U. S. NUCLEAR REGULATORY COMMISSION
REGION I

DOCKET/REPORT NOS.: 50-333/95-20

LICENSEE: New York Power Authority (NYPA)
Lycoming, New York

FACILITY: James A. Fitzpatrick Nuclear Power Plant
Scriba, New York

DATES: October 23-27, 1995

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TABLE OF CONTENTS

JAMES A. FITZPATRICK MOV INSPECTION 95-20
(October 23-27, 1995)

EXECUTIVE SUMMARY

The management oversight of the Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," program was effective. Notable strengths included the high percentage of valves (relative to boiling water reactors generally) that were dynamically tested, detailed program scope evaluations, and use of diverse methodologies to independently verify design-basis calculations.

Program documentation and test data provided an adequate basis to conclude that all safety-related MOVs would perform their intended safety functions under worst-case design-basis conditions. The NRC has determined that the actions to verify the design-basis capability of all GL 89-10 program MOVs were complete.

Open issues from previous NRC inspections were resolved based on review of action and commitment tracking system documentation and independent calculations performed by the inspectors. An unresolved item (**URI 93-80-02**) concerning potential failure of valve actuator motors under severe degraded voltage conditions was closed.

Independent oversight of the MOV program by the Quality Assurance (QA) organization was minimal. However, a thorough, critical self-assessment of the program was performed with QA participation.

DETAILS

1.0 INTRODUCTION AND PURPOSE

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

The NRC conducted the Part 1 inspection at James A. Fitzpatrick (JAF) in February 1993, as documented in NRC Inspection Report (IR) 93-80. A Part 2 inspection, conducted in February 1994, was documented in NRC IR 94-02. The purpose of this inspection was to follow-up the items identified during the Part 1 and 2 inspections, and to closeout the GL 89-10 program at JAF.

2.0 PROGRAM IMPLEMENTATION

2.1 Program Status and Scope

Generic Letter 89-10 requested that licensees notify the NRC in writing within 30 days after the MOV design-basis reviews, analyses, verifications, tests, and inspections have been completed. In November 1994, NYPA requested a six-month extension to its original MOV program schedule commitment date. An extension to August 31, 1995 was approved by the NRC in January 1995. In a letter dated August 24, 1995, NYPA notified the NRC that these items were complete.

The GL 89-10 program at JAF included 87 MOVs. Forty-nine (49) valves within the current program scope were tested dynamically. The licensee's criteria for removal of valves from the program were contained in procedure JAF-RPT-MULTI-00746, "Generic Letter 89-10 Motor-Operated Valve Program Plan," Appendix 6.2. The inspector found that the exclusion criteria were consistent with the guidance in GL 89-10 and its supplements. The licensee's evaluations were technically sound and well documented.

2.2 Design-Basis Reviews

The inspector assessed the quality of the licensee's MOV design-basis reviews by evaluating calculations for differential pressure, minimum motor terminal voltage, direct current (DC) MOV stroke time, and pressure locking of flexible wedge gate valves.

Differential Pressure

JAF performed Operating Conditions Evaluations (OCEs) to determine the worst-case design-basis differential pressure for each MOV in the program. NRC Inspection Report 93-80 documented that the licensee had not incorporated design-basis flow and fluid temperature into its OCEs. The inspector observed that JAF assumed fluid temperatures so as to maximize the density effect on calculated differential pressure. In addition, the pressure effects due to flow momentum were factored into the calculations where the pressure wave was determined to propagate before significant valve closure. The inspector concluded that the licensee adequately addressed this item by using in its OCEs conservative assumptions that were consistent with the guidance provided in the GL and its supplements.

Motor Terminal Voltage

JAF determined minimum MOV motor terminal voltage using a voltage divider method that considered cable length and type, thermal overload heater resistance, and locked rotor current. When applicable, the published locked rotor current was derated to account for increased circuit resistance due to elevated ambient temperature. For alternating current (AC) motors, JAF used the minimum motor control center voltage corresponding to the degraded grid relay settings. For the DC motors, the licensee utilized battery terminal voltage derived from the design-basis accident battery duty cycle as the starting point for the voltage divider calculations. Maximum current, minimum motor terminal voltage, and available motor torque then were determined using the methodology provided in Limitorque Maintenance Update 88-1. Generic motor curves provided by Limitorque Corporation were adjusted in the conservative direction to account for uncertainty. The licensee verified the results of each MOV stroke time calculation by performing independent calculations using an alternate methodology. The inspector noted that the results of the different calculations agreed well, and considered the diverse independent verifications to be a program strength.

Pressure Locking of Gate Valves

As documented in NRC Inspection Report 94-02, JAF dispositioned two susceptible MOVs (high pressure coolant injection valve 23MOV-19 and reactor core isolation cooling valve (RCIC) 13MOV-21) as having sufficient thrust capability to overcome pressure locking forces without valve modification. Subsequently, JAF similarly evaluated RCIC turbine steam inlet valve 13MOV-131. To determine thrust required to overcome pressure locking forces, the licensee utilized a methodology similar to that developed by Grand Gulf (Entergy method), but refined to account for wedge stiffness (bending, shear, and hub stretching loads). The inspector reviewed the licensee's calculations and confirmed the results through independent calculation. The inspector noted that JAF used valve factors derived either from testing of similar valves (adjusted for instrument inaccuracies) or best available industry information. Unwedging thrusts were taken from peak thrust indicated on diagnostic (VOTES) traces. Since the thrust values were out of the calibration range of the sensing equipment, the licensee adjusted the values upward in accordance with Liberty Technology, Incorporated's Customer Service

Bulletin 031. The licensee's evaluations used stem factors derived from an assumed stem coefficient of friction (COF) of 0.15. This value was approximately the mean plus one standard deviation of the licensee's test results. The inspector reviewed the capability of valves 23MOV-19, 13MOV-21, and 13MOV-131 using a more statistically appropriate stem COF of 0.17 (mean plus two standard deviations). The inspector noted that valve 13MOV-131 had only a small thrust margin. While the results of the licensee's evaluations were acceptable for the interim, the inspector informed the licensee that additional MOV capability would need to be demonstrated if the intent was to rely solely on that capability as a long-term solution. The licensee planned to replace valve 13MOV-131 with a globe valve during the next refuel outage.

Based on the preliminary review, the inspector did not identify any significant concerns regarding JAF's pressure locking evaluations. The generic issue of pressure locking and thermal binding of MOVs is open, however, pending NRC review of the licensee's response to Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," and is not considered to be a GL 89-10 program closure issue.

2.3 Operator Sizing and Switch Settings

Generic Letter 89-10 requested licensees to establish correct MOV switch settings using the results of the design-basis reviews. This entailed establishing a program to evaluate and revise, as necessary, the methods for selecting and setting switches for each valve operation. The inspectors reviewed procedure JAF-RPT-MULTI-00746, "Generic Letter 89-10 Motor-Operated Valve Program Plan," NYPA technical position papers, and other documents pertaining to the assumptions used in the GL 89-10 program, including evaluations of valve factor, stem friction coefficient, and load sensitive behavior. The program plan contained several tables that listed the MOVs by valve number, size, valve factor, thrust margin, and group. From these tables, the inspectors selected a valve sample that included examples used in JAF's program to verify design-basis capability. These methods included verification by: (1) valve-specific dynamic test at or near design-basis conditions, (2) valve-specific test, extrapolated to design-basis conditions, and (3) plant-specific data or industry data applied via grouping to MOVs that were not practicable to test. The inspectors reviewed the documents for the following MOVs:

10MOV-16A	Residual heat removal "A" minimum flow isolation
10MOV-26A	Residual heat removal "A" containment spray outboard isolation
10MOV-89B	Residual heat removal heat exchanger "B" service water outlet isolation
13MOV-131	Reactor core isolation cooling turbine steam inlet

Additional valves in the reactor water cleanup, high pressure coolant injection, and reactor core isolation cooling systems (GL 89-10, Supplement 3 valves) also were reviewed.

Calculations

JAF's thrust and torque calculations utilized the standard industry equations. Mean seat diameter was used to calculate valve seat area. A minimum valve factor of 0.50 typically was assumed for gate valves. In several cases in which test results or industry data indicated that more conservative values were necessary, higher valve factors were used. A valve factor of 1.1 was assumed for determining the thrust requirements for globe valves. To account for load sensitive behavior, JAF applied a margin (bias) of 1.83 percent (%) and included a random margin of 14.3E% derived from the square root of the sum of the squares (SRSS) of uncertainties such as diagnostic equipment error, torque switch repeatability, and spring pack relaxation. A stem friction coefficient (COF) of 0.17 was used to determine actuator output thrust.

Valve Factor and Grouping

The licensee divided its MOV population into 17 valve groups. Each group was based on valve type and manufacturer. Within a group, valve size and ANSI pressure class ratings varied, creating "sub-groups" within the initial group. The licensee typically used in-plant testing to justify the valve factors applied to non-dynamically tested MOVs. In other cases, Electric Power Research Institute (EPRI) or industry data was used to justify the valve factors applied. However, in a few instances, JAF had no directly applicable plant specific, industry, or EPRI data to validate the chosen valve factor. However, the inspector concluded that JAF's evaluations provided adequate assurance of design-basis capability. These cases are discussed below:

Valve groups 3.1.1, 3.2.2, and 3.2.3 contained globe valves of different sizes, manufacturers, and pressure classes, which could not be tested dynamically. A valve factor of 1.1 was assumed for these valves. Program closure was based on the large thrust margins available in both the open and close directions. The margins accounted for diagnostic equipment uncertainties, torque switch repeatability, and load sensitive behavior. The lowest margin was 82% (valve 10MOV-31B), and most margins exceeded 200%.

Valve group 3.2.1 consisted of two 3-inch, 900 psi, Borg-Warner Y-Globe valves that were categorized as "not meaningful to test." These were the only valves in the JAF program to be so designated, and the license was considering dropping the category from its program. The valves were justified on the basis of large thrust margins; assuming a valve factor of 1.1, both valves had a close margin of 800% and an open margin of 1000%.

The licensee had four butterfly valves in its program. Valve group 1.0 consisted of 2-inch ("), 4", and 12" Fisher Control butterfly valves. JAF used a calculation based on EPRI NP-7501, "Application Guide for Motor-Operated Butterfly Valves in Nuclear Power Plants," as a reference. The minimum margin for these valves in the close direction was 53%, and in the open direction 140%. The available margin constituted the basis for program closure of these MOVs, and the inspectors considered the basis to be acceptable. However, JAF will be expected to review the NRC Staff's comments on the EPRI Performance Prediction Model (PPM) as it applies to butterfly valves, and to address that information as appropriate.

Valve group 2.1.2 consisted of 3", 4", 8", and 10", 150 psi and 900 psi Velan flexible wedge gate valves. The licensee used a graph that correlated valve factor to valve size, and utilized linear regression analysis to derive a valve factor curve. Other curves were plotted to indicate two standard deviations of the data. A value of 0.00015 per pound of test pressure was added or subtracted to the valve factors depending on the design-basis differential pressure of each valve. The pressure adjustment was based in information from the EPRI Performance Prediction Program. Typical valve factors were 0.7 (close direction) and 0.5 (open direction). Subsequent in-plant dynamic testing of eight MOVs in this group validated the conservatism of the curves. The inspectors concluded that the dynamic testing provided an adequate basis for program closure of these MOVs.

Valve group 2.3.1 consisted of 3", 4", 6", 10", 16", and 20" Anchor Darling double disk gate valves of various pressure classes. The valve factors applied to these MOVs ranged from 0.5 to 0.61, and were based on in-plant testing and a study initiated by the licensee. The study looked at valve seat-disk friction of Deloro 50 seating material. Subsequent dynamic testing by JAF confirmed that the valve factors derived from the study were conservative.

Based on review of available thrust margins and discussions with JAF technical personnel concerning the use of EPRI test data and the EPRI PPM, the inspector concluded that the licensee's actions were adequate for program closure. The licensee will need to review its use of EPRI test data based on the NRC staff's conclusions on the EPRI PPM to be discussed in a future safety evaluation.

Load Sensitive Behavior

The inspectors reviewed the licensee's evaluation of load sensitive behavior. JAF's data was compiled from 27 dynamic tests. In the evaluation, the licensee determined that mean load sensitive behavior was 1.83%, with a standard deviation of 7.19%. As applied to non-dynamically tested MOVs, the mean was added as a bias error (added directly to other margins), and the value of two standard deviations was included as a random error along with other random equipment uncertainties using the SRSS method. The inspector noted that if the load sensitive behavior value for a particular test was less than the equipment uncertainties and the value of torque switch repeatability, the licensee applied it to the particular valve, but did not include it in the statistical analysis. The inspector requested that the licensee recalculate the mean and standard deviation values using all of the available data. The recalculated mean was 2.93% with a standard deviation of 7.9%. JAF personnel initiated a tracking item to correct the mean and standard deviation values used in the program. As a result, the thrust capability margins of two MOVs fell below the licensee's administrative limit of 20%. The licensee informed the inspector that the MOVs would be placed on the schedule for the upcoming outage to raise the torque switch settings and that monitoring for stem lubricant degradation would be increased. The inspectors concluded that the licensee had addressed load sensitive behavior adequately.

Stem Friction Coefficient

JAF did not measure torque during the early stages of the MOV program, and thus initially set up its MOVs using an assumed stem COF of 0.2. Validation of this assumption through testing was an open issue in a previous NRC inspection report (IR 94-02). Currently, the licensee measures torque whenever possible, and has also determined the mean and the standard deviation of the available static baseline test results for stem COF. The mean was found to be 0.119 with a standard deviation of 0.0241, resulting in a mean plus two standard deviations of 0.1686. JAF intends to use a value of 0.17 in the future, and to continue to monitor stem COF as part of its periodic verification program. The licensee also is comparing stem COFs derived from dynamic MOV tests with the existing values (particularly in the open direction) and making adjustments as necessary. The inspector concluded that the licensee's tests validated the initial stem COF assumption.

2.4 Design-Basis Capability

The inspectors reviewed procedure MP-059.37, "Analysis of MOV Diagnostic Testing Using Liberty Technologies VOTES System," valve test packages, and the methodologies used by the licensee to confirm MOV operability.

Capability Margin

The licensee assessed MOV capability margin by calculating the valve factor from a dynamically tested valve. If larger than previously assumed, the new value was fed back into the original design-basis calculation and a new minimum required thrust was determined. JAF adjusted the new thrust value for torque switch repeatability, diagnostic system uncertainties, load sensitive behavior, and spring pack relaxation as appropriate. For the close direction, the thrust value at torque switch trip was compared to the recalculated minimum required thrust. For the open direction, valve actuator capability was compared to the new required thrust. JAF administratively required a minimum margin of 20% for these comparisons. (Torque and thrust values also were evaluated against valve structural limits.) In addition, the margin had to account adequately for a potential degradation of 0.05 in stem COF. MOVs which failed to meet the criteria received additional engineering evaluation. The inspector reviewed a sample of the evaluations and identified no operability concerns.

Linear Extrapolation

NYPA developed several position papers and guidelines regarding linear extrapolation of dynamic test data. Licensee personnel stated that linear extrapolation at JAF was limited to tests performed at greater than or equal to 80% of design-basis differential pressure. With the exception of valve 13MOV-18, the inspector verified that the dynamic tests at JAF met this guideline. Valve 13MOV-18 was tested at 63% of design-basis differential pressure with a capability margin of 123%. The inspector considered the valve to be acceptable.

The inspector reviewed the design-basis dynamic test data for valve 10MOV-16A to evaluate the licensee's extrapolation method and the engineering reviews that were performed prior to returning the valve to service. The inspector noted that JAF's method adjusted the original design-basis thrust calculation to account for the difference between test differential pressure and the design-basis differential pressure. The adjusted value was compared to the thrust measured at flow cutoff. If the thrust measured at flow cutoff were less than the calculated value, the licensee reasoned that the calculation's assumptions were conservative, and that the valve could be returned to service. The inspector was concerned that this method did not consider the actual thrust margin available under dynamic conditions based on the torque switch setting. For example, if the load sensitive behavior present during the dynamic test was much larger than that assumed in the design calculation, this condition would not be detected prior to returning the MOV to service. Also, the selection of a flow cutoff point is not always reliable. Finally, the inspector found that actual values of valve factor and load sensitive behavior were being determined by engineering personnel in separate analysis packages. Based on review of evaluation completion dates, the inspector determined that the packages typically were completed prior to returning MOVs to service. However, the licensee's procedures did not require that this be done. The licensee initiated procedure changes that adequately addressed these concerns.

2.5 Periodic Verification of Design-Basis Capability

Generic Letter 89-10 requested licensees to develop methods to verify periodically that MOV degradation or control switch misadjustment has not occurred. Consistent with the GL guidance, the JAF program calls for as-found and baseline static diagnostic testing on a three refuel outage frequency in conjunction with detailed motor-actuator inspections. In addition, the licensee intends to perform limited dynamic testing to reverify valve factors and design-basis capability margins. The periodicity of these tests varies between three and six refuel outages, depending on the risk significance and margin of each MOV. The inspector concluded that the licensee's program met the intent of the GL for this item.

The inspectors did not determine the acceptability of JAF's periodic verification plans. The NRC ultimately will review this aspect of the MOV program following issuance of a generic letter. The licensee should review its program in light of the new GL and consider any appropriate adjustments. For example, the licensee should consider the benefits (such as identification of decreased thrust output and increased thrust requirements) and potential adverse effects (such as accelerated aging or valve damage) when establishing periodic tests for each GL 89-10 MOV.

2.6 Failure Analysis and Trending

The NRC's previous review and acceptance of JAF's MOV failure analysis and trending program were documented in NRC Inspection Report 93-80. The conclusions were confirmed during this inspection. The JAF MOV group reviews MOV maintenance documents and enters as-found adverse conditions and cause codes into a computerized database (LONDON) that is maintained by the

Preventive Maintenance Engineering Group. The licensee periodically evaluates this information to identify and correct recurring problems. The inspector concluded that the licensee's provisions for tracking and trending MOV performance were acceptable for GL 89-10 program closure.

3.0 PREVIOUS MOV PROGRAM ITEMS

The inspector reviewed unresolved and open followup items regarding programmatic issues identified during previous MOV inspections. In addition to the issues addressed in preceding sections of this report, the following items were closed during this inspection:

Potential Stem Lubrication Degradation

The licensee's periodic verification program includes evaluation of as-found and as-left static baseline test results to ensure that stem lubrication preventive maintenance practices maintain stem friction COFs within the bounding design value.

Torque Switch Repeatability

JAF had not implemented a 20% margin for torque switch repeatability where specified by Limitorque Maintenance Update 92-02, and intended to develop its own values through a series of static tests. Subsequently, the licensee adopted the Limitorque recommendation.

Weak Link and Seismic Analysis

JAF's program had not completed its seismic and weak link analyses and incorporated the results into design-basis thrust calculations. The inspector verified that the analyses were completed, and that the appropriate structural limits were used to establish maximum thrust and torque values.

Post-Maintenance Testing

The licensee's procedures did not provide for dynamic testing following maintenance that could significantly change valve performance. The inspector confirmed that administrative procedure AP-05.07, "Maintenance Testing and Post-Work Testing," was revised to include dynamic testing when appropriate. The post-maintenance testing provisions in the procedure were consistent with recommendation "f" of GL 89-10.

Dynamic Testing of Valves 10MOV-66A and 10MOV-66B

Dynamic tests of RHR heat exchanger bypass valves 10MOV-66A and 10MOV-66B were noted to have been performed under differential pressure and flow conditions that were inconsistent with design-basis values and each other. The licensee subsequently recalculated and revised the design-basis differential calculation for these MOVs and retested valve 10MOV-66B with acceptable

results. The original test conditions for valve 10MOV-66A exceeded the revised differential pressure requirement and did not require additional testing. The inspector noted that both valves had large thrust capability margins.

Dynamic Testing of Valve 46MOV-102B

In 1992 the licensee dynamically tested emergency service water valve 10 MOV-102B without taking diagnostic test data. The inspector verified that the valve was VOTES tested satisfactorily in December 1994.

(Closed) Potential Failure of Motor-Operated Valves Under Severe Degraded Voltage Conditions (URI 93-80-02)

In 1992 the licensee analyzed 14 MOVs for possible damage when powered for 11 seconds at a 70% degraded voltage condition, and concluded that the valve motors could withstand stall current without damage and perform their safety functions when voltage subsequently was restored to normal. The affected valves included the core spray injection valves and containment isolation valves in the drywell sump and reactor water cleanup systems. During the GL 89-10 Phase 1 inspection, the NRC questioned the assumptions which underlay the licensee's evaluations. In response to this item, the licensee performed motor heatup calculations using the technical information and methods provided in Limitorque Technical Update 93-03. The licensee reconfirmed that final stator winding temperatures were less than the published insulation limits, and that the motors provided sufficient torque following a stall event to operate the valves when derated for post-accident elevated ambient temperatures.

The inspector reviewed the licensee's evaluations and verified its conclusions through independent calculations. However, the inspector also found that the licensee had no documented technical basis for the initial assumption that the valve motors would stall under the postulated conditions. Using standard industry MOV sizing equations and information in the Limitorque technical update, the inspector concluded that the MOVs would not stall, and had ample thrust capability to perform their safety functions under worst-case accident conditions. The licensee initiated an action item to reevaluate the design bases of the affected MOVs, and to revise its design-basis documents as needed. The inspector concluded that the licensee's plan was acceptable.

4.0 QUALITY ASSURANCE AND MANAGEMENT SUPPORT

The GL 89-10 program had not been audited by the JAF quality assurance (QA) organization. In 1993 the licensee performed a self-assessment of the program that included QA participation. The inspector found the self-assessment to have been adequate in scope and depth, and self-critical. Nonetheless, the inspector concluded that QA oversight of the program, an extensive and safety significant activity, was minimal. The licensee stated that performance of an MOV program audit was being evaluated.

The licensee provided effective management support to the MOV program. This was evidenced by the high percentage of valves (relative to boiling water reactors generally) that were tested dynamically, good quality procedures and technical position papers, and participation of program staff personnel in industry activities such as the VOTES and MOV users groups, the Boiling Water Reactor Owners' Group valve technical resolution group, the EPRI technical advisory group, and the ComEd MOV AC motor test program.

5.0 MANAGEMENT MEETINGS

Licensee representatives were informed of the purpose and scope of the inspection at an entrance meeting conducted on October 23, 1995. Findings were discussed periodically with the licensee throughout the course of the inspection.

The inspectors met with the principals listed below to summarize preliminary findings on October 27, 1995. The licensee acknowledged the preliminary findings and conclusions, with no exceptions taken. The bases for the inspection conclusions did not involve proprietary information, and none was included in this inspection report.

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