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Mr. Ralph Beedle
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SUBJECT: SUPPLEMENT TO SAFETY EVALUATION ON THE ELECTRIC POWER RESEARCH INSTITUTE (EPRI) TOPICAL REPORT TR-103237, "EPRI MOV PERFORMANCE PREDICTION PROGRAM" (REVISION 1)

Dear Mr. Beedle:

The NRC staff has prepared a supplement to the safety evaluation dated March 15, 1996, on the subject topical report submitted by the Nuclear Energy Institute (NEI) on February 22, 1994 (Revision 0), and November 3, 1995 (Revision 1).

With the conditions and limitations described in the enclosed supplement and the safety evaluation dated March 15, 1996, the staff considers the EPRI Motor-Operated Valve (MOV) Performance Prediction Program to provide an acceptable computer methodology to predict the thrust or torque required to operate gate, globe, and butterfly valves within the scope of the program, to bound the effects of load sensitive behavior on motor-actuator thrust output, and to provide acceptable hand-calculation methods to bound the thrust required to operate the Anchor/Darling double-disk gate valves, Westinghouse flexible-wedge gate valves, WKM parallel-expanding gate valves, and Aloyco split-wedge gate valves addressed by the EPRI program.

The final version of the topical report should incorporate this letter, the safety evaluation, the enclosed supplement to the safety evaluation, NRC staff written comments provided to NEI on the EPRI program, and the submitted EPRI responses.

Please advise us within 30 days whether any material in the enclosed supplement to the safety evaluation is considered proprietary. Absent such notification, the staff will place the supplement to the safety evaluation in the NRC Public Document Room.

Sincerely,

Brian W. Sheron for

Ashok C. Thadani, Associate Director
for Technical Review
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Enclosure: Supplement to Safety Evaluation
cc w/o encl: See next page
Project No. 689

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SUPPLEMENT TO SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION OF ELECTRIC POWER RESEARCH INSTITUTE TOPICAL REPORT TR-103237, "EPRI MOTOR-OPERATED VALVE PERFORMANCE PREDICTION PROGRAM"

In November 1994, the Nuclear Energy Institute (NEI) submitted the Electric Power Research Institute (EPRI) Topical Report TR-103237, "EPRI MOV Performance Prediction Program," describing the EPRI motor-operated valve (MOV) program that predicts the thrust/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 computer methodology described in the topical report, with certain conditions and limitations. The SE addressed the EPRI computer model for globe and butterfly valves and various gate valves, and EPRI hand-calculation models for Anchor/Darling double disk gate valves and Westinghouse flexible wedge gate valves.

The staff prepared this supplement to the SE to discuss two additional gate valve designs that EPRI addresses by hand-calculation methods and to highlight other NRC concerns that have come to light since the issuance of the SE in March 1996. These gate valve designs are the WKM parallel-expanding gate valve and the Aloyco split-wedge gate valve. In addition to the staff review discussed in this SE supplement, users of the hand-calculation models for the WKM parallel-expanding gate valve and Aloyco split-wedge gate valve will be expected to review the SE for any applicable limitations and conditions.

I. GENERAL COMMENTS ON EPRI PERFORMANCE PREDICTION PROGRAM

In the SE dated March 15, 1996, the NRC staff provided specific conditions and limitations regarding use of the EPRI computer model for gate, globe and butterfly valves, and the EPRI hand-calculation models for Anchor/Darling double-disk gate valves and Westinghouse flexible-wedge gate valves. In applying the EPRI methodology, users will be expected to be aware of the conditions and limitations discussed in all sections of the SE and this supplement, and their applicability to the specific gate, globe or butterfly valve being addressed by the user.

In addressing the scope of its MOV Performance Prediction Methodology, EPRI indicates the applicability of its methodology to gate, globe and butterfly valves of various manufacture under a wide variety of fluid conditions. As discussed in the SE and this supplement, EPRI has presented sufficient justification to validate its methodology for a less extensive set of gate, globe and butterfly valves, and fluid conditions. For example, the NRC staff did not review the EPRI program for validation with respect to double offset butterfly valves, certain globe valve designs and flow directions, or motor actuator torque requirements for rotating rising-stem gate and globe valves. Where a user intends to rely on the EPRI methodology as a design standard

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beyond the bounds of the NRC staff's accepted validation, the user will be expected to validate the methodology for the specific gate, globe or butterfly valve, and its intended fluid conditions. Until completion of the validation effort, the use of the EPRI methodology might be determined to constitute the best available information on the performance of the specific valve under the applicable conditions.

In light of the lessons learned from the EPRI MOV Performance Prediction Program, EPRI has initiated revisions to the Nuclear Maintenance Applications Center (NMAC) application guides to update the methods for predicting thrust and torque requirements to operate motor-operated gate and globe valves and torque requirements for motor-operated butterfly valves. The NRC staff highlighted some of the lessons learned from the EPRI program in NRC Information Notice 96-48, "Motor-Operated Valve Performance Issues." The NRC staff is providing comments on the proposed revisions to the EPRI/NMAC MOV application guides.

The EPRI MOV Performance Prediction Methodology provides a bounding estimate of the thrust requirements for gate and globe valves and torque requirements for butterfly valves within the scope of the EPRI program when the conditions and limitations of the methodology are applied in their entirety. The NRC staff has reviewed the EPRI methodology as a complete package in that certain nonconservative assumptions in the models are compensated by other conservative assumptions in the analytical formulas. Selective use of test data or methods from the EPRI program may result in underpredicting the thrust or torque required to operate gate, globe or butterfly valves. For example, the NRC staff raised questions regarding the reliability of test data for some valves used in developing or validating the EPRI models. These questions included the lack of preconditioning to achieve a maximum friction coefficient. In using the EPRI models, it is important to understand the questions from the NRC staff and the written responses provided by EPRI. These questions and answers are to be included in the final Topical Report package.

Users of the EPRI MOV Performance Prediction Methodology are alerted to the fact that valves can degrade with time and that allowances may be necessary to account for these degraded conditions. For example, EPRI indicates that the long-term reliability of its predictions of the thrust required to operate valves depends on the implementation of an effective preventative maintenance program for the valves.

On page 9 of the SE, the NRC staff notes that EPRI has determined that gate valves with carbon steel guide slots and rails must have at least a minimum specified guide clearance for galling products not to fill the available clearance. EPRI discusses this minimum clearance with respect to stainless steel surfaces in Table 5-10 of the Topical Report.

On page 30 of the SE, the NRC staff noted that it did not consider EPRI to have provided sufficient justification to establish the points identified in its data traces as flow isolation for Anchor/Darling double-disk gate valves. The staff considers the EPRI method to be adequate for analytically predicting the thrust required to reach the full seat overlap for Anchor/Darling double-disk valves. The amount of flow through the valve at this stroke position will depend on the differential pressure loading, the disk area, and the seat contact stress. Testing by Commonwealth Edison Company, and by the Idaho National Engineering Laboratory sponsored by the NRC Office of Nuclear Regulatory Research, has indicated that significant thrust can be required to spread the disc wedges sufficiently to meet leakage limitations. Similarly, the thrust required to overcome the friction of the disc wedges when opening the valve can be significant. The user must ensure that sufficient wedging is achieved to meet valve specific leak tightness requirements, and that sufficient thrust is available to achieve the necessary wedging when closing and to overcome the wedge friction when opening.

In Section 10 of the Topical Report, EPRI allows users to apply valve-specific test data in determining a friction coefficient for input into the gate valve model. As discussed in EPRI's response to NRC staff questions, the user should not apply friction coefficients less than 0.3 where a thrust trace is used to determine a valve-specific friction coefficient, because of the unreliability of such low friction values and the high potential for the friction coefficient to increase as the valve undergoes additional service.

EPRI allows model users to extrapolate data for gate valves when closing under reduced differential pressure and flow conditions. The occurrence of a "hook" in the force trace indicates that the thrust required to close the gate valve is greatest before flow isolation. This could be caused by such conditions as the guide friction being higher than valve seat friction, or the presence of valve internal damage. In its response to NRC staff questions, EPRI states that the user would be cautioned to perform a model calculation for the partial differential-pressure flow condition using the measured friction coefficient. If the actual thrust data trace exceeds the model prediction at the "hook" or at seating, the EPRI model might underestimate the thrust requirements under design-basis conditions.

Table 4-5 of the EPRI Implementation Guide provides the applicability of the EPRI methodology to grease-type lubricants. The applicable greases are described in the applicability discussion of Section 9 of the EPRI Topical Report.

Section 5 of the EPRI Implementation Guide notes that the user should confirm that the differential pressure, flow and upstream pressure predicted by the flow module are consistent with the design-basis values. Users should be aware of this provision when applying the flow module for any valve in the EPRI program.

II. SPECIFIC COMMENTS ON EPRI HAND-CALCULATION MODELS FOR WKM PARALLEL-EXPANDING GATE VALVE AND ALOYCO SPLIT-WEDGE GATE VALVE

1. WKM Parallel-Expanding Gate Valve

a. Model Description

The WKM parallel-expanding gate valve has a "through conduit" design with a disk assembly twice as long as the disk in a conventional gate valve. A hole through the lower portion of the disk assembly aligns with the flow area of the pipe when the valve is open. The valve has two wedge-type disk pieces (gate and segment) that separate when moving relative to each other as the assembly operates with the valve stem. The valve has a shoe mechanism to prevent relative motion of the gate and segment, except near the full open and closed positions. When closing, the segment contacts the bottom of the valve bonnet resulting in expansion of the disk assembly against the seats to create a seal.

EPRI developed a hand-calculation model for bounding the thrust required to open and close the WKM parallel-expanding gate valve. The approach is typical of the other EPRI gate valve models, where individual force terms are combined to obtain the total predicted stem thrust. The terms considered include: the weight of the stem, gate and segment; packing friction; stem rejection; differential-pressure forces acting across the gate; and the torque reaction factor. With the exception of differential-pressure forces, these terms are calculated in the same manner as the EPRI gate valve computer model. The determination of the differential-pressure forces across the gate is a function of the friction coefficients at the various sliding surfaces, the differential pressure across the valve, and the seating force necessary to create a leak-tight seal at the downstream seat.

EPRI based its validation of the hand-calculation model on test data obtained in situ from three WKM parallel-expanding gate valves. The test data included opening and closing dynamic strokes for a 6-inch 300-pound class valve and an 8-inch 150-pound class valve, and opening hydrostatic strokes for a 16-inch 1500-pound class valve. All tests were conducted using water at ambient temperature with flow in the preferred direction (gate downstream).

EPRI considers the hand-calculation model applicable to WKM parallel-expanding gate valves with Stellite 6 hardfacing on the disk-to-seat interface that are installed in the preferred flow orientation. EPRI states that the model has been validated for only cold water conditions. The WKM Valve Company (currently Cooper Cameron Corporation) provided information to EPRI in the development of the hand-calculation model.

b. Model Evaluation

The NRC staff and its contractors evaluated the EPRI hand-calculation model for the WKM parallel-expanding gate valve by reviewing EPRI documentation and discussing the model with NEI, EPRI, and the EPRI Technical Advisory Group (TAG) utility members. On March 4, 1996, the NRC staff provided written comments to NEI on the EPRI model for the WKM parallel-expanding gate valve. On June 18, 1996, NEI provided EPRI's response to the staff comments.

EPRI relied on its separate-effects testing of friction coefficients and limited test data for WKM parallel-expanding gate valves in justifying the reliability of its hand-calculation model for these valves. In response to a staff concern regarding the extent of the valve test data, EPRI discussed the limitations on the applicability of the model and further information from industry testing of WKM parallel-expanding gate valves. In particular, EPRI stated that the applicability of the model is limited to prediction of thrust requirements for flow in the preferred direction because the validation data included only this valve orientation. EPRI also stated that the applicability of the model is limited to incompressible water flow because validation data were available only for this condition. EPRI includes an additional limitation of fluid temperature less than 150 °F due to a potential change in effective disk area under compressible or flashing flow conditions. EPRI obtained additional test data for seven 8-inch and four 3-inch WKM parallel-expanding gate valves that support the reliability of the maximum thrust predicted by the hand-calculation model.

Based on NRC staff and contractor review of the EPRI reports and data, the EPRI responses to staff comments, discussions between the staff and EPRI, and the supporting industry information, the staff does not object to the use of the EPRI hand-calculation model in bounding the thrust required to operate WKM parallel-expanding gate valves in accordance with the limitations and conditions in the SE and this supplemental SE. EPRI is expected to address new information as appropriate that becomes available with respect to the application and implementation of the model (such as development of valve damage criteria). Because of the limited data available in validating the hand-calculation model for the WKM parallel-expanding gate valves, model users are expected to compare their available data, if any, for these valves when applying the hand-calculation model. The staff also emphasizes that model users are responsible for establishing adequate margin in sizing and setting their valves. (See NRC staff comment 1 on WKM parallel-expanding gate valves, and EPRI responses.)

The WKM parallel-expanding gate valve includes a secondary flow path around the valve disk. EPRI applies an addend to the outer diameter of the seat ring for the pressure area term used in bounding the thrust requirement when the disk covers the flow area. EPRI compared its model predictions to actual test results to support the adequacy of the addend. (See NRC staff comment 2 on WKM parallel-expanding gate valves, and EPRI responses.)

EPRI allows users of the WKM hand-calculation model to input a disk-to-seat sliding friction coefficient obtained from reduced differential-pressure or hydropump testing. EPRI specifies a minimum allowable friction coefficient of 0.3 that may be input. However, the test data revealed several instances where a 0.3 friction coefficient was exceeded. This test information and the minimal amount of validation data do not allow the NRC staff to accept the EPRI methodology as a design standard if users apply the model with less than the default friction coefficients obtained by EPRI in its separate-effects testing. Model users will need to justify reliance on the model when friction coefficients are input. (See NRC staff comment 3 on WKM parallel-expanding gate valves, and EPRI responses.)

In evaluating its test information, EPRI found similar thrust requirements for opening and closing some WKM parallel-expanding gate valves. EPRI indicated that these results are expected considering the small stem rejection load and zero disk angle. (See NRC staff comment 4 on WKM parallel-expanding gate valves, and EPRI responses.)

The EPRI model does not include potential unpredictable behavior because the disk remains flat against the body seats during its full stroke and the valve does not contain disk/body guides. It would appear that mechanisms do not exist for the development of high contact loads and material damage in WKM parallel-expanding gate valves. However, recent testing of WKM valves at a nuclear plant (after NRC/EPRI detailed interactions) revealed apparent valve damage behavior. Therefore, EPRI should consider the need for valve damage criteria for the WKM parallel-expanding gate valve model. (See NRC staff comment 5 on WKM parallel-expanding gate valves, and EPRI responses.)

During closing of a WKM parallel-expanding gate valve, the maximum thrust occurs prior to flow isolation because of secondary flow around the disk and the resulting increased thrust requirements. After passing this closure point, the thrust required to close the valve decreases as the disk reaches initial wedging. Therefore, flow isolation and initial wedging will be achieved if the actuator is sized and set to overcome the maximum thrust required to fully stroke the valve. (See NRC staff comment 6 on WKM parallel-expanding gate valves, and EPRI responses.)

EPRI justified omission of the friction coefficient for sliding between the shoe mechanism and guides as insignificant. EPRI also determined that the force required to expand the segment was negligible. EPRI noted that the gate and segment could remain wedged during opening but that the unwedging thrust will be lower than if the segment collapses. (See NRC staff comment 7 on WKM parallel-expanding gate valves, and EPRI responses.)

EPRI provides a method to predict unseating thrust for WKM parallel-expanding gate valves. The unseating thrust is typically small compared to wedge-type valves because of the design of WKM parallel-expanding gate valve. EPRI compared test information to support the reliability of its method. (See NRC staff comment 8 on WKM parallel-expanding gate valves, and EPRI responses.)

In response to a staff question, EPRI obtained the opinion of the manufacturer of the WKM parallel-expanding gate valve regarding the EPRI model. The manufacturer stated that the EPRI methodology is consistent with its information on similar valves and that the model appears conservative in predicting thrust requirements. The manufacturer did not attempt to verify the accuracy of the equations in the model and stated that its review does not constitute endorsement of the EPRI model as the only method to predict the operating load for WKM parallel-expanding gate valves. (See NRC staff comment 9 on WKM parallel-expanding gate valves, and EPRI responses.)

EPRI validated the WKM model using test data from valves in situ and separate-effects test specimens. EPRI states that use of the default sliding friction coefficients (obtained by EPRI from its separate effects testing) in the WKM model will result in predictions of thrust requirements that will bound actual requirements if the valve undergoes appropriate preventative maintenance. The staff agrees with the need for appropriate preventative maintenance. (See NRC staff comment 10 on WKM parallel-expanding gate valves, and EPRI responses.)

Some WKM parallel-expanding gate valves include a spring-mechanism to hold the gate and segment together in midstroke positions. EPRI obtained supplemental test data from valves with this design. The model conservatively bounded the thrust required to operate valves with the spring mechanism. (See NRC staff comment 11 on WKM parallel-expanding gate valves, and EPRI responses.)

Many WKM parallel-expanding gate valves have a thermal relief valve installed in a hole through the segment. These thermal relief valves limit the pressure differential between the bonnet and upstream piping to about 250 pounds per square inch differential (psid). If a thermal relief valve is not installed in the hole through the segment, the bonnet and upstream pressures remain equal and the potential for pressure locking is eliminated. As discussed in the SE, the EPRI program does not address thrust requirements to overcome pressure locking. (See NRC staff comment 12 on WKM parallel-expanding gate valves, and EPRI responses.)

Similar to other EPRI models discussed in the SE, users of the EPRI hand-calculation model for WKM parallel-expanding gate valves are responsible for justifying the capability of the motor actuator to operate the valves. This includes consideration of the effects of load sensitive behavior on actuator output as discussed in the SE. (See NRC staff comment 13 on WKM parallel-expanding gate valves, and EPRI responses.)

c. Conditions/Limitations

EPRI is expected to address new information as appropriate that becomes available with respect to the application and implementation of the model. EPRI is also expected to address the need for damage criteria in the model.

Because of the limited data available for validating the hand-calculation model for WKM parallel-expanding gate valves, model users must compare their available data, if any, for these valves when applying the hand-calculation model.

The staff emphasizes that model users are responsible for establishing adequate margin in sizing and setting their valves.

The staff agrees with EPRI on limiting the applicability of the WKM parallel-expanding gate valve hand-calculation model to the preferred flow direction with liquid water at less than 150 °F.

The staff endorses the EPRI model as a design standard only where the EPRI-supplied default friction coefficient (obtained by EPRI from its separate-effects testing) for less than 150 °F is applied. Model users will need to justify reliance on the model when friction coefficients are input less than the default values obtained by EPRI from its separate-effects testing.

Model users will need to apply the maximum thrust predicted by the model up to initial wedging to ensure that flow isolation is achieved when closing the valve.

In addition to this SE supplement, model users are expected to review the SE for applicable conditions and limitations. For example, model users are responsible for justifying the capability of the motor actuator to deliver the required thrust to operate the valve, including load sensitive behavior.

2. Aloyco Split-Wedge Gate Valve

a. Model Description

The Aloyco split-wedge gate valve is similar in many respects to other wedge-type gate valves. However, the disk assembly of the Aloyco split-wedge gate valves consists of two separable disk halves that are connected by a ball-and-socket joint. The ball-and-socket joint carries the load between the two disk halves but does not prevent the disk halves from separating. There are three types of disk constraints used in the Aloyco split-wedge gate valve design (vertical plate guide, hook, and ear/slot).

EPRI developed a hand-calculation model for bounding the required thrust to open and close the Aloyco split-wedge gate valve. The approach is typical of the other EPRI gate valve models, where individual force terms are combined to obtain the total predicted stem thrust. The terms considered include: sliding friction force, forces in stem-axis due to fluid flow (opening stroke only), disk assembly conformance friction force (closing stroke only), packing friction, stem rejection force, disk assembly and stem weight, torque reaction factor, and unwedging force (opening stroke only). The disk assembly and stem weight, packing friction, stem rejection force, and torque reaction factor are determined in the same manner as the EPRI gate valve computer model. The remaining terms are calculated specifically for the Aloyco split-wedge gate valve design.

EPRI based its validation of the hand-calculation model on flow loop testing of a 4-inch, 150-pound class Aloyco split-wedge valve with vertical plate guides. The valve was oriented with the male disk downstream which is predicted by the model to require more thrust to hard seat the valve than the opposite orientation. The testing was conducted under ambient water conditions with pumped flow less than 15 feet per second.

EPRI considers the hand-calculation model applicable to Aloyco split-wedge gate valves with Stellite 6 hardfacing on the disk and seat ring faces, and with stainless steel on the stem ring, ball connector, and socket connector; water flow at temperatures up to 100 °F; valves oriented with the male disk downstream and the stem vertically upward; and valves with the vertical plate disk guides in the bonnet region. According to EPRI, the manufacturer declined to provide its views on the EPRI model.

b. Model Evaluation

The NRC staff and its contractors evaluated the EPRI hand-calculation model for Aloyco split-wedge gate valves by reviewing EPRI documentation and discussing the model with NEI, EPRI, and the EPRI TAG utility members. On May 30, 1996, the NRC staff provided written comments to NEI on the EPRI model for the Aloyco split-wedge gate valves. On August 20, 1996, NEI provided EPRI's response to the staff comments.

EPRI relied on its separate-effects testing of friction coefficients and limited valve test data in justifying the reliability of its hand-calculation model for Aloyco split-wedge gate valves. EPRI believes the model to be reliable for predicting the thrust required to achieve wedging for Aloyco split-wedge gate valves with certain conditions. EPRI establishes a temperature limitation because of the absence of stainless steel-to-stainless steel friction data for higher temperatures. EPRI performed its flow loop tests with the valve oriented with the male disk downstream, which EPRI believes requires greater thrust to reach hard wedging than the opposite orientation. With respect to the three types of disk guides, EPRI notes that the midstroke thrust requirements can be affected by the guide type. In summarizing its key limitations on use of the model for predicting the wedging thrust, EPRI stated that (1) water temperatures must not exceed 100 °F, (2) the valve orientation must be assumed to be male disk downstream, and (3) valves must have vertical plate guides in the bonnet region. For thrust required to reach full seat overlap (primary flow blockage), EPRI indicates no directional or temperature limitations. (See NRC staff comment 1 on Aloyco split-wedge gate valve, and EPRI response.)

For the closing valve stroke, the Aloyco split-wedge gate valve can experience a significant increase in the thrust requirement between primary flow blockage and initial wedging. The staff considers the model to adequately bound the thrust required to reach primary flow blockage for the low temperature water conditions evaluated as part of the EPRI program. EPRI was not able to demonstrate that its model reliably predicted the thrust required to reach initial wedging beyond primary flow blockage. Therefore, the staff accepts the use of the model as a design standard in predicting the thrust required to achieve primary flow blockage for the Aloyco split-wedge gate valve with vertical plate guides in the bonnet region for water conditions less than approximately 150 °F. For flow blockage, the thrust requirements are similar for valves oriented with either the male disk downstream or upstream. Model users will also need to justify that leakage limits are satisfied for the specific valves where only flow blockage is achieved. Model users will need to validate the use of the EPRI model as a design standard for flow blockage outside of these limitations.

For opening valve stroke, the staff accepts the model as a design standard for opening strokes with the applicable limitations established by EPRI in the Topical Report.

Model users will be expected to justify reliance on the model as a design standard for achievement of wedging in establishing the thrust required to close the Aloyco split-wedge gate valve. The staff agrees with the current EPRI conditions on use of its model for predicting thrust requirements to achieve wedging, such as the 100 °F temperature limitation, presence of vertical plate guides in the bonnet region, and assumption of valve orientation with male disk downstream. The staff also believes that model users will need to address the need for damage criteria and the limited data for large valves in justifying the use of the model as a design standard. Until further justification to expand the validation of the EPRI model, use of the EPRI model might be considered the best available information on the performance of Aloyco split-wedge gate valves. (See NRC staff comment 2 on Aloyco split-wedge gate valve, and EPRI response.)

EPRI found low friction coefficients for its test valve. EPRI notes that valves with low disk-to-seat contact stress showed erratic preconditioning results. EPRI did not take credit for these low friction coefficients in its model because of non-uniform preconditioning results. (See NRC staff comment 3 on Aloyco split-wedge gate valve, and EPRI response.)

When applying the actual friction coefficients for the test valve, the EPRI model significantly underpredicted the thrust requirements for fluid conditions of 200 psid differential pressure and above. EPRI indicates that the model adequately predicted the thrust requirements when the default coefficients obtained from its separate-effects testing were used. EPRI allows model users to input friction coefficients as low as 0.3 when applying the model. Based on this inability of the model to reliably predict thrust requirements with actual friction coefficients, the staff endorses the model only where the EPRI-supplied default friction coefficients obtained by EPRI from its separate-effects testing are used. Model users will need to justify reliance on the model when friction coefficients are input less than the default values obtained by EPRI from its separate-effects testing. (See NRC staff comment 4 on Aloyco split-wedge gate valve, and EPRI response.)

The EPRI model does not contain criteria regarding the potential for unpredictable valve behavior or internal damage. EPRI states that disk tipping scenarios with the possibility of damage had been envisioned when developing the model. However, EPRI considered the temperature limitations of the model, and the typical low pressure and temperature service applications for these valves at nuclear plants, to result in a negligible potential for internal damage. Where model users intend to justify reliance on the model as a design standard for predicting thrust required to achieve primary flow blockage above 150 °F or to achieve wedging, the staff considers that model users will be expected to justify that their specific application does not have a potential for valve damage during operation. Over the long term, EPRI should consider the development of damage criteria in its hand-calculation model for Aloyco split-wedge gate valves. (See NRC staff comment 5 on Aloyco split-wedge gate valve, and EPRI response.)

EPRI provides a method to predict unwedging thrust for Aloyco split-wedge gate valves similar to flexible or solid wedge gate valves. In response to a staff question, EPRI provided additional justification of the reliability of its prediction of unwedging thrust for these valves. (See NRC staff comment 6 on Aloyco split-wedge gate valve, and EPRI response.)

The design of Aloyco split-wedge gate valves is similar in many respects to other wedge-type gate valves. Model users need to review the SE for conditions and limitations applicable to the Aloyco split-wedge gate valve. (See NRC staff comment 8 on Aloyco split-wedge gate valve, and EPRI response.)

Based on NRC staff and contractor review of the EPRI reports, the EPRI responses to staff comments, discussions between the staff and EPRI, and the supporting industry information, the staff does not object to the use of the EPRI hand-calculation model in bounding the thrust required to operate Aloyco split-wedge gate valves in accordance with the limitations and conditions in the SE and this supplemental SE. EPRI is expected to address new information as appropriate that becomes available with respect to the application and implementation of the model. Because of the limited data available in validating the hand-calculation model for the Aloyco split-wedge gate valves, model users are expected to compare their available data, if any, for these valves when applying the hand-calculation model. The staff also emphasizes that model users are responsible for establishing adequate margin in sizing and setting their valves.

Similar to other EPRI models discussed in the SE, users of the EPRI hand-calculation model for Aloyco split-wedge gate valves are responsible for justifying the capability of the motor actuator to operate the valves. This includes consideration of the effects of load sensitive behavior on actuator output.

c. Conditions/Limitations

EPRI is expected to address new information as appropriate that becomes available with respect to application and implementation of the model.

Because of the limited data available for validating the hand-calculation model for Aloyco split-wedge gate valves, model users must compare their available data, if any, for these valves when applying the hand-calculation model.

The staff emphasizes that model users are responsible for establishing adequate margin in sizing and setting their valves.

The staff accepts the use of the model as a design standard in predicting the thrust required to achieve primary flow blockage for the Aloyco split-wedge gate valve with vertical plate guides in the bonnet for water conditions less than approximately 150 °F. Model users must justify that leakage limits are satisfied for the specific valves. Model users will need to validate the use of the EPRI model as a design standard for flow blockage outside of these limitations.

The staff accepts the use of the model as a design standard for opening valve strokes in accordance with the limitations established by EPRI.

With respect to wedging, the staff agrees with the limitations that EPRI has placed on the application of its Aloyco split-wedge hand-calculation model. The staff also believes that model users will need to address the need for damage criteria and the limited data for large valves in justifying the use of the model as a design standard.

Until further justification to expand the validation of the EPRI model, use of the EPRI model might be considered the best available information on the performance of Aloyco split-wedge gate valves.

Model users must justify reliance on the Aloyco split-wedge gate valve model when friction coefficients are input other than the EPRI-supplied default friction coefficients obtained by EPRI from its separate-effects testing.

For predictions of thrust required to achieve wedging or high-temperature flow blockage, model users are expected to justify that Aloyco split-wedge gate valves will not undergo damage in their specific valve application. Over the long term, EPRI should consider development of damage criteria for its model.

Model users must review the SE for conditions and limitations applicable to the Aloyco split-wedge gate valve. For example, model users are responsible for justifying the capability of the motor actuators to deliver the required thrust including consideration of load sensitive behavior.