NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-483/94002(DRS)

Docket No. 50-483 License No. NPF-30

Licensee: Union Electric Company
Post Office Box 149 - Mail Code 400
St. Louis, MO 63166

Facility Name: Callaway Nuclear Power Plant

Inspection At: Callaway Site, Steedman, MO

Inspection Conducted: January 10 through 28, 1994

Inspectors: M. P. Huber — Date: 2/17/94

C. A. Gainty — Date: 2/17/94

NRC Consultant: M. R. Holbrook, Idaho National Engineering Laboratory

Approved By: J. M. Jacobson, Chief, Materials and Processes Section — Date: 2/18/94

Inspection Summary

Inspection on January 10 through 28, 1994 (Report No. 50-483/94002(DRS))
Areas Inspected: Announced safety inspection of the implementation of the licensee's response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve (MOV) Testing and Surveillance" (2515/109).
Results: This inspection focussed on the licensee's program implemented to address GL 89-10. Two inspection followup items were identified (Sections 3.7 and 3.9.3). No violations were identified. It appeared that the MOV program was implemented and addressed the recommendations of GL 89-10. The licensee indicated that a close-out letter would be forthcoming.

The licensee demonstrated a strength in the area of evaluating lubrication degradation (Section 3.9.1).

A weakness was noted with the licensee's MOV capability assessments (Section 3.2.2).

TABLE OF CONTENTS

DETAILS

1.0 Persons Contacted

Union Electric (UE)

D. F. Schnell, Senior Vice President, Nuclear
G. L. Randolph, Vice President, Nuclear Operations
J. Blosser, Plant Manager
J. V. Laux, Manager, Quality Assurance
R. D. Affolter, Superintendent, Nuclear Engineering/Design Control
J. A. McGraw, Superintendent, Nuclear Engineering/Systems
D. E. Heinlein, Supervising Engineer, Systems
R. A. Hamblen, Supervising Engineer, Electrical Controls and Design
F. W. Eggers, III, Supervising Engineer, Quality Assurance/Technical Support
H. D. Bono, Quality Assurance
G. Hughes, Supervising Engineer, Independent Safety Engineering Group
S. H. Reed, Engineer
M. A. Reidmeyer, Engineer
S. Petzel, Engineer
W. P. Muskopf, Engineer

U. S. Nuclear Regulatory Commission (NRC)

L. R. Wharton, Project Manager, Nuclear Reactor Regulation
S. Lee, NRR Intern

The personnel listed above attended the exit interview on January 28, 1994. The inspectors also contacted other licensee personnel during the inspection.

2.0 Licensee Action on Previous Inspection Findings (92701)

2.1 (Closed) Open Item (50-483/91020-01(DRS)): Power factors used in MOV degraded voltage calculations were not applicable to the installed motors and resulted in non-conservative evaluations. The licensee obtained the appropriate power factor values, revised the calculations, and evaluated the effect on MOV capability. No operability concerns were identified. This item was closed.

3.0 Inspection of the Implementation of the Program Developed in Response to Generic Letter 89-10

3.1 Program Scope

Two MOVs were added and five were removed from the GL 89-10 program since the initial GL 89-10 inspection conducted in January 1992. Removal justification was reviewed and found to be consistent with the recommendations of GL 89-10. 150 MOVs remain in Callaway's GL 89-10 program.

3.2 Design Basis Reviews

3.2.1 Differential Pressure and Flow Requirements

The inspectors reviewed the licensee's design basis maximum expected differential pressure calculations and found them to be acceptable.

3.2.2 Degraded Voltage Calculations

Two errors were identified in the licensee's method for calculating MOV capability at degraded voltage: (1) The licensee assumed that actual running loads would always be less than the standard industry values when determining the total thrust requirements. For several MOVs, the actual running loads were actually higher, in some cases significantly higher than the standard industry values. (2) For butterfly valves, the "reduced voltage term" in the standard Limitorque equation used to determine MOV capability at degraded voltage was not squared as required for AC motors. This appeared to be an oversight because the gate and globe MOV capabilities at degraded voltage were calculated properly.

Based on the two methodology errors discussed above, this area was considered a weakness of the program. However, the licensee's well organized and integrated program and spread sheets allowed a prompt determination of the effect of the errors on MOV operability and available margin. No operability concerns were noted and the licensee agreed to revise the calculations and incorporate acceptance criteria for running loads during future testing.

Information from Limitorque's Technical Update 93-03, issued September 1993, was incorporated into calculations ZZ-214, Revision 3 and ZZ-224, Revision 2, for evaluating AC motor operator output capability. Technical Update 93-03 was issued by Limitorque Corporation to provide guidance in addressing a potential 10 CFR 21 condition dated May 13, 1993 regarding the reduction in MOV 3-phase AC motor torque output at elevated temperatures.

3.3 Design Basis Capability

3.3.1 MOV Switch Settings

The licensee's GL 89-10 program focus was on performing DP tests (where practicable) to obtain data for the thrust requirements, instead of using thrust calculations. As-found dynamic testing was performed to obtain spring pack displacement, which was then converted to the DP thrust requirement. MOVs were instrumented with the MOVATS Displacement Measuring Transducer (DMT) during dynamic testing and the data was used to determine the amount of spring pack displacement required to overcome differential pressure effects and stem rejection. A subsequent static test was performed using the MOVATS Torque Thrust Cell (TTC) to correlate the spring pack displacement obtained during the dynamic tests to the output thrust. The thrust was extrapolated to design basis conditions (when necessary) and adjusted to account for diagnostic equipment uncertainties and torque switch repeatability. The licensee expects to utilize information from the Electric Power Research Institute's (EPRI)

Performance Prediction Program as part of a justification for the extrapolation methods. The inspectors considered the extrapolation to be the first stage of a two stage approach where the valves have been setup using the best available data.

A second static test was used to ensure that the thrust available at torque switch trip (TST) was in a thrust window based on the adjusted minimum required thrust (determined from the DP and static baseline tests) and the MOV's degraded voltage capability and structural limits. Twenty-five percent additional margin was added to the minimum required when available. Some MOVs were modified to increase their capability and meet the goal of 25% additional margin. Other MOV modifications were being considered by the licensee.

The capability analysis assumed a stem friction coefficient of 0.20 in most cases. The TTC was used to determine the static stem friction coefficient at TST. Static stem friction coefficients were as high as 0.18 and the average was less than 0.15, but less than the 0.20 assumed in the capability analysis. The licensee will need to demonstrate that its assumption for stem friction coefficient was appropriate for flow isolation in light of its measurement of this value at TST.

The licensee does not quantify apparent valve factors, dynamic stem friction coefficients and the amount of load sensitive behavior. Since torque and thrust were not measured during DP tests, only a rough estimate for variables listed above could be calculated. The DP test methodology apparently accounts for losses because the DP thrust determines the required thrust, versus a calculation with variables that need to be quantified. One assumption inherent to the test methodology was that the dynamic stem friction coefficient was always the same, or worse, than that measured during static baseline test. If the stem friction coefficient improved under design basis conditions, a lower thrust requirement would be derived. The licensee indicated that the thrust requirement derived for an MOV that was DP tested was the thrust required for that valve and therefore, if the efficiency improved under dynamic conditions, then the required thrust was lower but still accurate. However, if this data was applied to other non-testable MOVs, it may be non-conservative, but it still may be the best available data for a group. Use of the data for MOV groups should be continually evaluated by the licensee to ensure that best available data was used.

One concern identified was that the methodology appeared to assume no change in spring pack behavior between the as-found dynamic test and the subsequent static baseline test. The licensee documented a maintenance history review to ensure that modifications to the spring pack and/or actuator occurring between dynamic and static baseline tests which could affect the validity of the DMT data were properly addressed. The review indicated that four MOVs were modified between dynamic and the static baseline testing. Two were being scheduled for new dynamic tests. There was no plans for additional testing of the remaining two MOVs. It appeared that margin was available to account for potential differences between dynamic and static baseline tests for these valves. The inspectors concurred that the MOVs had considerable margin, however, the licensee should provide additional data, if possible, to justify the position.

During review of the diagnostic equipment error analysis incorporated in program procedures, the inspectors noted that the calculation for determining minimum available torque at TST contained a sign error that could result in a non-conservative value. The licensee reviewed their computerized error analysis spreadsheet and verified that this was only a typographical error. Further, a revision was initiated to correct procedure.

The diagnostic equipment error was recently revised to account for the various combinations of sensors used during testing, resulting in increased errors associated with the equipment in some cases. Plant personnel stated that torque switch settings were informally reviewed and no potential operability concerns resulted from the new errors. The licensee planned to document the conclusions from the review.

3.3.2 Differential Pressure Testing Scope

103 MOVs, the total number practicable, were tested under DP conditions with system flows. Test procedures were written to achieve the maximum flow rate possible using the system pumps and configurations. Justifications were written for MOVs that could not be DP tested. Twelve MOVs that were DP tested did not meet the licensee's criteria for use of linear extrapolation of the DP test results to design basis conditions. Best available data was applied to these valves to determine their design basis thrust requirements.

3.3.3 MOVs Not Practicable to DP Test

Valves were grouped at Callaway to apply the best available data to MOVs that could not be dynamically tested. Some valves were in groups where DP thrust requirements were taken directly from other dynamically tested MOVs. The licensee used the industry standard thrust equation to determine thrust requirements for those valves that could not be dynamically tested, or would not have in-plant dynamic test data applied. Valve factors of 0.40 to 1.0 for wedge gate valves, 0.40 for parallel disc gate valves, and 1.10 for globe valves were used. Actuator output thrust capability was evaluated with an assumed stem coefficient of 0.20. A margin of 15% was added for MOV load sensitive behavior, for those valves not setup with in-plant dynamic test data.

3.4 MOV Brakes

MOVs at Callaway were not equipped with motor brakes, therefore there was no concern in this area.

3.5 Evaluation of Test Data and MOVATS Traces

The inspectors reviewed procedures, dynamic test packages, static test results and Performance Prediction Reports for the selected valves. The test conditions were as follows:

VALVE	CLOSE DP (psid)	% DESIGN BASIS	OPEN DP (psid)	% DESIGN BASIS
ALHV0007	1599	93	1599	93
ALHV0011	1624	94	1624	94
BGHV8106	2572	94	2572	94
EGHV0060	94	84	94	[illegible]
EJHV8716A	184	81	184	81
FJHV8716B	189	83	189	83
EMHV8923B	180	83	180	356

A review of the test packages for EGHV0060 determined that the valve failed to fully stroke during the original as-found DP test conducted May 12, 1989. The torque switch was adjusted and the MOV successfully passed a retest conducted at 88 psid (102% of design basis DP). This MOV failure was reported under a licensee event report (89-009-00). In December 1990, the packing was replaced and running loads were reduced approximately 3600 pounds. Because of this, the licensee reduced the torque switch setting from 3 1/8 to 3.

During refuel outage 5 (March 1992) when the valve was not required to be in service, EGHV0060 did not fully close against flow conditions when stroked by operations personnel. A DP test with diagnostics was conducted to determine the cause of the failure. As part of this testing, the torque switch was repeatedly increased until a setting of 3 3/4 was reached and the MOV stalled out due to full compression of the spring pack. At this time, the valve and actuator were disassembled and the spring pack was replaced with a heavier one. SOS-92-1011 was generated to evaluate the over thrust/over torque condition. The actuator internals inspection did not detect any stress or wear-related problems. However, excessive wear in a non-stellited portion of the valve was noted during the valve internals inspection. The valve problems were repaired and like valves were inspected for similar conditions. No other problems were identified.

After repair of the valve internals, a dynamic test was successfully conducted with the TTC installed. Based on this test data, EGHV0060 experienced 19% load sensitive behavior, an increased stem friction coefficient and a valve factor of 0.74 under cold water conditions. The licensee indicated that all sister valves were successfully dynamically tested. Plans were also in place to modify the valve internals in an attempt to reduce the valve factor. Licensee actions appeared adequate.

3.6 Schedule

The Callaway MOV program progressed in accordance with the established schedule. It appeared that the GL 89-10 recommendations were adequately implemented. All DP and static baseline testing for MOVs in the GL 89-10 program were completed. Best available data has been used for sizing and switch settings for MOVs where valve specific DP test data could not be used. Work was expected to continue to address generic industry concerns.

3.7 Periodic Verification of MOV Capability

Design basis capability of MOVs will be reverified with static diagnostic tests except in cases where valve maintenance performed may affect the thrust required to close or open a valve against design differential pressure. The licensee made several assumptions in an attempt to justify why static testing would be adequate. Since the EGHV0060 dynamic test failure was apparently caused by internal valve degradation that was not detected when tested statically, it would indicate that static testing alone may not be adequate for purposes of periodic verification. The licensee continued to review a course of action to resolve this issue. This was considered an inspection followup item (50-483/94002-01(DRS)).

3.8 MOV Failures, Corrective Actions and Trending

The NRC inspectors reviewed problem reports associated with recent MOV failures. The failures appeared to be properly diagnosed and corrective actions appeared effective. The licensee was trending MOV problems, parameters and test data.

3.9 Associated Reviews

3.9.1 Maintenance

The MOV lubrication frequency (18 months) was consistent with the manufacturer's recommendation. Additionally, the licensee had completed a considerable amount of as-found static tests and as-left static tests to perform an assessment of lubrication degradation at the Callaway plant. Written justification was being developed by the licensee. This area was considered a program strength.

3.9.2 Walkdown

The inspectors performed a general plant inspection and a detailed inspection of approximately 20 MOVs. Valve stems appeared to be well lubricated and the MOV's exterior conditions were acceptable. Housekeeping was also acceptable.

3.9.3 Pressure Locking and Thermal Binding

The inspectors concluded that more evaluation would be required to completely address the functionality of the MOVs that were considered to be susceptible

to pressure locking and/or thermal binding. The assessment of the potential for pressure locking and thermal binding was documented in document UOMNE 93-164, dated August 19, 1993 and concluded that several valves were subject to pressure locking and/or thermal binding. However, plant personnel decided that the phenomenon had not occurred at the Callaway plant, and should it occur in the future, procedural directions and administrative controls would be sufficient to address the problem. The inspectors advised the licensee that their conclusion was not completely justified and the licensee indicated their intent to further review this item. The issue of pressure locking/ thermal binding was considered an inspection followup item pending further review (50-483/94002-02).

3.9.4 Training

The training program for engineers and technicians performing work on MOVs appeared to be acceptable. Personnel working in the area of MOVs were knowledgeable, professional and proficient.

4.0 Licensee Self-Assessment

The inspectors reviewed two quality assurance audits and one recent surveillance report related to MOV testing. In general, the efforts in this area were considered to be good. The audits were thorough in scope and detail and there were a number of good, technical findings. Findings appeared to receive appropriate attention, were resolved promptly and were tracked for closure by the licensee's SOS system.

5.0 Inspection Followup Items

Inspection followup items involve activities which were not completed within the inspection period; where additional inspection was necessary and planned. Inspection followup items are discussed in Sections 3.7 and 3.9.3.

6.0 Exit Meeting

The inspectors met with licensee representatives (denoted in Section 1.0) at the conclusion of the inspection on January 28, 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 identified some documents as proprietary, however, those documents were not included in the report. None of the documents or processes included in the report were identified as proprietary.

ATTACHMENT 1

CALLAWAY VALVE DATA

VALVE NUMBER	VALVE SIZE AND MANUFACTURER	TEST CONDITIONS	DYNAMIC VALVE FACTOR	STEM FRICTION COEFFICIENT*	LOAD SENSITIVE BEHAVIOR**
ALHV0007 MOTOR DRIVEN AUXILIARY FEEDWATER PUMP (MDAFP) TO STEAM GENERATOR (S/G)	4" MASONEILAN 900' GLOBE	1599 psid (c) 1599 psid (o)	UNAVAILABLE	0.13 (STATIC)	UNAVAILABLE
ALHV0011 MDAFP TO S/G C	4" MASONEILAN 900' GLOBE	1624 psid (c) 1624 psid (o)	UNAVAILABLE	0.14 (STATIC)	UNAVAILABLE
BBHV8000A PRESSURIZER POWER OPERATED RELIEF VALVE BLOCK VALVE	3" WESTINGHOUSE 1525' FLEX WEDGE GATE	STATIC TEST ONLY	UNAVAILABLE	0.13 (STATIC)	UNAVAILABLE
BBPV8702B RCS LOOP 4 HOT LEG TO RHR PUMPS ISOLATION	12" WESTINGHOUSE 1525' FLEX WEDGE GATE	STATIC TEST ONLY	UNAVAILABLE	0.14 (STATIC)	UNAVAILABLE
BGHV8106 CVCS CHARGING HEADER TO REGENERATIVE HEAT EXCHANGER CONTAINMENT ISOLATION	3" WESTINGHOUSE 1525' FLEX WEDGE GATE	2572 psid (c) 2572 psid (o)	UNAVAILABLE	0.10 (STATIC)	UNAVAILABLE
EGHV0060 COMPONENT COOLING WATER FROM RCS INBOARD CONTAINMENT ISOLATION	12" ANCHOR/DARLING 150' DOUBLE DISC GATE	94 psid (c) 94 psid (o)	0.74 (c)***	0.09 (STATIC) 0.13 (DYNAMIC)	16%
EJHV8716A RHR TRAIN A SI SYSTEM HOT LEG RECIRCULATION ISOLATION	10" WESTINGHOUSE 316' FLEX WEDGE GATE	184 psid (c) 184 psid (o)	UNAVAILABLE	0.10 (STATIC)	UNAVAILABLE
EJHV8716B RHR TRAIN B SI SYSTEM HOT LEG RECIRCULATION ISOLATION	10" WESTINGHOUSE 316' FLEX WEDGE GATE	189 psid (c) 189 psid (o)	UNAVAILABLE	0.07 (STATIC)	UNAVAILABLE
EMHV8923B REACTOR WATER STORAGE TANK TO SI PUMP SUCTION ISOLATION	6" WESTINGHOUSE 150' FLEX WEDGE GATE	180 psid (c) 180 psid (o)	UNAVAILABLE	0.12 (STATIC)	UNAVAILABLE

* No instrumentation was used to obtain stem friction coefficient under dynamic conditions. The stem lubricant used was Mobilux EP-1.

** No instrumentation was used to obtain this data except for EGHV0060.

*** Calculated based on stated valve size of 12".

c - Closed direction

o - Open direction