September 30, 2002

Mr. Gary L. Vine
Senior Washington Representative
Electric Power Research Institute
2000 L Street, N.W., Suite 805
Washington, DC 20036

SUBJECT: SUPPLEMENT 3 TO SAFETY EVALUATION ON ELECTRIC POWER RESEARCH INSTITUTE TOPICAL REPORT TR-103237-R2, "EPRI MOTOR-OPERATED VALVE PERFORMANCE PREDICTION PROGRAM," ADDENDUM 2 (TAC NO. MA6484)

Dear Mr. Vine:

In November 1994, the Nuclear Energy Institute (NEI) submitted for NRC review the Electric Power Research Institute (EPRI) Topical Report TR-103237, "EPRI MOV Performance Prediction Program," describing the EPRI motor-operated valve (MOV) methodology that predicts the applicable thrust or torque required to operate gate, globe, and butterfly valves over a wide range of differential pressure, temperature, and flow conditions. On March 15, 1996, the NRC staff issued a safety evaluation (SE) documenting the staff's acceptance of the EPRI MOV Performance Prediction Methodology (PPM) described in the subject topical report, with certain conditions and limitations. On February 20, 1997, the staff issued a supplement to that SE documenting its acceptance, with certain conditions and limitations, of the EPRI hand-calculation models for two additional gate valve designs, and highlighting other aspects of the EPRI program.

On September 8, 1999, NEI submitted for NRC review Addendum 1, "PPM Version 2.0," and Addendum 2, "Thrust Uncertainty Method," to EPRI Topical Report TR-103237-R2. Version 2.0 of the EPRI MOV PPM described in Addendum 1 to the topical report resolves several previous modeling errors and incorporates other improvements to the modeling software. On April 20, 2001, the NRC staff issued Supplement 2 to the SE on the EPRI MOV PPM concluding that the changes made to the PPM in Version 2.0 improve the ability of the EPRI model to predict the applicable thrust or torque required to operate gate, globe, and butterfly valves. In Addendum 2 to TR-103237-R2, EPRI describes the development of its Thrust Uncertainty Method that takes into account conservatism in the EPRI MOV PPM to predict a more realistic thrust requirement for closing gate valves.

In the enclosed Supplement 3 to the SE on the EPRI MOV PPM, the staff describes its review of the EPRI Thrust Uncertainty Method. Based on review of Addendum 2 to EPRI Topical Report TR-103237-R2 as supplemented by NEI submittals dated January 5 and December 6, 2001, and June 10, 2002, the staff finds that the Thrust Uncertainty Method developed by EPRI is acceptable for the prediction of minimum allowable thrust at control switch trip (or flow isolation) for applicable motor-operated gate valves under cold water applications within the scope of the Thrust Uncertainty Method. Therefore, the staff concludes that the Thrust Uncertainty Method may be applied consistent with the criteria specified for the EPRI MOV PPM in EPRI TR-103237-R2 and Addenda 1 and 2 to TR-103237-R2, as supplemented by NEI submittals dated January 5 and December 6, 2001, and June 10, 2002.

The NRC staff's findings and conclusions on the use of the EPRI MOV PPM, and applicable limitations and conditions, are provided in an SE dated March 15, 1996; the SE supplements dated February 20, 1997, and April 20, 2001; and the enclosed supplement to the SE.

The NRC requests that EPRI publish an accepted version of Addendum 2 to EPRI Topical Report TR-103237-R2 within 3 months of receipt of this letter. The accepted version shall incorporate (1) this letter and the enclosed SE between the title page and the abstract, (2) the information provided in the NEI submittals dated January 5 and December 6, 2001, and June 10, 2002. and (3) a "-A" (designating accepted) following the report identification number (i.e., TR-103237-R2-A).

Pursuant to 10 CFR 2.790, we have determined that the enclosed supplement to the SE does not contain proprietary information. However, we will delay placing the safety evaluation supplement in the public document room for a period of ten (10) working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

If the NRC's criteria or regulations change so that its conclusion in this letter, that the topical report is acceptable, is invalidated, EPRI and/or the applicant referencing the topical report will be expected to revise and resubmit its respective documentation, or submit justification for the continued applicability of the topical report without revision of the respective documentation.

Sincerely,

/RA/

William H. Ruland, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 669

Enclosure: Safety Evaluation

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The NRC staff's findings and conclusions on the use of the EPRI MOV PPM, and applicable limitations and conditions, are provided in an SE dated March 15, 1996; the SE supplements dated February 20, 1997, and April 20, 2001; and the enclosed supplement to the SE.

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William H. Ruland, Director
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SUPPLEMENT 3 TO SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ON ELECTRIC POWER RESEARCH INSTITUTE

TOPICAL REPORT TR-103237-R2, "EPRI MOTOR-OPERATED VALVE

PERFORMANCE PREDICTION PROGRAM," ADDENDUM 2

1.0 INTRODUCTION

In November 1994, the Nuclear Energy Institute (NEI) submitted for review by the U.S. Nuclear Regulatory Commission (NRC) the Electric Power Research Institute (EPRI) Topical Report TR-103237, "EPRI MOV Performance Prediction Program," describing the EPRI motor-operated valve (MOV) methodology that predicts the applicable thrust or torque required to operate gate, globe, and butterfly valves over a wide range of differential pressure, temperature, and flow conditions. On March 15, 1996, the NRC staff issued a safety evaluation (SE) documenting its acceptance of the EPRI MOV Performance Prediction Methodology (PPM) described in the topical report, with certain conditions and limitations. The SE addressed the EPRI computer model for various gate, globe, and butterfly valves, and EPRI hand-calculation models for Anchor/Darling double-disk gate valves and Westinghouse flexible-wedge gate valves. On February 20, 1997, the NRC staff issued a supplement to that SE documenting its acceptance, with certain conditions and limitations, of the EPRI hand-calculation models for WKM parallel-expanding gate valves and Aloyco split-wedge gate valves, and highlighting other aspects of the EPRI program.

On September 8, 1999, NEI submitted for NRC review Addendum 1, "PPM Version 2.0," and Addendum 2, "Thrust Uncertainty Method," to EPRI Topical Report TR-103237-R2. Version 2.0 of the EPRI MOV PPM described in Addendum 1 to the topical report addresses several modeling errors and incorporates other improvements to the modeling software. On April 20, 2001, the NRC staff issued Supplement 2 to the SE on the EPRI MOV PPM concluding that the changes made to the PPM in Version 2.0 improve the ability of the EPRI model to predict the applicable thrust or torque required to operate gate, globe, and butterfly valves. In Addendum 2 to TR-103237-R2, EPRI describes the development of its Thrust Uncertainty Method that takes into account conservatism in the EPRI MOV PPM to predict a more realistic thrust requirement for closing gate valves.

In this supplement to the SE on the EPRI MOV PPM, the NRC staff documents its review of the EPRI Thrust Uncertainty Method described in Addendum 2 to EPRI Topical Report TR-103237-R2 as supplemented by NEI submittals dated January 5 and December 6, 2001, and June 10, 2002.

2.0 REGULATORY REQUIREMENTS AND RECOMMENDATIONS

The NRC regulations require that MOVs important to safety be treated in a manner that provides assurance of their intended performance. Criterion 1 to Appendix A, "General Design Criteria for Nuclear Power Plants," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 50) states, in part, that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. The quality assurance program to be applied to safety-related components is described in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. In Section 55a of 10 CFR Part 50, the NRC requires licensees to establish inservice testing (IST) programs in accordance with the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* and, as IST programs are updated according to 10 CFR 50.55a, the ASME *Code for Operation and Maintenance of Nuclear Power Plants*.

In response to concerns regarding MOV performance, the NRC staff issued Generic Letter (GL) 89-10 (June 28, 1989), "Safety-Related Motor-Operated Valve Testing and Surveillance," which requested that nuclear power plant licensees and construction permit holders ensure the capability of MOVs in safety-related systems to perform their intended functions by reviewing MOV design bases, verifying MOV switch settings initially and periodically, testing MOVs under design-basis conditions where practicable, improving evaluations of MOV failures and necessary corrective action, and trending MOV problems. The staff requested that licensees complete the GL 89-10 program within approximately three refueling outages or 5 years from the date of issuance of the generic letter. Permit holders were requested to complete the GL 89-10 program before plant startup or in accordance with the above schedule, whichever was later.

On September 18, 1996, the NRC staff issued GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," requesting each licensee to establish a program, or ensure the effectiveness of its current program, to verify on a periodic basis that safety-related MOVs continue to be capable of performing their safety functions within the current licensing bases of the facility. In GL 96-05, the NRC staff summarized several industry and regulatory activities and programs related to maintaining long-term capability of safety-related MOVs. For example, the staff discussed the use of the EPRI MOV PPM in establishing an effective MOV program.

Many licensees are applying the EPRI MOV PPM as part of their program to provide assurance of the capability of MOVs to perform their safety functions in response to GL 89-10 and GL 96-05. Application of the EPRI MOV PPM allows licensees to determine the design-basis capability of MOVs without dynamic testing under high differential pressure and flow conditions. This method of evaluating MOV design-basis capability is important because dynamic testing is not practical for some MOVs as installed in nuclear plants. In addition, licensees are able to minimize the extent of dynamic testing of their safety-related MOVs through application of the EPRI MOV PPM. Also, licensees can use the EPRI MOV PPM as part of their long-term programs to periodically verify the design-basis capability of safety-related MOVs by providing sizing and setup criteria that may bound potential degradation in valve performance over time.

3.0 EPRI THRUST UNCERTAINTY METHOD

In support of the effort by the nuclear industry to address MOV performance issues, EPRI developed the MOV PPM for use by licensees in predicting the thrust and torque required to operate gate, globe, and butterfly valves under dynamic flow conditions. As described in EPRI Topical Report TR-103237-R2, "EPRI MOV Performance Prediction Program," the EPRI MOV PPM program included the development of improved methods for prediction or evaluation of system flow parameters; gate, globe, and butterfly valve performance; and motor-actuator rate-of-loading effects (load sensitive behavior). EPRI developed the PPM based on fundamental engineering principles related to MOV design and operation, including consideration of fluid flow and friction forces. EPRI performed separate effects testing to evaluate specific MOV parameters. EPRI conducted numerous MOV tests to provide data for model and method development and validation, including flow loop testing, parametric testing of butterfly valve disk designs, and plant in-situ flow testing. EPRI integrated the individual models and methods into an overall methodology including a computer model and implementation guide.

In Addendum 2 to Topical Report TR-103237-R2 submitted by NEI on September 8, 1999, EPRI described the development of the Thrust Uncertainty Method that takes into account conservatism in the EPRI MOV PPM to provide a more realistic (less bounding) estimate of the thrust required to operate gate valves than predicted by the PPM. In this effort, EPRI compared the thrust required to operate sample gate valves during flow loop tests conducted as part of the development of the PPM to the thrust requirement predicted by the PPM to establish a representative prediction ratio for the actual-to-predicted thrust required to operate the valves. In applying the Thrust Uncertainty Method, a licensee would use the representative prediction ratio to reduce the EPRI MOV PPM thrust prediction for a specific gate valve to a nominal value. The licensee would determine a thrust prediction uncertainty for that valve based on the EPRI MOV PPM thrust prediction and the nominal thrust prediction obtained using the Thrust Uncertainty Method. The licensee would then establish a minimum thrust to be provided at the control switch trip setpoint (or flow isolation) for the applicable MOV, based on the nominal thrust prediction of the Thrust Uncertainty Method combined with applicable bias and random setup uncertainties (including rate-of-loading effects, diagnostic test equipment uncertainty, control switch repeatability, and the thrust prediction uncertainty).

In Addendum 2 to EPRI TR-103237-R2, EPRI summarizes the Thrust Uncertainty Method as providing a control switch setting thrust for closing solid and flexible wedge gate valves (including Westinghouse gate valves but excluding Borg-Warner gate valves), or predicting the flow isolation thrust for Anchor/Darling double disk and Aloyco split-wedge gate valves, in cold water applications less than 100°F with flow up to 50 feet/second, and in hot water applications up to 550°F at any flow rate. EPRI also specified that the Thrust Uncertainty Method is applicable to gate valve closure strokes that are torque-switch controlled. In the NEI submittal dated June 10, 2002, EPRI modified the Thrust Uncertainty Method and established additional criteria for its application. For example, EPRI increased the representative thrust prediction ratio used in the Thrust Uncertainty Method to calculate the nominal thrust requirement for cold water applications to 0.74, and increased the upper tolerance limit to 1.014 for use in calculating the thrust prediction uncertainty. EPRI eliminated the Thrust Uncertainty Method from hot water applications, but adjusted the upper temperature limit for cold water conditions to 150°F. EPRI indicated that any statistical evaluation of plant rate-of-loading data must satisfy a 95/95 statistical criterion for upper tolerance limit. EPRI specified that an operability margin must be available between the as-left torque switch setting and the Thrust Uncertainty Method thrust prediction equal to 10 percent for high or medium risk MOVs, and 5 percent for low risk MOVs, to account for uncertainties in the development and validation of the Thrust Uncertainty Method. EPRI clarified that the Thrust Uncertainty Method can only be applied if the EPRI MOV PPM prediction applied in the Thrust Uncertainty Method uses the PPM default friction coefficient. If differential pressure test data are available for an MOV to be set using the Thrust Uncertainty Method, or if differential pressure test data are obtained for an MOV set using the method, EPRI specified that plant-specific procedures should be applied to ensure that the setup of the MOV based on the Thrust Uncertainty Method is consistent with or bounds the setup based on actual test data. EPRI requires users of the Thrust Uncertainty Method to consider plant-specific and industry experience, and applicable MOV service conditions, to have confidence that the MOV's performance is consistent with the justification basis for the Thrust Uncertainty Method (e.g., the valve factor and rate-of-loading are not both expected to be high).

4.0 EVALUATION

In preparing the SE dated March 15, 1996, and the supplement dated February 20, 1997, on the EPRI MOV PPM, the NRC staff, with contract assistance from the Idaho National Engineering and Environmental Laboratory (INEEL), evaluated the development of the models used in the PPM, the application of test data by EPRI in validating those models, and the overall PPM assessment conducted by EPRI. In performing its review, the staff recognized the use of fundamental engineering principles by EPRI related to MOV design and operation in developing the PPM, including consideration of fluid flow and friction forces. EPRI determined specific aspects of MOV performance (such as valve internal friction coefficients) from the results of separate effects testing. EPRI then validated the individual PPM models (system, gate valve, globe valve, and butterfly valve) using applicable data from MOV flow tests. EPRI made adjustments to the PPM where determined to be appropriate based on MOV flow tests, such as including a 5 percent margin for gate valves manufactured by Borg Warner to provide assurance that the PPM thrust prediction bounded actual valve performance. EPRI performed an assessment of the integrated MOV PPM using flow loop and plant in-situ test data.

Following the extensive review of the MOV performance models, separate effects tests, and flow tests, the NRC staff concluded in the SE dated March 15, 1996, that the EPRI MOV PPM is an acceptable methodology, with certain conditions and limitations, to predict the thrust or torque required to operate gate, globe, and butterfly valves within the scope of the program, and to bound the effects of load sensitive behavior on motor-actuator thrust output. In a supplement dated February 20, 1997, to the SE, the staff accepted methods developed by EPRI for two unique gate valve designs to predict their operating thrust requirements with certain conditions and limitations. On April 20, 2001, the staff issued another supplement to the SE on the EPRI MOV PPM concluding that the changes made to the PPM in Version 2.0 improve the ability of the EPRI model to predict the applicable thrust or torque required to operate gate, globe, and butterfly valves.

During the development of the MOV PPM, EPRI conducted separate effects tests to determine the friction coefficient of Stellite material used on valve internal sliding surfaces. For cold water applications, EPRI found that hundreds of valve strokes might be necessary for the Stellite friction coefficient to achieve a bounding value. This phenomenon was also observed during tests sponsored by the NRC's Office of Nuclear Regulatory Research and conducted by INEEL. When the bounding Stellite friction coefficient is applied in the EPRI MOV PPM, the thrust predicted to be required to close gate valves under cold water conditions is typically much greater than found to be necessary from actual valve tests. In its Thrust Uncertainty Method, EPRI provides a means to account for this potential conservatism in the prediction of the valve operating requirements by the PPM. The Thrust Uncertainty Method developed by EPRI predicts a minimum allowable closing thrust at control switch trip (or flow isolation) for applicable motor-operated gate valves based on a nominal value for the predicted thrust requirement and a thrust prediction uncertainty combined with other MOV setup uncertainties.

The quantification of the conservatism of the EPRI PPM in establishing the Thrust Uncertainty Method represented a significant challenge for EPRI. The NRC staff conducted several public meetings with NEI and EPRI, and issued requests for additional information, as part of the review of the Thrust Uncertainty Method. In NEI submittals dated January 5 and December 6, 2001, and June 10, 2002, EPRI took several actions to modify the Thrust Uncertainty Method, strengthen its justification, and establish additional criteria for its application. In this SE supplement, the staff summarizes the more significant issues addressed in completing its review of the Thrust Uncertainty Method.

In reviewing the specific flow loop test data used by EPRI in developing the Thrust Uncertainty Method, the NRC staff found that the data represented only a small sample of the total population of safety-related motor-operated gate valves in the nuclear industry. In Addendum 2 to TR-103237-R2, EPRI described the Thrust Uncertainty Method as determining an average (mean) prediction ratio of the actual valve operating thrust compared to the PPM predicted thrust for use in calculating the nominal thrust required to close a gate valve under cold water conditions, based on about 62 test strokes from 14 valves. The staff's review determined that EPRI's thrust prediction ratio data for closing gate valves under cold water conditions reflected a non-normal distribution with the median (0.74) higher than the mean (0.697). In the NEI submittal dated June 10, 2002, EPRI modified the Thrust Uncertainty Method to apply the median (0.74) of the thrust prediction ratio data as more representative of the data for determining the nominal thrust required to close a gate valve in cold water applications. EPRI also modified the Thrust Uncertainty Method to apply an upper tolerance limit of 1.014 (compared to 1) in determining the thrust prediction uncertainty to be combined with other uncertainties to predict a minimum allowable thrust for MOV control switch setting (or flow isolation). The NRC staff considers these modifications to the Thrust Uncertainty Method to address the issues regarding sample size and distribution of the thrust prediction ratio data for cold water applications.

Based on its review, the NRC staff did not consider a statistical analysis to be sufficient as the primary basis for acceptance of the Thrust Uncertainty Method. As noted, the thrust prediction ratio data represented a small sample of the total safety-related MOV population, and revealed a non-normal distribution with the median higher than the mean for cold water applications. In addition, the staff determined that the upper tolerance limit for the data was close to or greater than one depending on the applied statistical approach. In the NEI submittal dated June 10, 2002, EPRI provided additional analysis to support its modification of the Thrust Uncertainty Method to use the median (0.74) of the thrust prediction ratio data and an upper tolerance limit of 1.014 in predicting the minimum allowable thrust for MOV control switch setting (or flow isolation) for cold water applications. In particular, EPRI determined that the use of the median of the thrust prediction ratio data for cold water applications was appropriate to reflect the distribution of the data toward higher values. EPRI reported that its statistical evaluation of the upper tolerance limit of the thrust prediction ratio data using a one-sided tolerance limit approach for a non-normal distribution found 95 percent confidence that 95 percent of the data are bounded by the highest data point (1.014). The NRC staff considers EPRI's revised statistical analysis to be supportive in a qualitative manner of the deterministic considerations used to justify the Thrust Uncertainty Method.

In Addendum 2 to TR-103237-R2, EPRI reported that test data from 19 strokes of 12 valves had been used in its validation of the Thrust Uncertainty Method. In response to NRC staff concerns regarding the minimal validation data, EPRI provided a graphical analysis in the NEI submittal dated June 10, 2002, of the actual-to-predicted thrust requirement ratio versus rate-of-loading effects. EPRI's analysis relies on the independence of valve factor and the rate-of-loading effect in the MOV's performance characteristics. The graphical analysis presented by EPRI indicates the success of the Thrust Uncertainty Method in predicting an acceptable control switch thrust setting for 83 data points in cold water applications. EPRI notes that the success of 83 cases without a failure would suggest a reliability of 99 percent or greater. The NRC staff considers EPRI's use of more extensive data and analysis techniques for validation of the Thrust Uncertainty Method to resolve the validation issues in Addendum 2 to TR-103237-R2.

During its review, the NRC staff found the viability of the Thrust Uncertainty Method for gate valves operated under hot water conditions to be questionable. For example, Addendum 2 to TR-103237-R2 indicates that EPRI used only 12 closing strokes from 7 valves to determine an average thrust prediction ratio for hot water conditions. Further, EPRI determined that the PPM and Thrust Uncertainty Method predicted an inadequate thrust requirement for one hot water valve stroke. In response to these concerns, EPRI limited the application of the Thrust Uncertainty Method to only cold water conditions in the NEI submittal dated June 10, 2002. In making this modification, EPRI increased the maximum allowable cold water temperature for applying the Thrust Uncertainty Method from 100°F to 150°F based on the minimal variation (about 0.02) in the Stellite friction coefficient between these temperatures. The NRC staff considers the elimination of hot water applications from the Thrust Uncertainty Method to be appropriate, and EPRI to have adequately justified the extension of the cold water temperature limit to 150°F.

The NRC staff recognized that the Thrust Uncertainty Method may remove margin from the MOV thrust setting originally provided by application of the EPRI MOV PPM. Therefore, the staff discussed with EPRI the consideration of risk significance of the MOV when applying the Thrust Uncertainty Method. In the NEI submittal dated June 10, 2002, EPRI specified that MOVs set using the Thrust Uncertainty Method must have at least 5 percent margin for valves with low risk significance and at least 10 percent margin for valves with medium or high risk significance. EPRI indicates that the evaluation of MOV risk significance shall be conducted in accordance with accepted risk evaluation methods that include input from an expert panel (e.g., methods implemented in applying the Joint Owners Group Program on MOV Periodic Verification established in response to GL 96-05). EPRI defines margin as the difference between the measured thrust at torque switch trip and the minimum allowable thrust at torque switch trip predicted by the Thrust Uncertainty Method, divided by the minimum allowable thrust at torque switch trip predicted by the Thrust Uncertainty Method. EPRI specifies that the minimum margins are required for design purposes and operability evaluations, and are meant to be coincident with (not in addition to) existing administrative margins. The NRC staff considers these additional criteria for application of the Thrust Uncertainty Method to resolve the issue regarding MOV risk significance.

The NRC staff discussed with EPRI the fundamental assumption of the Thrust Uncertainty Method that it is unlikely that a gate valve will exhibit both a high valve friction coefficient and a high rate-of-loading effect. In response to the significance of this assumption, EPRI requires in the NEI submittal dated June 10, 2002, that users of the Thrust Uncertainty Method consider plant-specific and industry experience, and applicable MOV service conditions, to have confidence that the performance of the MOV to be evaluated is consistent with the justification basis for the Thrust Uncertainty Method (e.g., the valve factor and rate of loading are not both expected to be high). EPRI further specifies that, if differential pressure test data are available for an MOV to be set per the Thrust Uncertainty Method, or if differential pressure test data are obtained for an MOV that was set per the Thrust Uncertainty Method, plant-specific procedures should be applied to ensure that the setup of the MOV based on the Thrust Uncertainty Method is consistent with or bounds the setup based on test data. EPRI also indicates that the Thrust Uncertainty Method will require that any statistical evaluation of plant-specific rate-of-loading data meets a 95/95 statistical criterion for upper tolerance limit. EPRI noted that it will clarify that the PPM prediction on which specific application of the Thrust Uncertainty Method is based must use the default friction coefficients from the PPM guidelines. The NRC staff considers these additional criteria for application of the Thrust Uncertainty Method to address the issue of continued attention to valve friction coefficient data and rate-of-loading effects obtained from plant-specific and industry-wide sources to enable licensees to monitor valve performance characteristics such that the assumptions of the Thrust Uncertainty Method are maintained.

The NRC staff discussed with EPRI whether the thrust prediction ratio data used in the Thrust Uncertainty Method might be affected by the differential pressure across the valve during its operation. In response, EPRI provided in the NEI submittal dated June 10, 2002, a graph of thrust prediction ratio versus contact stress on the valve disk for the 62 test strokes used to determine the representative prediction ratio for cold water applications. The graph indicates that the thrust prediction ratio is not generally affected by the contact stress. As there is insufficient thrust prediction ratio data from tests of valves with contact stresses greater than 15,000 pounds per square inch (psi) of force, EPRI indicated that the applicability of the Thrust Uncertainty Method will be restricted to valve strokes for which the calculated contact stress is no more than 15,000 psi. The NRC staff considers EPRI to have addressed the issue of potential differential pressure effects on the Thrust Uncertainty Method.

In summary, EPRI has resolved the issues identified by the NRC staff during the review of the Thrust Uncertainty Method. For example, EPRI has modified the Thrust Uncertainty Method in light of the NRC review findings, such as applying a more representative thrust prediction ratio and upper tolerance limit for calculating the minimum allowable thrust at the MOV control switch trip setpoint (or flow isolation) for cold water applications, and eliminating the use of the Thrust Uncertainty Method for hot water applications. In addition to the application criteria for use of the MOV PPM specified in TR-103237-R2, EPRI supplemented the criteria for application of the Thrust Uncertainty Method in Addendum 2 to TR-103237-R2 through the NEI letters dated January 5 and December 6, 2001, and June 10, 2002. In an SE dated March 15, 1996, and supplements dated February 20, 1997, and April 20, 2001, the NRC staff provides its findings and conclusions on the use of the EPRI MOV PPM with certain limitations and conditions. Also in response to the review issues, EPRI developed more extensive validation methods and analyses in support of the Thrust Uncertainty Method.

5.0 CONCLUSION

Based on review of Addendum 2 to EPRI Topical Report TR-103237-R2 as supplemented by NEI submittals dated January 5 and December 6, 2001, and June 10, 2002, the NRC staff concludes that the Thrust Uncertainty Method developed by EPRI is acceptable for the prediction of minimum allowable thrust at control switch trip (or flow isolation) for applicable motor-operated gate valves under cold water applications within the scope of the Thrust Uncertainty Method. Therefore, the Thrust Uncertainty Method may be applied consistent with the criteria specified for the EPRI MOV PPM in EPRI TR-103237-R2 and Addenda 1 and 2 to TR-103237-R2, as supplemented by NEI submittals dated January 5 and December 6, 2001, and June 10, 2002. The NRC staff's findings and conclusions on the use of the EPRI MOV PPM, and applicable limitations and conditions, are provided in an SE dated March 15, 1996; the SE supplements dated February 20, 1997, and April 20, 2001; and this supplement to the SE.

Principal Contributor: T. Scarbrough, NRR/EMEB

Date: September 30, 2002