U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-255/94015(DRS)

Docket No. 50-255 License No. DPR-20

Licensee: Consumers Power Company
212 West Michigan Avenue
Jackson, MI 49201

Facility Name: Palisades Nuclear Generating Plant

Inspection At: Palisades Site, Covert, MI

Inspection Conducted: September 12 through 30, 1994

Inspectors: S.D. Burgess FOR MPH 11-3-94
M. P. Huber Date

S.D. Burgess 11-3-94
S. D. Burgess Date

11-3-94
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NRC Consultant: Mark Holbrook, INEL

Approved By: for J. M. Jacobson, Chief 11/4/94
Materials & Processes Section Date

Inspection Summary

Inspection conducted September 12 through 30, 1994 (Report No. 50-255/94015(DRS))
Areas Inspected: Announced safety inspection of the licensee's response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve (MOV) Testing and Surveillance" (2515/109) the licensee's self-assessment in this area, and licensee actions on previously identified items.
Results: One violation, with four examples, was identified regarding untimely and inadequate corrective actions. Additionally, the MOV program implementation had not shown significant progress for the past two years. Virtually no quality design basis testing was performed and numerous deficiencies were identified with engineering calculations.

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DETAILS

1.0 Persons Contacted

Consumers Power Company (CPCo)

* T. Palmisano, Plant Manager
* D. Aalderink, Nuclear Performance Assessment Department (NPAD)
* D. Bixel, Air-operated valve (AOV) Program Manager
* P. Bruce, Staff Engineer
* R. Brzezinske, NPAD
* D. Fadel, Engineering Programs Manager
* G. Foster, Valve Program Section Head
* R. Gambrill, MOV Engineer
* P. Gire, Licensing Engineer
* K. Haas, Licensing Director
* J. Hanson, Engineering Manager (Acting)
* D. Hice, Training
* R. Kasper, Maintenance
* D. Malone, RSD Director (Acting)
* W. O'Connell, MOV Coordinator
* L. Reynolds, Senior Engineer
* D. Rogers, Operations Manager
* R. Vincent, Licensing Administrator
* S. Wawro, Outage and Planning Manager
* J. Woodbury, Contractor (VECTRA)

U. S. Nuclear Regulatory Commission (NRC)

* G. Wright, Chief, Engineering Branch
  J. Jacobson, Chief, Materials & Processes Section
  M. Parker, Senior Resident Inspector
* D. Passehl, Resident Inspector

* Denotes those attending the exit meeting on September 30, 1994.

2.0 Licensee Action on Previous Inspection Findings

(Closed) Inspection Followup Item (50-255/92014-01(DRS)): Capability assessments for the main steam isolation valves (MSIV) bypass valves showed that the valves may not develop enough thrust to close during a main steam line break. To address the issue, the licensee performed an analysis of the effects of a main steam line break (MSLB) on the containment with the extra blowdown expected through an open MSIV bypass valve. The analysis demonstrated that containment design pressure was not exceeded and there was no change on peak containment temperature resulting from a MSLB with the bypass valves open. Therefore, it was concluded that there was no safety significance and the valves were appropriately removed from the GL 89-10 program. This item is closed.

3.0 Generic Letter 89-10 Program Implementation

This Part 2 inspection verified and evaluated the licensee's GL 89-10 program implementation by examining a cross-section of the Palisades MOV population. The following MOVs were reviewed during this inspection:

MO-0753	Auxiliary feedwater (AFW) supply to steam generator (S/G) E-50A isolation
MO-3011	High pressure safety injection (HPSI) to reactor coolant loop 2A injection
MO-3015	Shutdown cooling inlet isolation
MO-3016	Shutdown cooling inlet isolation
MO-3068	HPSI to reactor coolant loop 1A isolation
MO-3082	HPSI hot leg injection
MO-3083	HPSI hot leg injection
MO-3190	Low pressure safety injection (LPSI) "B" shutdown cooling suction
MO-3199	LPSI "A" shutdown cooling suction

3.1 Program Scope

The inspectors determined that the program scope was consistent with GL 89-10 recommendations and the rationale for removing eight MOVs appeared adequate. The Palisades plant had a total of 46 safety related MOVs, of which 38 valves were in the GL 89-10 program. The program valves consisted of 23 gate valves and 15 globe valves. The licensee deleted eight valves from the GL 89-10 program (MO-3041, 3045, 3049, 3052, PO-1745 and 1746, and MO-0501 and 0510). The licensee's justification for deleting valves MO-3041, MO-3045, MO-3049, and MO-3052 from the program was that prior to the primary coolant system exceeding 325 °F, breakers for these MOVs were physically locked open after the valves were opened. The licensee verified that these valves were not safety significant between cold-shutdown and 325 °F. Valves PO-1745 and PO-1746 were air dampers. The licensee adequately justified the deletion of these valves because GL 89-10, Supplement 1, excluded air dampers from DP testing. Valves MO-0501 and MO-0510 were also deleted from the program. Failure of these valves to close resulted in no safety consequences to the plant. The valves do not have an active safety function and were not required to open as the main steam safety valves were relied on to reduce system pressure and temperature.

3.2 Design Basis Reviews

3.2.1 Differential Pressure and Flow Requirements

The inspectors reviewed the design-basis maximum expected DP calculations and found them to be acceptable. The piping diagrams; Final Safety Analysis Report (FSAR); technical specifications; normal, abnormal and emergency operating procedures (EOP), and other plant documents were reviewed to determine the worst case design basis conditions for the sample of MOVs reviewed. The conditions assumed were appropriate. Conditions resulting from a mispositioning of an MOV and the potential for thermal binding was also addressed in the design-basis documents (DBD). The DBDs appeared adequate.

3.2.2 Degraded Voltage Calculations

The inspectors reviewed the licensee's methodology for performing degraded voltage calculations for ac MOVs and concluded that the methodology was acceptable, pending minor corrections. No dc powered MOVs were used in safety-related applications at Palisades.

Calculations assumed an appropriate grid voltage based on a voltage corresponding to the second level under-voltage relay setpoint but did not account for the relay tolerances. Additionally, some of the calculations used a nonconservative power factor that was based solely on the assumption that the number would be conservative. The locked-rotor power factor values published by the vendor were not utilized. Cable temperatures used in the calculations reflected the conservative ambient temperatures and the motor current was assumed to be the locked rotor current.

The inspectors and the licensee staff recalculated the MOV terminal voltage using more conservative power factors and determined that the difference in motor terminal voltage was insignificant. Although the safety significance of this was minimal, the licensee was planning to revise the degraded voltage calculations to incorporate the degraded grid setpoint tolerance and conservative power factors. The calculations will be reviewed during a future inspection.

3.3 Design Basis Capability

3.3.1 MOV Sizing and Switch Settings

Progress was made since the Part 1 inspection towards completing engineering calculations for sizing and setting of MOV switches; however, there were errors in the methodology and calculations.

Palisades used the industry standard thrust equation to determine thrust requirements. Typical valve factors included 0.40 for gate valves and 1.10 for globe valves. A stem friction coefficient of 0.20 was typically assumed when determining actuator output thrust capability. A 12% margin was identified for load sensitive behavior. Pullout efficiencies were used in the determination of actuator opening capability and run efficiencies were used for the closing direction. Minimum thrust requirements for setting of actuator torque switches were adjusted to account for diagnostic equipment inaccuracy and torque switch repeatability and MOV degradation.

Adequate justification for the assumed valve factors was not available at Palisades. The use of a 0.40 valve factor for rising stem gate valves was supposed to be based on plant test data and the use of best available data from other sources. Plant test data was available for two MOVs that were dynamically tested in-situ prior to this inspection. The two dynamic tests were open hydrostatic tests with no system flow; therefore, the test results were of limited value. Further, MO-1042A (power-operated relief valve (PORV) block valve) was sent off-site for prototype testing in 1989. However, due to poor pressure data resolution and unreliable force measurements, an accurate valve factor could not be determined.

Therefore, based on the minimal on-site dynamic testing, unsuccessful prototype testing, and the limited attempts to obtain industry testing, the inspectors determined that the licensee did not have adequate justification for their assumed valve factors. The licensee agreed to consider the use of higher valve factors and perform DP testing to confirm the assumed valve factor.

Margins added to account for load sensitive behavior (LSB) and valve degradation were incorrectly characterized in the error analysis used to adjust the minimum thrust requirements. The LSB and valve degradation margins were included under the radical of the square root of the sum of the squares method. Section 4.4.1 of ANSI Standard ISA-S67.04, "Setpoints for Nuclear Safety-Related Instrumentation," specified that bias errors such as LSB and degradation margin cannot be combined in this manner because they are not random in nature.

The MOV thrust calculations specified a maximum allowed thrust limit designed to prevent structural damage caused by thrust due to inertia. However, the limit was not adjusted to account for diagnostic equipment uncertainty and torque switch repeatability. Additionally, the maximum actuator thrust limit, used to determine the target thrust window, was based on 250% of the published actuator thrust rating and the maximum actuator torque limit was based on 200% of the published actuator torque rating. Palisades personnel agreed that actuator limits should be based on a maximum of 140% of the actuator thrust rating and 110% of the actuator torque rating, as allowed by Limitorque. The licensee conducted a screening and determined that no unanalyzed overthrust conditions existed as a result of the errors. All applicable thrust calculations would be revised to properly incorporate all margins (LSB, valve degradation, diagnostic equipment inaccuracy, and torque switch repeatability) and to use the appropriate thrust and torque limits.

Stem friction coefficients measured during static tests did not exceed the assumed value of 0.20 with FelPro N5000 applied to the valve stems. Although the test results demonstrated the adequacy of the assumption for static conditions, none of the test data was obtained from dynamic testing. The stem friction coefficients present at flow isolation during dynamic tests should be evaluated to ensure that test results are applicable and a 0.20 is justified for design-basis conditions.

NRC Inspection Report No. 50-255/92014(DRS) discussed CPCo plans to evaluate the effects of high ambient temperatures on motor performance when applicable information was available from Limitorque. Limitorque issued Potential 10 CFR Part 21 condition, "Reliance 3 Phase Limitorque Corporation Actuator Motors (Starting Torque at Elevated Temperatures)," which was received by Palisades on May 22, 1993. Assessment of the impact of this Part 21 was originally scheduled for completion by August 1993. However, the initial evaluation to assess the impact on MOV operability was not completed until September 10, 1994, approximately one year later. The failure to timely evaluate the Part 21 issue was considered a violation of 10 CFR 50, Appendix B, Criterion XVI (50-255/94015-01a(DRS).

3.3.2 Differential Pressure and Flow Testing

The inspectors found the progress of DP testing to be inadequate. The licensee performed a minimal number of DP tests at the time of the inspection. This effort was not justified considering that several refueling outages and a lengthy forced outage provided opportunity for the testing. Furthermore, additional DP testing was not scheduled until the summer of 1995 and the licensee was not prepared to begin any DP testing should a forced outage occur.

The usable DP tests completed to date included two globe valves tested in 1991, and two gate valves tested in 1993. The gate valve tests were open hydrostatic tests with no significant flow. The DP testing was of limited use and did not completely demonstrate design basis capability nor did it provide data to justify GL 89-10 programmatic assumptions such as valve factor and LSB. Previous DP testing completed prior to GL 89-10 was reviewed and analyzed by the licensee in an attempt to take credit for these tests as part of their current program. However, based on the testing conditions and the quality of the data obtained, the inspectors deemed that the tests did not fully demonstrate design basis capability and were not usable to justify program assumptions. The failure to perform a significant amount of testing, five years after the issuance of GL 89-10, was an indication of poor program oversight by management.

The inspectors reviewed dynamic test packages and post-test review packages for the sampled MOVs. The dynamic test data was reviewed by the licensee using the industry standard equation, the valves' mean seat diameters, and the dynamic test conditions. This review indicated an opening valve factor of 0.64 for MO-3199 and 0.32 for MO-3190.

As identified above, the hydrostatic test of MO-3199 showed that the opening valve factor was 0.64, instead of 0.40 as assumed by the thrust calculation. The impact of this valve factor was not immediately assessed by the licensee's test evaluation. Further, the inspectors noted that the thrust calculation was not updated to use the higher valve factor. Although the higher valve factor did not affect the valve's ability to function, the inspectors were concerned that the original testing was not properly analyzed and the information was not fed back into the thrust calculations. The licensee indicated that revised test procedures have been developed to ensure that higher than assumed coefficients are identified and resolved with condition reports, and that any higher factors will be incorporated into revised thrust calculations. The inspectors will evaluate the use of these procedures during a future inspection.

In 1988, the licensee dynamically tested HPSI valves MO-3007, 3009, 3011, and 3013 for IEB 85-03. These tests were conducted with the first version of the MOVATS diagnostic equipment. Because the tested MOVs were globe valves with open-only safety functions, the licensee wanted to use these dynamic tests as part of their generic letter program. Inspectors requested to review the MOVATS traces to assess the choice of displacement values used in the evaluation of the IE 85-03 testing. However, the licensee was unable to provide any record of these traces. The licensee's diagnostic procedure specified that hard copies of the diagnostic traces were to be attached to the work order. The lack of computer-generated test traces that normally form the

basis for engineering analysis to demonstrate design-basis capability was considered a weakness in the licensee's GL 89-10 program.

The HPSI hot leg injection valves, MO-3082 and MO-3083, were DP tested in 1991 at approximately 99% of design DP. However, the acceptance criteria was not fully developed and the testing was never analyzed to determine actual margin or valve factor. The DP test results were not fully analyzed until the summer of 1994. The analysis evaluated data from the 1991 DP test as well as from 1993 static testing in an attempt to determine valve factor, torque switch trip margin, rate of loading, and as-left thrust acceptability. The 1991 DP test diagnostic traces indicated that the valve stem never experienced tension and therefore the trace could not be "truly" zeroed. To address this added uncertainty the licensee conservatively evaluated the traces. Based on the actuator's margin the inspectors did not have an operability concern. However, the tests were of limited use in justifying programmatic assumptions and in demonstrating complete design basis capability. The fact that the licensee did not fully analyze the 1991 test data until three years after the testing was considered to be another example of a violation of 10 CFR 50, Appendix B, Criterion XVI (50-255/94015-01b(DRS)).

3.3.3 Grouping

No formal grouping plan or method was in place at Palisades. Although discussed in the MOV program plan procedure EM-28-01, "Motor Operated Valve Program," Revision 2, the concept of grouping by application of the best available data, as addressed in Supplement 6, had not been fully applied. This was primarily due to the lack of on-site DP testing and limited attempts to obtain industry test data. Grouping will be reviewed during a future inspection.

The licensee wanted to group redundant high pressure safety injection (RHPSI) valves MO-3062, 3064, 3066, and 3068 to the above HPSI tests. The licensee attempted to justify the grouping based on a similar application of identical globe valves with flow over the seat. However, the inspectors considered this application to be inconsistent with the guidance of GL 89-10, Supplement 6. The HPSI test data was questionable given the diagnostic equipment inaccuracy and the test conditions were approximately 50% of the design-basis conditions identified. Therefore, the licensee was not grouping the RHPSI MOVs to valves where data was obtained from testing conducted at, or near, design-basis conditions. Further, the inspectors were concerned that degradations may have occurred since the HPSI testing was performed in 1988. Licensee personnel stated that Palisades would consider including these RHPSI and HPSI MOVs in the 1995 refueling outage test scope, to the extent necessary, to meet the guidance in Supplement 6 on grouping testable MOVs.

3.4 MOV Brakes

Motor brakes were not added to any MOV in the Palisades GL 89-10 program and therefore were not a concern.

3.5 Schedule

The licensee applied for a schedule extension to complete their GL 89-10 program. Initially, up to 18 DP tests not yet performed were included in the extension request; however, the licensee considered adding MOVs to the DP test

program. Additionally, the necessity for revised thrust calculations, degraded voltages calculations, and the amount of DP tests to be performed during the outage indicated a considerable amount of effort. The licensee indicated that all remaining DP tests would be performed and the design-basis capability of all MOVs in the GL 89-10 program would be confirmed prior to start-up following the 1995 refueling outage.

The approval of the extension request is dependent on the assurance that the MOVs would be capable of performing their design basis functions. Preliminary review of the valves included in the extension did not result in operability concerns. The licensee will pursue formal extension approval with NRR.

3.6 Periodic Verification of MOV Capability

Palisades planned to use static testing to periodically verify MOV design-basis capability. The use of static testing only to verify continued capability of an MOV to operate under worst case differential pressure and flow conditions had not been considered adequate because of the uncertain relationship between the performance of an MOV under static conditions and under design basis conditions. The 4 HPSI valves originally tested in 1988 as part of the IE 85-03 program were retested on a 5 year frequency using a static test. The licensee would be expected to identify and justify a method that verified design-basis capability would be maintained. Palisades personnel stated that the review method for periodic verification may include some level of dynamic testing.

3.7 Maintenance

The inspectors reviewed maintenance procedures involving the disassembly, inspection, repair, and assembly of various Limitorque operators; the adjustment of torque and limit switches; the lubrication of valve stems, and the packing of valves. The sampled procedures appeared to be adequate. Post-maintenance testing (PMT) specified for stem packing adjustments appropriately specified diagnostic monitoring of the valve during packing adjustment for all valves in the program. PMT was also appropriately specified depending on the type of maintenance performed.

The material condition of MOVs in the plant was good; however, two minor concerns were noted with the lack of a grounding strap on MO-3072 and a handwheel/support interference on valve MO-3198. Work requests were written for both deficiencies. No further concerns were noted.

3.8 MOV Failures, Corrective Actions, and Trending

A review of the licensee's disposition of MOV failures and deficiencies identified a weakness in the timeliness in handling MOV corrective actions, particularly when addressing MOVs that have experienced an overthrust or overtorque condition. For example:

- Four MOVs, MO-743, MO-760, MO-1043A, and MO-3072, were diagnostically tested during 1993, and were in a potential actuator overthrust condition due to failure to incorporate diagnostic system inaccuracies and torque switch repeatability errors. The actuator overthrust condition was identified approximately one month before the NRC inspectors' arrival. A condition report to evaluate the overthrust

condition was not generated until prompted by a discussion with the inspectors. The MOV actuators were overloaded 140% to 153% of the actuators' rated thrust. As discussed in Limitorque Maintenance Update 92-1 and NRC Inspection Report 99900100 (June 28, 1993), Limitorque recommends inspection of an actuator if it may have experienced multiple overloads of greater than 140% (or 162% where a specific Kalsi Engineering study is applicable) of the thrust rating for SMB-000 to 1 actuators, or greater than 120% of the thrust rating for other sized actuators. The licensee's failure to promptly identify and evaluate the overthrust condition of the four valves was considered another example of a violation of 10 CFR 50, Appendix B, Criterion XVI (50-255/94015-01c(DRS)).

During the inspection Palisades began the process of reviewing and ultimately implementing the Kalsi overthrust report into the Palisades MOV program. The Kalsi report would allow, with conditions, thrusts up to 162% of rated thrust.

- AFW SG FOGG Valve, MO-0759, was subjected to a motor stall condition twice during May of 1993. For both motor stall events, the overthrusts were adequately evaluated and addressed in their deviation reports' corrective actions. However, the actuator overtorquing (168% of rated torque) resulting from the motor stall condition was not evaluated. As indicated in Limitorque Maintenance Update 92-1 and NRC Inspection Report 99900100, Limitorque recommended actuator inspection when an actuator was torqued more than once above 120% of rated torque. Limitorque also recommended inspection of an actuator after any overload greater than 200% of rated torque. The NRC pointed out the lack of overtorque evaluation to the licensee who subsequently generated a condition report and contacted Limitorque. The licensee requested a technical interpretation from Limitorque on the actuators ability to continue operation for a maximum of ten strokes. However, Limitorque stated that the actuator unit could not continue service until an inspection was performed per "Limitorque Maintenance Update 92-1." The licensee subsequently rendered the valve inoperable and began processing a safety evaluation to allow plant operation with the inoperable valve.

  The licensee's failure to promptly identify and evaluate the overtorque condition of the valve was considered another example of inadequate and untimely corrective action in violation of 10 CFR 50, Appendix B, Criterion XVI (50-255/94015-01d(DRS)).

The licensee had not implemented a trending program for MOV failures. A data base was developed listing all pertinent information needed to perform trending; however, the program had not been proceduralized. Furthermore, the person assigned to the program implementation was leaving that position and a replacement had not been selected. The inspectors were concerned since the trending program was considerably behind implementation expectations for a GL 89-10 program. The trending program was also not listed in Palisades' MOV recovery plan as an action item. The lack of a trending program to identify MOV failures was considered a weakness.

The licensee had also not implemented a trending program that would monitor valve diagnostic parameters. The MOV program procedure EM-28-01, Revision 2, stated that selected diagnostic test data parameters such as thrust margin,

stem factors, and packing friction may be monitored; however, the licensee had not utilized this data for any trending purposes.

An implemented diagnostic or maintenance trending program could have identified and corrected the root cause for the multiple incidents of overthrusting of valves such as MO-0759 as identified earlier.

3.9 Pressure Locking and Thermal Binding

The potential for pressure locking and thermal binding of gate valves was examined in response to INPO SOER 84-7, "Pressure Locking and Thermal Binding of Gate Valves." None of the valves investigated were thought to be susceptible to pressure locking. Thermal binding was evaluated as part of the deign-basis reviews and documented in the DBDs. Thermal binding had occurred at Palisades; however, no valves were identified that might be required to open during an accident at colder temperatures, than would be seen during a surveillance test.

Additional evaluations to address the potential for pressure locking/thermal binding were in progress. The licensee was reviewing a methodology to calculate the capability to overcome pressure locking. Using calculations has not been endorsed by NRC and may not be adequate to demonstrate the capability of an MOV to overcome pressure locking. This issue will be reviewed and evaluated during a future inspection following issuance by NRC of generic correspondence on this issue.

4.0 Licensee Self-Assessment

The self-assessment efforts compared the program to specific NRC commitments and addressed the program from a reliability standpoint. Two relatively recent self-assessments were performed; one by plant personnel and another by an outside organization. Both assessments were self-critical; however, some followup corrective actions were deficient and untimely. For example, the lack of corrective actions in response to the Limitorque Part 21 regarding elevated temperature effects on motors (Section 3.3.1) was identified in a self-assessment conducted in November 1993, and still no corrective action was taken until September 1994.

5.0 Exit Meeting

The inspectors met with licensee representatives (denoted in Paragraph 1) at the conclusion of the inspection on September 30, 1994. The inspectors summarized the purpose and scope of the inspection and the findings. The inspectors also discussed the likely informational content of the inspection report with regard to documents or processes reviewed by the inspectors during the inspection. The licensee did not identify any such documents or processes as proprietary.