testing should either demonstrate acceptable time under those design basis conditions or account for the anticipated effect by including an appropriate margin within the test criteria.

The licensee kept records of MOV stroke times obtained during surveillance testing. While the stroke times were recorded, the licensee identified that they were still developing computer software to fully develop their trending capabilities in this area.

The inspectors noted that the static zero pressure stroke times for some MOVs were already close to FSAR acceptable stroke times. This issue will be referred to NRR for further evaluation and will be a followup item for future inspections. (Followup Item 50-528/91-25-11)

5. SUMMARY OF OVERALL PROGRAM ADMINISTRATION

The inspectors found that overall administration of the licensee's program appeared to be established with interim controls which required some customizing of plant procedures to expedite the program. The inspector cautioned the licensee to insure that required controls were not bypassed in their efforts to expedite portions of their program.

The inspectors found that some of the licensee's plant departments did not fully recognize the significance of the design basis testing program nor the GL 89-10 program. This was evidenced by the reluctance to recognize that the purpose of the design basis testing was to provide assurance of MOV operability under design basis conditions and, for example, in the case of the torque switch chatter, the licensee stated that the failure of the MOV to operate under test conditions did not constitute a failure to operate under design basis conditions.

Regarding the significance of the GL 89-10 program, there appeared to be some misconception that the purpose of the program was only to satisfy a commitment to NRC recommendations and no regulatory requirements were involved. The inspectors emphasized that the basis of the GL 89-10 program was to provide assurance that specific design requirements were fulfilled. Specifically, these design requirements are given in General Design Criteria 1, 4, 18 and 21 of Appendix A to 10 CFR Part 50 and Criterion XI of Appendix B to 10 CFR Part 50.

In general, the inspectors observed that the licensee had made strong commitments to develop an MOV program to meet the intent of GL 89-10. However, in light of the findings detailed in this report, the licensee is encouraged to maintain adequate resources to ensure timely and thorough implementation of all of the GL 89-10 program components.

6 EXIT MEETING

The inspectors met with the licensee management representatives denoted in Section 1 on July 26, 1991. The scope of the inspection and the findings were discussed. The inspectors identified that additional information would be reviewed in order to complete the inspection. Review of the additional information necessary to complete the inspection was concluded on August 13, 1991.

7. LICENSEE DOCUMENTS REVIEWED

Response to GL 89-10: 12/28/90

Program Description: Implementation Plan, R.O. 6/22/90, R.1., 7/5/91

Scope: EER 90-XE-037

Design Basis Review: Motor Operated Valve Design Basis Review and Torque/Thrust Calculation, 81DP-4DC 10, R.O.

Sizing and Switch Setting Calculations:

- MOV Thrust Torque and Actuator Sizing Calculation, 13-JC-ZZ-201 R.O. 7/27/90, CCN.1 1/16/91, CCN.2, 7/12/91
- TOL Sizing, 13-EC-PH-250, 1/24/89
- Engineering Guide for AC Motor-Sizing (draft)

Design Basis Testing:

- SI System MOVATS testing, 73 TI 97243 R.O.
- AFW System MOVATS testing, 73 TI-97744 R.O.
- Strain gaging, W.O. 476622, EER91-XE-016

Periodic Verification:

- Retest, NATM 30AC-9WP04, R.1 9/1/88
- Valve Motor Operator Monitoring and Test Program, 73 PR-9ZZ04, R.2, 7/28/89

Failures Corrective Action and Trending:

- EER-MO-033
- DCP-3CM-SI-150, 10/84
- N001.1.01-828-1 Seismic Qualification Report
- NATM 94AC-OLC02 Review of Conditions Adverse to Quality for 10 CFR 21
- MNCR 91-SI-1057

Control of Switch Settings:

- CAR 91-0021
- 13J-ZZI-004 MOV Setpoint Controlled Data Base
- EER-91-MO-046 Unit 3 Interim CMODB

Diagnostics:

- MOVATS Engineering Report 5.0 R.0 1/91, Equipment Accuracy Summary

Maintenance:

- 32MT-9ZZ43.44,45,46 Limitorque Actuators
- 32MT-9ZZ99 R.O. Rotork Actuators (draft)
- 32MT-9ZZ48 Maintenance of Limitorque MOVs
- 32MT-9ZZ50 Motor Generator Trouble Shooting
- 30AC-9WP04 Retest

Trending:

- 81DP-0RA08 Failure Data Trending
- 73DP-0EE02 Utilitzation and Processing Failure Data Trending Reports