U. S. NUCLEAR REGULATORY COMMISSION
REGION I

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Report No.	50-423/98-82
Licensee:	Northeast Nuclear Energy Company
Facility:	Millstone Unit 3
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EXECUTIVE SUMMARY

Millstone Unit 3
NRC Inspection Report 50-423/98-82

This special inspection reviewed the status of the Millstone Unit 3 Motor-Operated Valve (MOV) program to determine its acceptability for supporting restart and for determining if Northeast Utilities (NU) had met their commitments under Generic Letter (GL) 89-10. The review included the various corrective actions taken by NU contained in Significant Items List Item 26.

Substantial progress was made toward closure of the GL 89-10 program. NU applied the results obtained from the Electric Power Research Institute's Performance Prediction Methodology to establish the design-basis thrust requirements for more than 100 of the 143 valves in the MOV program. Where standard program assumptions and using the EPRI PPM were not feasible, the use of alternate test plans clearly identified those valves that required additional methods to justify current switch settings. Modifications were implemented to improve the performance of many MOVs, including the installation of new double-disc PORV block valves for which an offsite prototype test was performed at design basis conditions. The quality of calculations and technical information for supporting MOV program closure was generally good. However, the NRC was unable to reach closure regarding the review of the GL 89-10 program because of the following:

- Several types of errors were found in MOV thrust calculations. The thrust calculation for the safety injection accumulator outlet isolation valves was incorrect in evaluating the unwedging capability and the opening capability under maximum differential pressure conditions, in that the structural weak-link limit, in lieu of the actuator's open degraded voltage thrust capability, was used as an estimate of the motor-actuator output capability. Also, the database software called *SMARTBOOK* used to store and develop MOV thrust/torque calculations caused errors within MOV calculations by not selecting from specific indicated allowable torque and thrust limits. The presence of these errors, including their significance and generic nature, was a violation of 10 CFR 50, Appendix B, Criterion III, "Design Control" **(VIO 50-423/98-82-10)**.

- Nine Inspector Followup Items were identified, primarily related to the resolution of questions pertinent to alternate test plan valves or where the NRC requests resolution, clarification, or verification regarding specific MOV issues prior to GL 89-10 program closure. A written response to these items is being requested to facilitate program closure. Also, an unresolved item was opened **(URI 50-423/98-82-11)** pending the review of requested information regarding some missing MOV engineer training records.

Report Details

III. Engineering

E1 Motor-Operated Valve Program Review (T/I 2515/109)

Background

On June 28, 1989, the NRC issued Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," which requested licensees to establish a program to ensure that switch settings for safety-related motor-operated valves (MOVs) were selected, set, and maintained properly. Seven supplements to the GL have been issued to provide additional information and guidance on the development of programs. Previous NRC inspections at Millstone Unit 3 were conducted based on guidance contained in NRC Temporary Instruction 2515/109, "Inspection Requirements for Generic Letter 89-10."

E1.1 Justification of MOV Program Assumptions

a. Inspection Scope

The main purposes of this inspection were: (1) To review the Millstone Unit 3 MOV program for verifying its completion in accordance with GL 89-10, thus completing the staff's review of GL 89-10; (2) To review the Millstone Unit 3 MOV program to determine its acceptability for supporting a safe restart while addressing Significant Items List Item 26. Program documents reviewed included "Millstone Motor Operated Valve Program Manual," Rev. 9, dated August 2, 1997. Thrust calculations, evaluations, test results, conditions reports, and other design documents were reviewed with much of this information pertinent to the following MOVs:

3CHS*LCV112B	Volume Control Tank Outlet Isolation
3CHS*MV8438B	Charging Pump B Discharge Isolation
3CHS*MV8109B	Reactor Coolant Pump B Seal Supply Containment Isolation
3FWA*MV35A	Auxiliary Feedwater Isolation
3RCS*MV8000A	Pressurizer Power Relief Isolation (PORV Block Valve)
3RCS*MV8000B	Pressurizer Power Relief Isolation (PORV Block Valve)
3SIH*MV8802A	Safety Injection Pump Discharge to Hot Leg Containment Isolation
3SIL*MV8804A	Low Pressure Safety Injection to Charging Pump Suction
3SIL*MV8808A	Safety Injection Accumulator Tank Outlet Isolation
3SWP*MOV102C	C Service Water Pump Discharge Isolation

b. Observations and Findings

General

In March of 1997, Northeast Utilities (NU) significantly revised Millstone's GL 89-10 MOV program to include a complete revision of the methods to be used to establish MOV design-basis capability. These methods relied primarily on results obtained

from Electric Power Research Institute's (EPRI) Performance Prediction Model (PPM). Inspection 50-423/97-203 documented the staff's assessment of NU's approach. Certain MOVs were not able to be set up using the EPRI PPM and other alternate approaches (referred to hereafter as "alternate test plan" valves) were needed. The details of the alternate test plan valves were included in Calculation 89-094-01546M3, "MP3 MOV Alternate Test Plans and Differential Pressure Test Methodology," Rev. 1, dated February 10, 1998.

Valve Factors and Grouping

NU applied results obtained from EPRI's PPM to establish the design-basis thrust requirements for all applicable MOVs. This included MOVs that could otherwise be tested under dynamic conditions. For those valves where the PPM was not applicable, the licensee developed alternate test plans (ATPs) to establish appropriate valve factors.

ATP approaches to justify valve factors typically used existing in-plant dynamic tests to justify alternatives to the PPM. Valves using this approach are shown in the table below.

Valve	Valve Size	Valve Vendor	Applied Valve Factor	Alternate Valve Factor Method
3RHS*MV8701A/C	12" Gate	Westing-house	0.40	Grouped with in-plant results from 3RHS*MV8702B/C
3RHS*MV8702B/C	12" Gate	Westing-house	0.40	In-plant testing
3CHS*MV8105	3" Gate	Aloyco	0.45	In-plant testing
3CHS*MV8106	3" Gate	Aloyco	0.45	In-plant testing
3SIH*MV8801A/B	4" Gate	Aloyco	0.50	In-plant testing
3SIH*MV8802A/B	4" Gate	Aloyco	0.50	Grouped with in-plant results from 3SIH*MV8801A/B
3SIH*MV8835	4" Gate	Aloyco	0.40	In-plant testing
3SIL*MV8840	8" Gate	Walworth	0.75	In-plant testing
3CHS*MV8438A/B/C	4" Gate	Westing-house	0.40*	In-plant testing

* 3CHS*MV8438B will be retested and new valve factor assigned prior to plant startup.

As part of the ATP long term monitoring for the valves listed in the above table, NU committed to dynamically retest the affected valves during the next 2 consecutive refueling outages to ensure that the selected valve factors remain adequate and to determine if further dynamic testing is required. The licensee will not retest 3SIH*MV8801A/B because the worst-case high differential pressure scenario for these valves (and 3SIH*MV8802A/B) is based on a no-flow trapped-pressure condition where the valve must open. EPRI unwedging thrust requirements were calculated and were less than the actuators' capabilities. PPM results were used for the lower differential pressure case where system flow would be expected. After discussions with the inspectors, the licensee initiated Action Requests (ARs) for each group of valves to ensure that planned dynamic tests would be scheduled and performed as specified. The inspectors considered these approaches to be acceptable.

Valves 3MSS*MOV74A/B/C/D are 8" Pacific globe valves which serve as the Steam Generator pressure relief bypass valves. In this application, these valves would operate under high temperature compressible fluid conditions. As noted in the NRC Safety Evaluation (SE) of EPRI's Topical Report TR-103237, "EPRI MOV Performance Prediction Program," the globe valve model is applicable to cold-water (less than 150°F) pumped-flow conditions. Therefore, NU was unable to apply the PPM to these valves. The ATP provides that valves 3MSS*MOV17A/B/D (steam isolation valves to the AFW Turbine Driven Pumps) will be dynamically tested and the results applied to 3MSS*MOV74A/B/C/D to resolve the high temperature and compressible fluid concerns. The licensee has committed to perform these dynamic tests prior to restart of Unit 3. However, the inspectors noted that the proposed alternative testing does not address globe valve performance under steam blowdown conditions. The licensee agreed to revise the ATPs to address the blowdown condition. Inspector Followup Item **50-423/98-82-01** is opened to verify implementation of this action.

The licensee has applied PPM results to several gate valves which have stainless steel guide and slot surfaces that would experience fluid temperatures above 100°F which exceeds the bounding conditions of the PPM model. To resolve this comment, NU plans to sponsor a test program with EPRI that will determine the appropriate friction coefficients to use for stainless steel guide surfaces for fluid temperatures above 100°F. This work will be tracked by AR 98003726 and is scheduled for completion by the end of December 1998. Inspector Followup item **50-423/98-82-02** is opened to verify this commitment.

The NRC Safety Evaluation regarding the EPRI PPM includes a condition that PPM users compare unwedging data to the PPM hand-calculation method for predicting unwedging thrust requirements. This comparison was not done by NU. The licensee stated that an engineering calculation will be developed to address this condition and Section 6.2.1 of the ATP would be revised to include the results of this comparison. AR 98003828 was issued to accomplish these tasks. Inspector Followup Item **50-423/98-82-03** is opened to verify implementation of this calculation and revision of the ATP.

Load Sensitive Behavior

NU load sensitive behavior assumptions include a bias margin of 5.6%, and a random margin of 26.4% which is combined with other random errors using the square-root sum of the squares methodology. NU based these new assumptions on results published by EPRI as part of the Performance Prediction Program (PPP). NU also performed a statistical analysis of in-plant testing that supported the use of EPRI's load sensitive behavior values. (Note: See Section E1.2 regarding the dynamic testing of 3CHS*MV8438B where an initial load sensitive behavior value of about 40% was measured. Subsequent evaluation, corrective action, and testing resulted in a current load sensitive behavior value of about 6% for this valve.) The inspectors noted that the licensee's extensive use of the PPM in lieu of dynamic testing resulted in a limited amount of data available to support justification of program assumptions. The licensee responded by stating that an engineering calculation will be developed to capture dynamic test data for gate and globe valve load sensitive behavior and Section 6.2.1 of the ATP would be revised accordingly. AR 98003828 was issued to accomplish this work. Inspector Followup Item **50-423/98-82-04** is opened to verify implementation of the evaluation of the load sensitive behavior data.

Stem Friction Coefficient

NU applied a stem friction coefficient assumption of 0.20 in the thrust calculations for gate and globe valves. NU based this assumption on a statistical analysis of Millstone in-plant valve closing test data, using a 95% confidence level which resulted in a value slightly above 0.18. The inspectors noted that a separate statistical analysis of the gate valve open stem friction coefficients resulted in a value slightly above the assumed 0.20, primarily due to low values that increased the standard deviation of the data. However, no actual test values exceeded the assumed 0.20 stem friction coefficient. While the inspectors were not concerned with this result, it was noted that the analysis was based on a small amount of test data. The licensee responded to this observation by stating that additional testing will augment this data analysis as part of the long term MOV periodic verification program to increase confidence in the program's stem friction coefficient assumptions. The inspectors also noted that the licensee initiated an Action Request to incorporate in-plant stem friction coefficient data into an engineering calculation. Inspector Followup Item **50-423/98-82-05** is opened to verify implementation of these actions.

Several MOVs have stem nuts with threads that were machined by the on-site maintenance group and resulted in poor actuator performance. One of these valves, 3FWA*MOV35C, was recently dynamically tested and found to have an open stem friction coefficient of 0.24. Condition Report (CR) M3-98-1087 was initiated and the licensee agreed to replace 3FWA*MOV35C's stem nut with one obtained from an approved off-site supplier. (See Section E1.2 for a complete discussion of this issue).

For certain valves the ATPs provide a stem friction coefficient that is less than the

MOV program assumed value of 0.20. Selected values used by the thrust calculations are based on static test results. The ATPs also require that these MOVs will be part of a Periodic Verification focus group that will be monitored for potential stem friction coefficient degradation.

Butterfly Valve Bearing Coefficient

NU has implemented the PPM to establish the torque requirements for Millstone's butterfly valves. Millstone Unit 3 has four service water system butterfly valves with bronze bearings that operate in raw water conditions. The PPM would normally default to a bearing coefficient of 0.60 for these valves. However, the licensee had performed dynamic testing of these valves that supported the use of a 0.20 bearing coefficient. Therefore, this lower bearing coefficient was used in the PPM to establish the torque requirements for these butterfly valves. This issue was identified in the ATPs for 3SWP*MOV102A/B/C/D. Future dynamic tests will be performed to ensure that the assumed bearing coefficients remain adequate. The inspectors found this approach acceptable. The licensee agreed to revise Section 6.2.1 of the ATP to clarify the basis for this approach, including how test data will be obtained, evaluated, and documented in an engineering calculation. Inspector Followup Item **50-423/98-82-06** is opened to verify implementation of these actions.

c. Conclusions

NU's use of the PPM to establish MOV thrust requirements provides an acceptable method for the majority of Unit 3's MOVs. The use of ATPs clearly identifies those valves that require additional methods to justify current MOV switch settings. Regarding additional information needed to justify MOV program assumptions for GL 89-10 closure, six Inspector Followup Items were opened to verify certain licensee commitments or the implementation of intended licensee actions.

E1.2 MOV Design-Basis Capability

a. Inspection Scope

The inspectors reviewed thrust calculations and actuator capability assessments for the selected MOVs. The purpose of this review was to assess NU's efforts to establish design-basis capability for all MOVs in Millstone Unit 3's GL 89-10 program. This inspection also included the review of corrective actions specified in several licensee event reports (LER), such as LER 96-019 regarding the PORV block valves.

b. Observations and Findings

PORV Block Valve Thrust Requirements

The NRC in Inspection Report 50-423/97-203 (**IFI 50-423/97-203-01**) found that NU was replacing the PORV block valves (3RCS-MV8000A/B) with new 3"

Anchor/Darling 1500# double-disc gate valves which were modified to improve structural weak-link considerations. To ensure proper valve design, the valve vendor performed a prototype test of these valves under design-basis steam blowdown conditions at Duke Power's Marshall test facility. This testing resulted in valve seat damage that was later resolved by modifying the valve's internal wedge clearances. The modified prototype valve was successfully tested. NU used the PPM methodology to establish the thrust requirements for these valves. However, the inspectors noted that the PPM would no longer be directly applicable to the installed valves due to the modified nature of the design. Further, manufacturing tolerances would prevent the direct applicability of the prototype test to the production valves. The licensee responded to this and other comments as follows:

- To demonstrate that the PPM was applicable to the modified Anchor/Darling double-disc design incorporated into the production valves, NU obtained specific valve measurements of the prototype test valve from Duke Power and performed a PPM calculation using the actual prototype test conditions. A comparison between PPM results and prototype test results revealed that the PPM was conservative for the modified double-disc design. The inspectors found this method of PPM justification to be acceptable.

- NU assumed that the PORV block valves were only required to achieve flow isolation to meet their closed safety function. This implied that the applied stem thrust only needed to be sufficient to move the disc over the seat ring to block flow. Additional force is necessary to cause the internal wedges to spread the discs and mechanically seal the valve. The inspectors noted that if a double-disc gate valve is not fully wedged and the upstream pressure decays away, it will lose its sealing force. Therefore, some additional stem thrust would be needed to ensure that the PORV block valves continue to meet their closed safety function. The licensee agreed to revise design-basis documents and thrust calculations to establish a minimum thrust requirement that ensures adequate mechanical wedging of the valve discs.

- EPRI's methodology for Anchor Darling double disc gate valves determined that the wedge orientation affects the thrust requirements when disc wedging is required. Having the lower wedge downstream is the preferred orientation. If the lower wedge is upstream, the thrust requirements are higher. NU was confident that the valves were installed with the wedges in the preferred orientation. Since documentation was not available to support this position, CR M3-98-0792 was issued to confirm the preferred wedge orientation. NU performed radiographic examinations and verified that the wedges for both PORV block valves were in the preferred orientation. The licensee also increased the torque switch settings for 3RCS-MV8000A & B to provide additional confidence that adequate mechanical wedging would occur under design-basis conditions.

- Other corrective actions included in CR M3-98-0792 specified that applicable maintenance procedures would be revised by September 30, 1998, to ensure that the lower wedge is installed properly after any future maintenance. Also,

by June 15, 1998, the licensee will review the NRC Safety Evaluation of the EPRI PPM to identify and ensure any applicable conditions and limitations are met, and to ensure that the conditions and limitations are incorporated into appropriate procedures and calculations. Similar actions have also been initiated for Unit 2.

The inspectors confirmed that NU was processing a UFSAR change request for revising Sections 5.4.12.2 and 5.4.13.2 to reflect the new PORV block valves. Based on the licensee's actions and commitments, the inspectors considered that the PORV block valves issues were resolved and that Inspector Followup Item **50-423/97-203-01** should be closed.

Charging Pump Discharge Isolation Valve (3CHS*MV8438B)

During recent dynamic testing of 3CHS*MV8438B, the licensee determined that this valve had an abnormally high load sensitive behavior (about 40%). The licensee attributed this poor performance to incorrectly machined stem nut threads made during fabrication by the on-site maintenance group. Since the 3CHS*MV8438B's stem nut was one of several that had been machined by the on-site maintenance group, NU noted that other MOVs could have similar performance. Therefore, CR M3-98-0578 was issued to evaluate the prior test data for the affected MOVs. The following actions were initiated:

- A new stem nut for 3CHS*MV8438B was obtained from an approved off-site supplier and installed. The subsequent post-maintenance dynamic test determined that 3CHS*MV8438B's load sensitive behavior significantly decreased to approximately 6% which confirmed the licensee's assumption that the stem nut was the cause of 3CHS*MV8438B's previous high load sensitive behavior. Once the dynamic test evaluation is completed, the licensee will make appropriate revisions to 3CHS*MV8438B's thrust calculation.

- The licensee determined that the following valves also had stem nuts that were machined by the on-site maintenance group:

3CHS*MV8438A/C	3FWA*MOV35A/B/C/D
3MSS*MOV18B/C	3RHS*MV8701A

- Valves 3CHS*MV8438A&C were dynamically tested and were found to have acceptable performance. Valves 3FWA*MOV35A/B/C/D also were dynamically tested. Valves 3FWA*MOV35A/B/D had acceptable stem nut performance. However, 3FWA*MOV35C was found to have a high stem friction coefficient performance (0.24) in the open direction. Since this test result deviated from the MOV program standard value of 0.20, CR M3-98-1087 was issued for corrective action. NU committed to replace 3FWA*MOV35C's stem nut and to statically retest this valve prior to Unit 3 restart.

- The licensee initiated work orders to replace prior to restart the stem nuts in the remaining MOVs, 3MSS*MOV18B&C and 3RHS*MV8701A, where acceptable

differential pressure tests were not possible to resolve the issue. Further, during the next refueling outage, new stem nuts will be installed for those MOVs where acceptable differential pressure tests have been done with the "in-house machined" stem nuts.

Based on the licensee's actions and commitments, the inspectors considered the stem nut machining issues to be resolved.

Margin Improvement Plans

NU did not have a formal margin improvement plan for low margin MOVs. This decision was based on the assumed conservatisms of NU's setup methodology which included a 10% performance degradation margin applied in all thrust/torque calculations. However, the inspectors noted that several MOVs are justified in Alternate Test Plans using alternatives to NU's standard program methods. A risk ranking review of the ATP valves found that 4 MOVs, 3SIL*MV8804A/B (high risk) and 3SIH*MV8802A/B (medium risk) had safety function margins of less than 6%. Licensee personnel stated that gear change modifications will be implemented for 3SIL*MV8804A/B, and that 3SIH*MV8802A/B will be modified to change from torque switch control to limit switch control. These actions will increase available margin and will be implemented during the next refueling outage. Inspector Followup Item **50-423/98-82-07** is opened to verify this commitment.

Limitorque 110% Torque Limit

During review of the thrust calculations, the inspectors noted cases where the torque at torque switch trip was allowed up to 110% of the actuator's torque rating. In the past, Limitorque's guidance has been: 1) to allow peak torque up to 110% of the actuator's rating if torque at torque switch trip did not exceed 100% of the rating, and 2) to allow peak torque up to 120% of the actuator rating if the torque at torque switch trip did not exceed 110% and if valve cycles were limited to 100. The difference between these two positions was that NU would find it acceptable if the torque at torque switch trip and peak torque were in the range of 100% to 110% of the actuator's rating. NU has requested Limitorque to confirm that NU's interpretation of this guidance is appropriate. A formal response has not been received from Limitorque. Inspector Followup Item **50-423/98-82-08** is opened to verify the appropriate resolution of this issue between NU and Limitorque.

Yarway Globe Valves (3RHS*FCV610/611)

The RHR pump miniflow recirculation valves (3RHS*FCV610/611) are 2-inch, Yarway, motor-operated globe valves that are required to open on pump startup for providing adequate pump cooling. Once the RHR system is supplying sufficient flow to the Reactor Coolant system, 3RHS*FCV610/611 will close to maximize injection flow. The licensee found that these valves could open and close repeatedly during surveillance testing due to the design of the flow control circuit that governs MOV operation. This condition was not considered a problem until a safety analysis found that during a small break loss of coolant accident (LOCA),

similar flow conditions could exist and cause the valves to cycle in a similar manner. If these valves were to exceed their motor duty cycle, the motors could fail and thereby not perform their intended safety function. Therefore, the licensee initiated a design change package that will modify the valve control circuit prior to plant startup and prevent any repetitive cycling of these valves.

A separate issue regarding sixteen Yarway motor-operated globe valves was identified in CR M3-97-4541. Specifically, assuming a failure of the open limit switch, sufficient actuator capability may exist to produce enough force and breach the valve pressure boundary.

Inspector Followup Item **50-423/98-82-09** is opened to verify the acceptable resolution of these issues prior to restart.

c. Conclusions

The licensee responded effectively to the inspectors' comments regarding the PORV block and charging pump discharge isolation valves. Inspector Followup Items were identified for resolution prior to restart: (1) to verify NU commitments for the thrust margin improvement of several MOVs; (2) to verify an appropriate resolution of the Limitorque actuator 110% torque limit; and (3) to verify the acceptable resolution of the Yarway motor-operated globe valve issues.

E1.3 MOV Design Calculations

a. Inspection Scope

The inspectors reviewed various documents used to establish the design-basis requirements for the inspection sample valves identified in Section E1.1. These design documents included: (1) a system design-basis review document that identified the various system parameters including the differential pressure requirements; (2) an evaluation of thrust requirements (usually a determination based on EPRI's PPM); (3) a target thrust/torque calculation which compared the thrust requirements to actuator capabilities and structural limits; and (4) a weak link calculation. The purpose of the review was to assess the adequacy and completeness of the various NU documents governing MOV design activities.

b. Observations and Findings

Individual MOV thrust calculations are performed in accordance with Calculation #97-MOV-01012MG, "Technical Justification/Methodology for Preparation of Millstone Units 1, 2, & 3 MOV Thrust/Torque Calculations", which provides a QA method for performing such calculations in accordance with the MOV program (i.e., PI-9, "Determination of Stem Thrust Requirements"). Each calculation is subdivided into sections to provide a logical flow of information and to perform certain evaluations within the calculation. For example, Section 15, "Max Allowable Open

Limits for Gate Valve" and Section 16, "Max Allowable Disc Pullout for Gate Valve" are included to evaluate if the gate valve actuator has sufficient capability to overcome the required pullout force and differential pressure thrust for the valve opening stroke.

During the review of Calculation 89-094-1017ES, "Millstone Unit 3 Target Thrust/Torque Calculations for 3SIL*MV8801A, 3SIL*MV8801B, 3SIL*MV8801C, 3SIL*MV8801D," Rev. 4, dated January 26, 1998, the following errors were noted:

- Section 15: Incorrectly compared the minimum required opening thrust to the actuator's open structural limit instead of the actuator's open degraded voltage thrust capability (which was more limiting).

- Section 16: Incorrectly compared the estimated dynamic disc pullout thrust requirement (based on the EPRI PPM unwedging calculation) to the actuator's open structural limit instead of the actuator's open degraded voltage thrust capability (which was more limiting).

Similar errors were included in other MOV calculations and the inspectors considered these errors as the first example of a violation of 10 CFR 50, Appendix B, Criterion III, "Design Control".

NU used a database software tool (i.e., *SMARTBOOK*) to store data and to develop the MOV target thrust/torque calculations that were used to establish design-basis requirements. The inspectors were concerned because the calculational errors appeared to be caused by the software logic instead of incorrect input values. This would result in errors that could affect all of Millstone's MOV target thrust/torque calculations. Also, although NU instructed its engineers not to rely on *SMARTBOOK* and to do a thorough preparation and independent calculation review, it appeared that the
independent second-level engineering reviews of the calculations as required by Chapter 4, "Design Inputs and Design Verification", of the Millstone Station design Control Manual were not effective.

In light of the observed errors, the inspectors performed a detailed review of several calculations, including Calculation 89-094-0900ES, "Millstone Unit 3 Target Thrust/Torque Calculation for 3SIL*MV8804A, 3SIL*MV8804B," Rev. 5, dated February 9, 1998. Additional errors were found as follows:

- Section 18: An incorrect torque value was sometimes displayed in the comparison answer box; the software did not accurately select between the specified torque limits as required.

Similar errors were found in Calculation 89-094-1017ES, "Millstone Unit 3 Target Thrust/Torque Calculations for 3SIL*MV8801A, 3SIL*MV8801B, 3SIL*MV8801C, and 3SIL*MV8801D," Rev. 4, dated January 26, 1998.

- Section 18: In some cases, the software truncated the most significant digit of the torque value displayed in the comparison answer box.

Note: Section 18 is titled "Closed Capability for MOVs on Limit Control"

These errors were considered to be the second example of a violation of 10 CFR 50, Appendix B, Criterion III, "Design Control".

NU initiated corrective actions to identify the root cause and correct these errors as documented in CR M3-98-0790. The licensee discussed the preliminary results of the root cause analysis, which was quite thorough, and found that there were at least 2 root causes:

- The methods specified by the MOV Program Manual PI-9, the methodology calculation (Calculation 97-MOV-01012MG), *SMARTBOOK*, and the field implementation were not in agreement or solidly linked. This was attributed to MOV program organizational changes.

- There was complacency in checking thrust calculations which was attributed to a human performance problem.

As part of the corrective actions, all gate valve calculations were reviewed to determine if any operability concerns existed. This review found that the estimated unwedging thrust requirements exceeded the open capability for 8 MOVs. Seven of these valves were subsequently found to be operable based on in-plant open dynamic tests. The last valve was acceptable because it did not have an open safety function. The inspectors reviewed these operability evaluations and considered the conclusions to be appropriate.

NU indicated that the following corrective actions would be completed prior to plant restart:

- All calculations will be reviewed for similar errors or other types of errors. Preliminary results of this review indicated that additional errors were being found, but none have affected MOV setup.

- Reconcile and correct differences between PI-9, the methodology calculation, *SMARTBOOK*, and the field implementation documents.

- Work on revising calculations will be stopped until a method is developed to verify the calculations in the absence of a verified *SMARTBOOK* software tool.

- Prior to entering Mode 2, all calculations will be revised to be consistent with current switch settings demonstrating design-basis capability.

- A long term corrective action (not tied to plant restart) will establish administrative controls for *SMARTBOOK* or implement a controlled procedure for *SMARTBOOK*.

c. Conclusions

Several types of errors in MOV thrust calculations were found. 10 CFR 50, Appendix B, Criterion III, "Design Control", requires, in part, "...that measures shall be established to assure that applicable regulatory requirements and the design basis are correctly translated into specifications, drawings, procedures, and instructions." Given the significance and generic nature of the errors found in the design-basis calculations that had received an independent second-level engineering review, the inspectors considered these errors to be a violation of 10 CFR 50, Appendix B, Criterion III, "Design Control" (**VIO 50-423/98-82-10**).

E1.4 Pressure Locking and Thermal Binding (**URI 50-423/95-17-09**- Closed)

a. Inspection Scope

The inspectors reviewed NU submittals and a recent NRC safety evaluation report (SER) regarding Generic Letter (GL) 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves" as applied to Millstone Unit 3.

b. Observations and Findings

The licensee stated in an October 6, 1995 submittal that the steam generator PORV block valves (3MSS*MOV18A,B,C, and D) were susceptible to thermal binding. As corrective action, the licensee submitted a Technical Specifications change to require that, when the valves are shut, they should be declared inoperable and the appropriate Technical Specifications action statement entered. The Technical Specification change was submitted to the NRC for approval in the licensee's Letter B 16550 dated July 18, 1997, which would be implemented prior to Unit 3 restart.

The licensee issued Design Change M3-97-007 to modify the pressurizer PORV block valves (3RCS*MV 8000A and B). The inspectors reviewed this modification and verified that these valves were replaced with modified double disk valves that are not susceptible to pressure locking or thermal binding. (See Section E1.2)

Consistent with the above discussion, on January 13, 1998, the NRC issued a SER applicable to Millstone Unit 3 stating that NU's actions in response to GL 95-07 were acceptable.

c. Conclusions

In accordance with the NRC SER indicating that NU's actions in response to GL 95-07 at Millstone Unit 3 were acceptable, **URI 50-423/95-17-09** is closed.

E1.5 MOV Program Organization

a. Inspection Scope

The inspectors reviewed the current organization regarding its development since the last inspection and its abilities to implement the MOV program.

b. Observations and Findings

Shortly after the August 1997 MOV program inspection (See NRC IR 50-423/97-203), two key managers, the MOV program manager and the design engineering supervisor, resigned their positions and were replaced by the current NU managers. During the discussion of the results of the interim root cause analysis regarding the MOV thrust calculation errors, it was apparent that the organizational changes in the fall of 1997 was one of the root causes for the errors. The current staff was aggressively pursuing corrective actions, seeking causes for the problems, and asking many questions. This was demonstrated by the efforts of the interim root cause analysis observed by the inspectors. The current MOV staff also responded adequately during this inspection to the various questions and technical issues presented by the inspectors.

c. Conclusions

Notwithstanding the past organizational changes being one of the root causes of the MOV calculational errors, the inspectors considered that the current organization was adequately implementing the MOV program.

E2 Engineering Support of Facilities and Equipment

E2.1 Tracking and Trending Program

a. Inspection Scope

The inspectors reviewed MOV Program PI-16, "MOV Periodic Testing, Periodic Verification, and Tracking and Trending Program." Specific examples of equipment problems, such as valve packing and stem scoring repairs, were reviewed, including the performance of post-maintenance testing as required by PI-14, "Post-Maintenance Testing and Lubrication Requirements."

b. Observations and Conclusions

PI-16 included appropriate guidance for the development of a detailed tracking and trending program, such as key parameters (e.g., unseating thrust/torque, running load, motor current, etc.) to be monitored for assessing MOV performance. The detailed program will include 5 groups plus a focus group which includes all alternate test plan valves. As-found data will be collected during such testing. The details of the tracking and trending program were being finalized in conjunction with the commitments made in response to GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves."

Stem Scoring Repairs

NU provided a list of Condition Reports and work orders issued since January 1995 regarding MOVs with stem scoring problems. The inspector discussed CRs related to two MOVs where up to .010" of material was removed from the stem to remove scoring marks. This work was performed in accordance with approved procedures using the information in Appendix D, "Guidelines for Valve Refurbishment Prior to Packing Replacement" which is part of Maintenance Specification SP-ME-883, "Alternate Valve Stem Packing Replacement." The inspector verified that the removal of this small amount of material did not invalidate the prior calculation of the valve thrust limit since the stem diameter in the repaired area was greater than the minor diameter in the threaded area of the stem. The inspector also verified that the licensee performed appropriate post maintenance testing after completion of the repairs.

Valve Packing Repairs

NU provided a list of work orders for about 25 MOVs issued since January 1996 regarding MOVs which required packing repairs. From this list the inspector discussed the work performed including post maintenance testing of a high risk MOV, the charging pump SI header isolation valve (SIH MOV8801B). This MOV had demonstrated erratic running loads due to heavy stem scoring. In addition to repacking the valve, the stem was replaced. A static diagnostic test of the MOV was performed to assure adequate performance after the repairs. The inspector reviewed work orders for several other MOVs where the packing was replaced and the MOVs were retested or scheduled for retest with diagnostic test equipment. The inspector considered these actions acceptable and noted that this practice was consistent with the MOV program guidance included in PI-14, "Post-Maintenance Testing and Lubrication Requirements."

E2.2 MOV Program Scope

a. Inspection Scope

The inspectors reviewed NU's efforts to implement MOV Program PI-1, "MOV Program Scope Determination."

b. Observations and Findings

NU has determined that 143 MOVs are within the scope of the Unit 3 GL 89-10 MOV program. The detailed work for making this determination was included in the Unit 3 MOV Program Scope Determination Calculation 89-094-939ES, Revision 01. The inspector requested NU to provide any CRs that had been issued since January 1996 regarding MOV program scope issues. CR M3-98-0078, which was the only CR issued on scope issues, had been initiated in January 1998 and identified instances where Calculation 89-094-939ES might require clarification regarding the prior exclusion of certain MOVs from the GL 89-10 program. For example, the calculation indicated that the RCS loop isolation and bypass valves had been excluded from the MOV program since they provided no active safety function. The inspector verified that the electric power to these MOVs was normally deenergized with the respective breakers locked open during normal operation as specified in the RCS System Electrical Checklist. Thus, the inspectors did not identify any concerns regarding the exclusion of these valves from the GL 89-10 MOV program.

c. Conclusions

The inspector verified that no MOVs had been added or deleted from the MOV program since August 1995 when 143 MOVs were established within the scope of GL 89-10.

E2.3 MOV Program Qualification of Personnel - Training Requirements

a. Inspection Scope

The inspectors interviewed several engineers who were assigned the detailed responsibilities for the preparation, review, and approval of MOV thrust calculations. The engineers' training records were reviewed regarding the requirements specified in PI-17, "Qualification of Personnel."

b. Observations and Findings

The engineers interviewed had prepared and independently reviewed thrust Calculation 89-094-1017ES for the SI accumulator outlet isolation valves. These engineers had been employed by NU around October 1997 and it was evident that they had received appropriate training prior to assuming their job responsibilities. Based on the interviews, it was evident that each engineer had received specific training from the lead engineer regarding Calculation # 97-MOV-01012MG, "Technical Justification/Methodology for Preparation of Millstone Units 1, 2, & 3 MOV Thrust/Torque Calculations." This calculation provides a QA method for performing MOV thrust calculations in accordance with PI-9 of the MOV Program Manual.

While reviewing the engineers' training records and in response to an inspector request, the design engineering supervisor indicated that the physical records documenting this training had been lost for all engineers who received this training in October 1997. The licensee considered this problem to be an isolated occurrence based, in part, on a recent QA audit of MOV personnel training performed where no similar findings were present.

c. Conclusions

The records for some specific training of MOV personnel had been lost. In addition to responding to the violation regarding errors in the thrust calculations (Section E1.3), the inspectors requested that the licensee review this problem and report any findings and corrective actions deemed necessary to prevent recurrence. Unresolved Item **50-423/98-82-11** is opened pending the review of this information.

E2.4 Walworth Valve Yoke Cracking (SIL Item 51)

a. Inspection Scope

NRC Information Notice 93-97, "Failures of Yokes Installed on Walworth Gate and Globe Valves," discussed cracking problems experienced with these valves at other nuclear facilities. The inspectors reviewed the repairs performed for steam generator pressure relief isolation valve 3MSS*MOV18C and steam generator feedwater isolation valve 3FWA*MOV35C.

b. Observations and Conclusions

The inspection included a field walkdown of both valves and a review of the maintenance records documenting the repairs. Work order M3-96-09719 described the repairs for 3MSS*MOV18C which involved the removal of linear indications and subsequent weld repair of the excavations in accordance with the NU weld program. Work order M3-97-14207 described the repairs for 3FWA*MOV35C which involved the installation of a new yoke. The inspector verified that the repairs for both valves were completed and inspected satisfactorily by quality control inspection personnel. No abnormalities were noted during the visual inspection in the field. The repaired yokes are to be reinspected every 2-4 years.

E8 Miscellaneous Engineering Issues

E8.1 (Closed) IFI 50-423/95-01-01 Item 6 - Justify All Non-Dynamically Tested MOV Valve Factors: Inspection 95-01 found that NU was applying a generic 0.90 valve factor to the thrust calculations of some non-dynamically tested MOVs. More recently, NU used EPRI's PPM as the primary method to establish MOV thrust requirements. As noted in Inspection 50-423/97-203, the PPM is not applicable in all cases. Therefore, NU developed alternate test plans for these valves. As noted in Section E1.1, additional dynamic testing of 3MSS*MOV17A/B/D will be

performed prior to plant startup and the results applied to 3MSS*MOV74A/B/C/D to resolve the high temperature and compressible fluid concerns identified in the ATP. This IFI is administratively closed since this issue is being tracked by new IFIs identified in this inspection report.

E8.2 (Closed) IR 50-423/96-05, Section U3.E1.1 - Justify Valve Factors for 3CHS*MV8468A/B: Inspection 50-423/96-05 identified a concern with the licensee's choice of valve factors that were used for valves 3CHS*MV8468A/B. The inspectors verified that the licensee is using the EPRI PPM results to establish the design-basis requirements for 3CHS*MV8468A/B. Therefore, the inspectors considered this issue to be closed.

E8.3 (Closed) IFI 50-423/95-01-01 Item 3 & IFI 50-423/95-17-03 Complete Load Sensitive Behavior and Stem Friction Coefficient Analysis: Inspections 50-423/95-01 and 50-423/95-17 found that the licensee had not completed the program justifications for load sensitive behavior and stem friction coefficient. These issues were to be reviewed when Millstone's dynamic test program was finished. As noted above, additional dynamic testing of 3MSS*MOV17A/B/D will be performed prior to plant startup. Further, the licensee intends to include the finished load sensitive behavior and stem friction coefficient analysis in a new engineering calculation. This IFI is administratively closed since this issue is being tracked by new IFIs identified in this inspection report.

E8.4 Review of Updated Final Safety Analysis Report

Discovery of a licensee operating its facility in a manner contrary to the Updated Final Safety Analysis Report (UFSAR) description highlighted the need for a special focused review that compares plant practices, procedures, and/or parameters to the UFSAR descriptions. While performing the inspections discussed in this report, the inspector reviewed Millstone Unit 3 UFSAR Sections 5.4.7, "Residual Heat Removal System," 5.4.10, "Pressurizer," and 5.4.13, "Safety and Relief Valves". With the exception of the need to revise the description in Section 5.4.13 to reflect the new PORV block valves recently installed and tested (see Report Section E1.2), the inspector verified that the wording in the UFSAR was consistent with the observed plant practices, procedures, and parameters.

V. Management Meetings

X1 Exit Meeting Summary

Licensee representatives were informed of the purpose and scope of the inspection at an entrance meeting conducted on February 9, 1998. Findings were discussed periodically with the licensee throughout the course of the inspection. The inspectors met with the principals listed below on February 27, 1998, at which time a final exit meeting with the licensee was conducted to summarize preliminary inspection findings. The licensee acknowledged the preliminary findings and conclusions, with no exceptions taken. The bases for the inspection conclusions did not involve proprietary information, nor was any such information included in this inspection report.

PARTIAL LIST OF PERSONS CONTACTED

Northeast Nuclear Energy Company

M. Brothers	Vice-President, Operations
M. Long	MOV Technical Support Supervisor
J. McElwain	Unit 1 Recovery Officer
C. Mejia	MOV Design Engineering Supervisor
J. Rhodes	MOV Program Manager
R. McIntosh	Unit 3 Licensing Engineer
D. Smith	Manager, Regulatory Compliance
R. Van Steenbergen	MOV Design Engineer

U.S. Nuclear Regulatory Commission

B. Korona	Unit 3 Resident Inspector
J. Durr	Branch Chief, Region I, DRP

INSPECTION PROCEDURES USED

TI 2515/109	Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance

ITEMS OPENED, CLOSED, AND DISCUSSED

OPENED

50-423/98-82-01	IFI	Dynamically test 3MSS*MOV17A/B/D and address steam blowdown conditions.
50-423/98-82-02	IFI	Determine by test appropriate friction coefficients for stainless steel guide surfaces >100 F.
50-423/98-82-03	IFI	Include calculation in alternate test plan to compare unwedging data to EPRI PPM hand calculation method.
50-423/98-82-04	IFI	Capture dynamic test data for gate and globe valve load sensitive behavior.
50-423/98-82-05	IFI	Incorporate in-plant stem friction coefficient data into an engineering calculation.
50-423/98-82-06	IFI	Clarify how test data will be obtained, evaluated, and documented to ensure that the assumed bearing coefficients for 3SWP*MOV102A/B/C/D remain adequate.
50-423/98-82-07	IFI	Verify actions to be taken, including modifications to 3SIL*MV8804A/B and 3SIH*MV8802A/B, to improve the thrust margin for low margin valves.
50-423/98-82-08	IFI	Verify appropriate resolution of the 110% torque limit issue between Limitorque and NU.
50-423/98-82-09	IFI	Verify acceptable resolution of Yarway globe valve issues prior to restart.
50-423/98-82-10	VIO	Correct MOV thrust calculational errors.
50-423/98-82-11	URI	Resolve questions regarding missing training records.

CLOSED

50-423/97-203-01	IFI	PORV block valve thrust requirements.
50-423/95-01-01	IFI	Justify all non-dynamically tested MOV valve factors (Item 6). Complete load sensitive behavior and stem friction coefficient analysis (Item 3).
50-423/95-17-03	IFI	Complete load sensitive behavior and stem friction coefficient analysis.
50-423/95-17-09	URI	Pressure locking and thermal binding.

LIST OF ACRONYMS USED

AR	Action Request
CHS	Charging System
CR	Condition Report
EPRI	Electric Power Research Institute
IFI	Inspector Followup Item
GL	Generic Letter
MOV	Motor-Operated Valve
NRC	Nuclear Regulatory Commission
NU	Northeast Utilities
PI	Program Instruction
PORV	Power Operated Relief Valve
PPM	Performance Prediction Methodology
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
SI	Safety Injection
SIL	Significant Items List
UFSAR	Updated Final Safety Analysis Report