May 9, 2002

MEMORANDUM TO: Christopher I. Grimes, Program Director
Policy and Rulemaking Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

FROM: Peter C. Wen, Project Manager ***/RA/***
Policy and Rulemaking Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MAY 1, 2002, MEETING WITH THE NUCLEAR ENERGY INSTITUTE AND ELECTRIC POWER RESEARCH INSTITUTE REGARDING MOTOR-OPERATED VALVE THRUST UNCERTAINTY METHOD

On May 1, 2002, the NRC staff held a public meeting with representatives of the Nuclear Energy Institute (NEI) and the Electric Power Research Institute (EPRI) to discuss NRC staff comments on Addendum 2, "Thrust Uncertainty Method," to the EPRI Topical Report TR-103237-R2, "EPRI Motor-Operated Valve Performance Prediction Program," describing the EPRI Motor-Operated Valve (MOV) Performance Prediction Methodology (PPM). NEI submitted Addendum 2 to EPRI Topical Report TR-103237-R2 to the NRC staff by a letter dated September 8, 1999. At a public meeting conducted on September 20, 2000, NEI requested that the NRC staff review Addendum 2 to EPRI Topical Report TR-103237-R2, and prepare a supplement to the EPRI MOV PPM safety evaluation (dated March 15, 1996) for the application of Addendum 2 to the EPRI topical report by nuclear power plant licensees. Attachment 1 is a list of the meeting participants.

The purpose of the meeting on May 1, 2002, was to discuss EPRI's response to the NRC staff's comments on Addendum 2 to EPRI Topical Report TR-103237-R2 provided during the public meeting on October 18, 2001 (ADAMS Accession # ML013230415). NEI submitted the response prepared by EPRI in a letter dated December 6, 2001 (ADAMS Accession # ML020160518). To help EPRI prepare for the May 1 meeting, the NRC staff held a telephone conference with NEI and EPRI on March 26 to relay the NRC staff's overall concerns regarding the Thrust Uncertainty Method. Attachment 2 provides a summary of the NRC staff comments on the EPRI supplemental responses submitted on December 6, 2001.

As background, the Thrust Uncertainty Method developed by EPRI estimates the conservatism in the thrust predicted by the EPRI MOV PPM to be necessary to operate gate valves under dynamic flow conditions. The Thrust Uncertainty Method then treats the quantitative conservatism as a random uncertainty that is statistically combined with other uncertainties. In this effort, EPRI compared the thrust required to operate sample gate valves during flow loop tests conducted as part of the EPRI MOV Performance Prediction Program to the thrust requirement predicted by its MOV 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 then determine a thrust prediction uncertainty for that valve by comparing the EPRI MOV PPM thrust prediction to the nominal thrust prediction obtained using the Thrust Uncertainty Method. Finally, the licensee would establish a minimum required thrust to be provided at the torque switch trip based on the nominal thrust prediction combined with bias and random uncertainties (including rate-of-loading effects, diagnostic test equipment uncertainty, torque switch repeatability, and the thrust prediction uncertainty).

At the conclusion of the meeting on October 18, 2001, the NRC staff indicated the main areas of concern regarding the Thrust Uncertainty Method as presented at that time. First, the staff noted that the data used in the Thrust Uncertainty Method to establish an average prediction ratio for determining a nominal value for the thrust required to close a gate valve represented a very small sample of the total population of safety-related motor-operated gate valves in the nuclear industry. Second, the non-normal distribution of the prediction ratios of the actual thrust required to close the sample gate valves under cold water conditions to the EPRI MOV PPM thrust prediction reflected a median value (0.7435) higher than the mean value (0.697) used for the average prediction ratio in the Thrust Uncertainty Method. Third, the comparison of the Thrust Uncertainty Method prediction ratio to the EPRI MOV PPM prediction ratio in Appendix C to Addendum 2 of the EPRI topical report was insufficient to support the assumption that the reliability of MOVs set using the Thrust Uncertainty Method would be consistent with typical probabilistic safety assessments. Fourth, the viability of the Thrust Uncertainty Method for gate valves operated under hot water conditions was questionable in light of the minimal amount of test data, and inadequate thrust prediction by the PPM and Thrust Uncertainty Method for one of the sample valves.

In its responses provided in the NEI submittal dated December 6, 2001, EPRI specified its actions to help resolve the concerns raised by the NRC staff during the October 18 meeting regarding the Thrust Uncertainty Method. For example, EPRI stated that the Thrust Uncertainty Method would be limited to gate valves in cold water applications. As part of this applicability revision, EPRI increased the upper limit of the temperature range to 150 °F for cold water applications. EPRI stated that the median value (0.7435) of the prediction ratio data would be used in the Thrust Uncertainty Method rather than the mean value (0.697) originally proposed. EPRI revised its figure presenting thrust prediction ratios versus rate-of-loading effects to provide additional support for the reliability of the Thrust Uncertainty Method. EPRI proposed that MOVs set up using the Thrust Uncertainty Method be allowed to be classified as high margin in the interim phase of the Joint Owners Group (JOG) Program on MOV Periodic Verification established in response to Generic Letter 96-05, “Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves.” EPRI also provided information on the reliability of the Thrust Uncertainty Method in comparison to MOV reliability assumed in typical probabilistic safety assessments.At the outset of the May 1 meeting, EPRI proposed to modify the Thrust Uncertainty Method to apply a value of 1.014 (rather than 1) as the upper tolerance limit in calculating the uncertainty of the required thrust prediction (U_{TPU}) to help resolve the NRC staff’s concerns. The required thrust prediction uncertainty is combined

with other MOV torque switch setup uncertainties (such as the random rate-of-loading effect, thrust measurement error, and torque switch repeatability) by the square root of the sum-of-the-squares method. The required stem thrust (T_{NOM}) is then increased by the percentage equal to the sum of the combined uncertainty and bias rate-of-loading effect. The proposal by EPRI to increase the upper tolerance limit to 1.014 would provide additional margin in the torque switch setup thrust specified by the Thrust Uncertainty Method.

During the May 1 meeting, EPRI described its initial reply to the NRC staff's comments on the December 6 submittal. Some of the key points discussed by EPRI and the NRC staff during the meeting regarding those initial replies are described in Attachment 3. The NRC staff then summarized those discussions as follows:

1. EPRI should base its justification for the Thrust Uncertainty Method on deterministic considerations with the statistical analysis being generally supportive of the approach.

2. EPRI should revise the inputs to the Thrust Uncertainty Method to apply 0.7435 as the representative prediction ratio in determining the nominal thrust requirement and to apply 1.014 as the upper tolerance limit in determining the thrust prediction uncertainty.

3. EPRI should establish application criteria for use of the Thrust Uncertainty Method that reflects its fundamental assumption that the valve friction coefficient and rate-of-loading effects will not both be high for any specific valve. The application criteria should address such aspects as safety importance, margins, service conditions, plant-specific and industry experience, rate-of-loading calculations, and valve friction coefficient assumptions.

4. EPRI should complete its evaluation of the potential effects of differential pressure or contact stress on the thrust prediction ratios.

In response to the NRC staff's summary, EPRI proposed draft application criteria for use of the Thrust Uncertainty Method. EPRI and the NRC staff discussed the proposed criteria and made adjustments based on those discussions. Attachment 4 is a summary of the draft application criteria discussed at the meeting.

At the conclusion of the meeting, the NRC staff indicated that the adjustments to the Thrust Uncertainty Method and the proposed application criteria would be helpful in resolving the remaining issues on the acceptability of the Thrust Uncertainty Method. Following receipt of the meeting summary, NEI plans to provide EPRI's response to the NRC staff's comments on the December 6 submittal, and also to describe the adjustments to the Thrust Uncertainty Method and the application criteria. The NEI submittal will also address plans for revising Addendum 2 to the EPRI topical report. The NRC staff stated that it would proceed with completion of its review of the Thrust Uncertainty Method upon submission of the information discussed during the meeting.

Having completed discussion of the agenda items, the meeting was adjourned.

Project No. 689

Attachments:
1. Attendance List
2. The NRC Staff Comments on EPRI Supplemental Response dated December 6, 2001, on Thrust Uncertainty Method
3. Discussion Points regarding NRC Staff Comments on Thrust Uncertainty Method
4. Draft Application Criteria for Thrust Uncertainty Method

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ATTENDANCE LIST

PUBLIC MEETING TO DISCUSS
ELECTRIC POWER RESEARCH INSTITUTE
TOPICAL REPORT TR-103237, ADDENDUM 2,
THRUST UNCERTAINTY METHOD

May 1, 2002

NAME	**ORGANIZATION**
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Thomas Scarbrough	NRC/NRR/DE/EMEB
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Jerry Jackson	NRC/RES/DET/ERAB
Jim Riley	NEI
John Hosler	EPRI
Paul Damerell	MPR Associates
Tom Walker	MPR Associates

ATTACHMENT 1

COMMENTS ON EPRI SUPPLEMENTAL RESPONSE DATED DECEMBER 6, 2001, ON THRUST UNCERTAINTY METHOD

1. Is there any flow loop data between 100 °F and 150 °F, or other information, to support EPRI view of no effect on average prediction ratio (APR)?

2. The basis for the "high margin" assumption with respect to motor-operated valves (MOVs) in the Joint Owners' Group program (RAI Question 3) set up using the Thrust Uncertainty Method was not clear.

3. The concerns with statistical validity of 95/95 analysis need to be resolved.

4. In the discussion of RAI Question 2, the NRC staff suggested that EPRI supplement the Appendix C discussion in Addendum 2 of the topical report. Clarify EPRI's response to this comment.

5. EPRI's response does not provide additional information on the population of tested gate valves (26) versus the number of valves (14) used to determine the APR.

6. Where is EPRI's response to RAI Question 6 discussion on probability of an MOV exhibiting both a high valve factor and rate-of-loading effect?

7. Did EPRI respond to RAI Question 8 discussion on use of rate-of-loading uncertainty for flow loop test population and provide guidance for application of the rate-of-loading uncertainty based on plant-specific data?

8. Do the prediction ratios support EPRI's view that a differential pressure effect is not present?

9. Discuss the resolution of comments on Figure B-3 that compares thrust prediction ratios to rate-of-loading effects.

10. Discuss how the slides in the EPRI response on MOV reliability provide confidence that Thrust Uncertainty Method will continue to provide the reliability assumed in probabilistic safety assessments.

ATTACHMENT 2

DISCUSSION POINTS REGARDING NRC STAFF COMMENTS
ON THRUST UNCERTAINTY METHOD

1. With respect to the upper limit of 150 °F for cold water applications, EPRI does not have specific motor-operated valve (MOV) flow data to support the increased temperature limit. However, EPRI noted that the median prediction ratio of 0.7435 to be used in the cold water calculations is approaching the 0.775 average prediction ratio of the hot water applications. Further, EPRI indicated that the separate effects testing revealed that the change in the coefficient of friction for Stellite valve seat material is only about 0.02, or about 3% of the tested value, between 100 °F and 150 °F.

2. The NRC staff did not consider EPRI to have justified its proposal that MOVs set up using the Thrust Uncertainty Method be allowed to be considered high margin valves in the Joint Owners' Group (JOG) program. However, the establishment of application guidance for the Thrust Uncertainty Method might resolve this comment. As noted previously, the appropriate treatment to be applied as part of the long-term JOG program to MOVs set using the Thrust Uncertainty Method cannot be determined until JOG establishes, and the NRC staff reviews, the criteria for long-term periodic verification of the design-basis capability of safety-related MOVs in the JOG final topical report.

3. The NRC staff and EPRI discussed the statistical analysis conducted by EPRI as part of its justification for the Thrust Uncertainty Method. The staff did not consider the statistical analysis conducted for the Thrust Uncertainty Method to be sufficiently rigorous to justify its acceptance. For example, the data used in the Thrust Uncertainty Method to establish an average prediction ratio for determining a nominal value for the thrust required to close a gate valve represented a relatively small sample of the total safety-related MOV population in the nuclear industry, and revealed a non-normal distribution with a median value of the data higher than the mean. In addition, the Upper Tolerance Limit determined for the data was close to or greater than the allowable limit of one depending on the applied statistical approach. As a result, the NRC staff stated that the justification for the Thrust Uncertainty Method should be based on deterministic considerations with the statistical analysis considered to be supportive of the Thrust Uncertainty Method in a qualitative manner.

4. EPRI indicated that the thrust prediction evaluations provided in Appendix C of Addendum 2 to the EPRI topical report would be supplemented to support the justification for the reliability of the Thrust Uncertainty Method. EPRI stated that it would supplement Appendix C of Addendum 2 with the analysis of thrust prediction ratios versus rate-of-loading effects. The EPRI analysis indicates graphically the success of the Thrust Uncertainty Method in predicting an acceptable torque switch thrust setting for over 80 cold water data points without failure, and the extent of the remaining margin following application of the Thrust Uncertainty Method.

5. EPRI discussed the test valves that were not included in the calculation of the average prediction ratio used in the Thrust Uncertainty Method. Most of the excluded test valves were not applicable to the Thrust Uncertainty Method. Those excluded test valves that were applicable with data available were found to have prediction ratios smaller than the 0.7435 median value to be used in the Thrust Uncertainty Method.

6. A fundamental assumption of EPRI's justification for the Thrust Uncertainty Method is the low likelihood that a solid or flexible wedge gate valve will exhibit both a high valve friction coefficient and rate-of-loading effect. The continued reliability of MOVs set up using the Thrust Uncertainty Method is dependent on this assumption remaining valid over their service life. EPRI indicated that it will ensure that this assumption is clearly understood by users of the Thrust Uncertainty Method.

7. EPRI revised its graph of thrust prediction ratios versus rate-of-loading effects to provide additional support for the Thrust Uncertainty Method. EPRI stated that it planned to specify more clearly that users of the Thrust Uncertainty Method must use rate-of-loading values based on plant-specific data with statistical analysis consistent with the Thrust Uncertainty Method, or use the rate-of-loading values determined as part of the EPRI MOV Performance Prediction Methodology (PPM).

8. EPRI presented initial evaluations of the potential effect of differential pressure on the prediction ratios comparing the actual operating thrust requirements and the EPRI MOV PPM thrust predictions. EPRI stated that it would provide a more detailed analysis in response to discussions during this meeting.

9. In response to previous NRC staff comments, EPRI revised its graph of thrust prediction ratios versus rate-of-loading effects to include a line representing the PPM thrust prediction. EPRI noted that the NRC staff's description of the concerns regarding the hot water valve data should have stated that both the PPM prediction and Thrust Uncertainty Method did not provide an adequate torque switch thrust setting for one valve. EPRI emphasized that users of the Thrust Uncertainty Method must apply the default valve friction coefficients in the MOV PPM and may not apply plant-specific valve friction coefficients. EPRI noted that the acceptability of the Thrust Uncertainty Method is the result of the margin in the default valve friction coefficient used in the PPM calculations, and not the margin in the specific performance of the PPM models themselves. EPRI stated that it will clarify the description of the thrust prediction ratios as plotted against the rate-of-loading effects.

10. EPRI discussed the support provided in statistical terms by the success of the Thrust Uncertainty Method in predicting an adequate torque switch thrust setting for over 80 data points.

DRAFT APPLICATION CRITERIA FOR THRUST UNCERTAINTY METHOD

1. The applicability criteria for use of the EPRI Motor-Operated Valve (MOV) Performance Prediction Methodology (PPM) must be satisfied.

2. The Thrust Uncertainty Method is only applicable to solid wedge and flexible wedge gate valves (excluding Borg-Warner gate valves) operating in the closing direction.

3. Valve operation must be controlled in the closing direction by the torque switch.

4. The Thrust Uncertainty Method can only be used for cold water applications up to 150 °F.

5. The rate-of-loading effect applied in the Thrust Uncertainty Method must be obtained from either (1) the EPRI MOV PPM; or (2) plant-specific data determined from a 95/95 confidence analysis.

6. An operability margin must be available between the as-left torque switch setting and the Thrust Uncertainty Method thrust prediction equal to 10% for high/medium risk MOVs and 5% for low risk MOVs to account for uncertainties in the development and validation of the Thrust Uncertainty Methodology.

7. The default valve friction coefficient of the EPRI MOV PPM must be used in calculating the required thrust prediction from the PPM as an input to the Thrust Uncertainty Method.

8. If differential pressure test data are available for the MOV to be set using the Thrust Uncertainty Method, plant-specific procedures must 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.

9. Users of the Thrust Uncertainty Method must consider plant-specific and industry experience, and applicable MOV service conditions, to have confidence that the MOV's performance is consistent with the assumptions of the Thrust Uncertainty Method regarding the valve friction coefficient and rate-of-loading effects sufficient to remain within the justification analysis for the Thrust Uncertainty Method.