ENCLOSURE 1

NUMARC

NUCLEAR MANAGEMENT AND RESOURCES COUNCIL

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November 30, 1992

Mr. Thomas G. Scarbrough
Mechanical Engineering Branch
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Scarbrough:

This letter transmits the EPRI TAG responses to the Staff questions as a result of the October 8 and 9, 1992, NRC/EPRI TAG meeting. We expect to further clarify the scope of the EPRI Performance Prediction Program during the December 3, 1992, meeting.

If you have any questions concerning our responses, please give me a call.

Sincerely,

R. Clive Callaway

R. Clive Callaway
Senior Project Manager
Operations, Management and
Support Services Division

RCC
Enclosure

cc: Ted Sullivan, NRC/NRR
Dr. G. Weidenhamer, NRC/RES
Bob Steele, INEL

EPRI/TAG Responses to the NRC Staff Comments on the EPRI MOV PPP
(November, 1992)

1. COMMENT:

EPRI should release the results of its motor-operated valve (MOV) tests on a regular basis for use by licensees in their Generic Letter (GL) 89-10 programs in sizing and setting MOVs for which design basis testing is not practicable. EPRI will need to provide the basis for valve or stem friction coefficients determined from the test results. This information should include valve disk position used to select the thrust required to close the valve such that the design requirements of the MOV are satisfied. At the October 1992 meeting, EPRI and NUMARC stated that guidance would be developed for use of preliminary EPRI test data by licensees.

RESPONSE:

Table 1 provides a listing of all Program products along with their estimated publication dates. Note that test data from MOV testing will be provided as testing is completed in each specific test loop. The MOV test data will be summarized on forms (see Figures 1 and 2). The time, thrust, torque, DP, apparent disc and stem coefficients of friction will be provided for selected points during the valve stroke. These include (for a closure) the point when maximum thrust occurred prior to initial wedging, at initial wedging and at flow isolation. Data at similar points will be provided for opening strokes.

It is important to note that the "apparent disk coefficient of friction" calculated by Wyle and reported on the summary forms is not to be confused with the actual coefficient of friction and is not a parameter which will be used in development or assessment of the Methodology. The apparent coefficient of friction calculation is based on solving the NMAC equation for disc coefficient of friction (See Figure 2).

The apparent disc coefficients of friction calculated from the flow loop data are <u>not</u> intended to represent true friction coefficients. The purpose of calculating an "apparent" disc μ in presenting the results of the flow loop gate valve tests is <u>only</u> to provide a straight forward basis for comparing measured thrusts at various points in the valve stroke to the single thrust prediction from the NMAC equation. In order for this comparison to be meaningful, the NMAC equation must be applied as it would for design basis purposes, i.e., the DP used is the full (valve closed) DP, the area of the disc is calculated using the mean seat diameter and the stem rejection load is calculated by multiplying the design basis upstream pressure (P_{up}) by the stem cross-sectional area (A_s).

All necessary information will be provided to the Program participants for their use in assessing performance of in plant MOVs of the same designs as those tested.

Obviously, when evaluations of flow loop test data are made which will be used to validate the MOV Methodology, they will properly account for the actual conditions (DP, area, etc.) occurring at intermediate stroke positions.

2. **COMMENT:**

EPRI should notify licensees, as quickly as feasible, if it finds that certain types or sizes of MOVs do not behave predictably and must be excluded from the EPRI program.

RESPONSE:

If, during the course of the Program, it is determined that conservative prediction of the performance of a specific valve design, in combination with specific operating conditions, will not be possible, EPRI will notify participating utilities that the methodology will not be applicable in such cases.

3. **COMMENT:**

EPRI has stated that it does not plan to develop criteria by which a licensee can verify that the performance prediction model is applicable to each specific MOV installed in the licensee's nuclear plant. EPRI stated that it assumes that the model is applicable to any MOV if the model predicts that the MOV will exhibit predictable behavior. The staff considers the absence of such criteria to be a potential weakness in the implementation of the EPRI model.

RESPONSE:

As discussed in the October, 1992 meeting, an evaluation of the applicability of the methodology to each specific MOV will be performed by the user as part of the implementation of the methodology. The applicability will be evaluated in several areas including system features, valve design features, and operator features. The range of applicability of the methodology (i.e., the criteria for evaluating whether the methodology is applicable to a particular MOV) will be determined based on the assumptions used in the models and the range of data used to support the models. EPRI will develop specific criteria in each area for use in applicability evaluations.

Once the method is shown to be applicable, it can be used to conservatively predict thrust/torque requirements for globe and butterfly valves.

For gate valves, after applicability is established, the method can be used to determine whether or not damage which exceeds the threshold for unpredictability would be expected to occur at design basis conditions. If such

damage is predicted, the model cannot be used to accurately predict required thrust and other approaches (i.e., reanalysis using measured internal dimensions, in situ testing or valve replacement) will need to be considered. If the method predicts that the damage threshold will not be exceeded, it can be used to conservatively predict required thrust at design basis conditions.

4. COMMENT:

The EPRI friction test program includes the development of a model to replicate the surface-to-surface contact conditions wear patterns that have been observed on valve internal parts resulting from MOV tests. EPRI will need to ensure that the model can account for orientation and lubrication. EPRI will also need to consider whether surface conditions of the valve internal parts (such as corrosion) can affect friction; particularly when MOVs will be installed in nuclear plant system environments detrimental to specific valve materials.

RESPONSE:

The friction tests at Battelle include studies of several different contact orientations which could be expected to occur in a gate valve. For example, the investigations include flat-to-flat configurations such as occur in guides and seats, edge-to-flat configurations such as occur in guides (when the disk is tipped), and edge-to-edge configurations such as occur in guides and seats (when the disk is tipped). The friction tests are carried out in demineralized water or steam which are expected to be free of oil/greases or other potential contaminants, which could potentially act as lubricants.

In general, gate valves installed in safety related systems have stellited disc and body seats. Stellite is not significantly susceptible to corrosion (oxidation rates are extremely low) and its performance would not be expected to degrade due to corrosion phenomena. In fact, the possible build up of an oxide layer on the surface of the stellite would be expected to reduce friction by providing a lubrication layer.

All EPRI flow loop testing is performed on valves which have been thoroughly cleaned (to remove any potential grease/oil/dirt) and then "preconditioned" to remove any oxide layer on the stellite surface. As a result, the apparent friction coefficients which are obtained during stellite to stellite sliding are expected to be conservative relative to in plant MOVs.

The effect of corrosion on carbon steel components is more complicated. Mild corrosion (i.e., the development of a thin surface oxide) typically reduces the coefficient of friction's by eliminating base metal contact. In isolated cases, severe corrosion could potentially alter internal clearances in a gate valve so as to affect

the amount of disk tipping which can occur. This could conceivably be handled by artificially increasing the manufacturers tolerance on certain dimensions. However, this is not within the current scope of the program.

5. COMMENT:

The focus of the EPRI program is on the initial qualification of the MOVs installed in nuclear power plants. EPRI will also need to address the effects of aging or degradation over the interval between preventive maintenance (such as cumulative corrosion of parts and reduction of actuator/stem lubrication).

RESPONSE:

Development and implementation of MOV preventative maintenance and periodic testing programs are the responsibility of each utility and are not within the scope of the EPRI Program.

6. COMMENT:

Long term aging can affect MOV performance. Ten explicit examples of these aging mechanisms are identified as common MOV degradation conditions and are contained in the list of 33 items included as Attachment A to GL 89-10. These examples are numbered 9, 10, 11, 12, 13, 14, 16, 20, 22 and 23. The recommendations in GL 89-10 for the periodic verification of MOV capability are intended to address these types of aging concerns. EPRI will need to develop appropriate methodologies to model and/or monitor (detect and trend) these effects such that licensees can satisfy their commitments to GL 89-10. The staff does not have adequate information to determine whether EPRI's plan to study aging through the testing of a few older MOVs installed in nuclear plants will provide sufficient information to address all of the staff's concerns.

RESPONSE:

All of the examples of "aging" mechanisms cited in comment 6 refer to items external to the valve itself and can be addressed through utility preventative and predictive maintenance programs. Assessment of the aging mechanisms is outside of the scope of the EPRI methodology development program.

7. COMMENT:

EPRI has stated that its actuator tests will use the Torque Thrust Cell (TTC) developed by ITI-MOVATS for diagnostic data. EPRI also has stated that thrust and torque measurements will be obtained during the MOV differential pressure and flow tests using Smart Stems developed by Teledyne. EPRI will need to

ensure that the accuracy's of the TTC and Smart Stems are validated for the actual thrust and torque ranges required to open and close the valve. This effort will need to include resolution of any accuracy issues raised by the testing of the TTC and Smart Stems by the MOV Users Group.

RESPONSE:

The Torque Thrust cells and Smart Stems used in the EPRI Program are all fully calibrated over the full range of expected opening/closing thrust and torques both prior to and following test completion. The Final Reports for the Actuator and MOV tests will provide analyses of TTC and Smart Stem accuracies in sufficient detail to establish data error bands.

8. **COMMENT:**

In studying load sensitive behavior (i.e., rate of loading affects), EPRI should determine if the reduction in actuator output resulting from this phenomenon is important for both opening and closing the valve.

RESPONSE:

Load sensitive behavior (i.e., rate of loading) may occur in the opening as well as closing directions. EPRI concurs that the final methodology and the procedure for its implementation will have to address the issue of possible rate of loading effects on valve opening and that the operator margin is adequate to accommodate such effects should they exist.

9. **COMMENT:**

EPRI has stated that preliminary testing indicates a small reduction in torque delivered by the actuator under loaded conditions as compared to unloaded conditions. EPRI should continue to evaluate this phenomenon to determine its potential effect on the capability of MOVs to perform their safety functions under design-basis conditions.

RESPONSE:

To date, torque variations observed at Battelle and Wyle have been small and may be statistically insignificant. However, the Program will fully assess any potential torque output losses under loaded conditions and will incorporate the results of this assessment into the final methodology.

10. **COMMENT:**

EPRI should provide a detailed description of its method for simulating pump flow to the staff as soon as possible. The staff will review this method of simulating pump flow and will provide EPRI with any concerns regarding this method.

RESPONSE:

Most safety-related MOV's are installed in pumped flow systems. The flow velocity, through these systems generally are less than 15 feet per second. Closure of an MOV under such conditions will result in a build-up in significant DP across the valve only near the very end of the stroke. Accurate simulation of this DP build-up in the EPRI test program is important to ensure that the loading time history on the valve disc is representative of the loading which would occur on such a valve in a plant pumped flow system.

For purposes of the EPRI Program, "pumped flow" is defined as a system where flow through the MOV is limited when the MOV is fully open by a pump or other system components to a nominal flow velocity in the range 10 to 15 feet per second. This range of flow velocities is typical of pumped flow systems in nuclear plants. It is to be distinguished from "blowdown flow" where the pressure upstream of the MOV is essentially constant and flow is limited only by the closing of the MOV and by the piping resistance which may be low.

Pump flow characteristic curves for a large number of plant systems were reviewed. In general, the head vs. flow curves were found to be quadratic. Based on the assumption of a quadratic pump curve, the relationship between flow rate and valve DP during a stroke is quadratic and is given by (Ref. Attachment 1):

$$\frac{\Delta P_v}{\Delta P_{v_{max}}} = \left(1 - \frac{Q^2}{Q^2_{max}}\right)$$

where:

ΔP_v = valve pressure drop at stroke position "x"
$\Delta P_{v_{max}}$ = valve DP closed (= pump shut-off head)
Q = flow rate at stroke position "x"
Q_{max} = flow rate with valve fully open

This is the basis of the specification used in establishing conditions for flow loop testing. This condition can be obtained or approximated in a number of ways in a flow loop. For example, the pressure upstream of the valve could be maintained

constant during the MOV stroke with a control valve while the full-open flow rate is restricted by an orifice in the system. This would produce the desired pumped-flow DP behavior across the MOV.

At the Wyle Norco facility, the fluid source is a very large pressure vessel whose pressure remains very nearly constant by regulating the tank ullage pressure using high capacity nitrogen regulators during a MOV stroke. Downstream of the MOV is a restricting orifice which restricts the flow when the MOV is open to the desired flow rate (e.g., 15 fps). This test method produces the desired DP behavior across the MOV.

At the Huntsville pumped flow loop, a slightly different approach was taken. There, a number of pumps are operated in parallel at a cumulative flow rate much higher than required to flow through the MOV at the nominal full-open flow rate (e.g., 15 fps). A significant fraction of the flow is bypassed around the MOV. By manually adjusting valves upstream and downstream of the MOV and in the bypass line, it is possible to establish a conditions such that the nominal full-open flow rate is achieved with the MOV fully open and the desired shut-off head is achieved with the MOV closed. The pressure at the inlet to the valve remains very nearly constant throughout the stroke and the pumped flow DP behavior is very nearly approximated.

In practice, a tolerance of approximately 5 percent is added to the theoretical curve and the result is used to evaluate the loop performance on each test. Figure 3 is a plot from the Huntsville Loop which shows that the test data approximates a quadratic and falls within the tolerance band.

It should be noted that achieving an accurate reproduction of the ideal pumped flow DP vs Flow curve is not critical to validating the Methodology. The Methodology will calculate required thrust for any arbitrary variation of DP with stroke position (including constant or varying upstream pressure). What is more important is that tests conducted provide a range of fluid loads on the valve disc to allow a comprehensive model validation. For example, in low velocity pumped flow the disk is loaded only near the fully closed position. Higher velocity pumped flow loads the disk earlier in the stroke and blowdown loads the disk even earlier. The techniques used at Wyle to simulate pumped flow systems provide this variation and as a bonus, quite accurately reproduce pumped flow system characteristics.

11. **COMMENT:**

At a May 1992 meeting, EPRI presented its matrix and schedule for testing 60 MOVs in test facilities or at nuclear plants, under various differential pressure, temperature, and flow conditions to validate its model. At the October 1992

meeting, EPRI stated that those tests may be used to refine the methodology. The staff does not consider tests used to refine the methodology appropriate for use in validating the methodology. EPRI will need to select additional MOVs to be tested to validate the methodology

RESPONSE:

The valve and operator models will be based on first principles. The separate effects test data will be used to refine the models and to obtain required empirical data. During model development, the flow loop and in situ test data (including NRC/INEL data) will be studied and reviewed to ensure that all significant physical phenomena which appear to be occurring are addressed by the models e.g., guide bending was observed during testing and the calculation of guide bending will be included in the methodology.

The flow loop and in situ test data will not be used to define empirical constants within the model, and the models will not be empirical correlations of MOV test data.

Once it is determined that all significant phenomena are addressed by first principles modeling and all empirical constants have been derived from the separate effects testing, the methodology will be used to make predictions of the flow loop and in situ test results. In addition to these comprehensive model-to-data comparisons, the methodology will be used to make "blind" predictions for selected tests. The tests selected for "blind" prediction will fully exercise the model over a wide range of valve design and test condition variations.

If there is inadequate agreement between model predictions and data, considerations of model refinement may need to be evaluated at that stage. Quantitative use of data, if needed, would need to be thoroughly evaluated and justified; the intent would be to utilize the best available information.

12. **COMMENT:**

At the October 1992 meeting, EPRI indicated that it is planning to test fewer MOVs at test facilities than stated in May 1992. EPRI plans to test more MOVs at nuclear plants to maintain the total of 60 MOVs tested. The staff is concerned that testing MOVs at nuclear plants will limit the range of test conditions and reduce the amount of test data obtained. The staff also is concerned about the small amount of testing under steam and high pressure/temperature conditions. In this regard, EPRI identified some of these tests as "Option 3" which might not be conducted. The reduction in the test database appears to result in the EPRI program covering smaller population of MOVs. The staff is concerned that some licensees will have

many MOVs outside the scope of the EPRI program and that completion of their GL 89-10 programs might be delayed.

RESPONSE:

No reduction has been made to the range of MOV designs to be covered by the MOV Flow Loop or in situ test Programs. Specifically, 4 butterfly valves have been deleted from the flow loop test program, but 6 butterfly valves have been added to the in situ test program. In addition, a new butterfly valve test project has been added to the Program. This project will test scale model (6 inch) butterfly valves in a separate test loop. These tests will focus on confirmation of scaling laws and assessment of upstream piping configuration effects on butterfly valve performance.

Although in situ testing generally results in data only at a single DP, it does provide real world MOV performance information. The current split of 34 MOV's in flow loops and 26 MOV's in situ is believed to represent a good balance between parametric and real world data for methodology validation.

No change has been made to the number of steam flow tests planned. However, tests which exactly replicate tests already performed by INEL have been moved to the end of the test sequence. Since data already exist for such valves under such conditions, these tests are considered lower priority. These tests or other tests which may be desired based on review of earlier test results will be completed contingent on funding availability.

13. COMMENT:

The staff noted in the matrix of valves to be tested by EPRI that only one parallel disk gate valve would be tested at a test facility and that the valve is a new design. EPRI stated that it would test one parallel disk gate valve at a nuclear plant. The staff noted that the test matrix included only a small number of butterfly valves and one over-the-plug globe valve. Further, the test matrix included one new design of split-wedge gate valve. EPRI may need to test additional valves to complete the validation for valve types that are minimally tested.

RESPONSE:

The philosophy for determining the MOV designs to be tested is to test the full range of design features which will need to be addressed by the models. Specifically, for gate valves, the model <u>will</u> predict the performance of solid/flexible wedge valves. These are by far the most predominant gate valve designs and the designs considered most susceptible to performance variation due

to vendor specific design differences. The test matrix includes substantial flexible/solid wedge gate valve design and test condition variations.

A second category of gate valves, i.e., unique designs with small representation in the overall MOV population, are being covered by testing to provide data under design basis conditions which can be used directly by utilities to assess expected performance for the same valve designs. Current plans call for addressing the parallel disc gate valve design in this manner. Because these are specific unique designs each manufactured by only a single vendor, the limited number of such tests planned are believed to be adequate to assess their performance.

Our testing coverage for butterfly valves is discussed in the response to Comment 12.

Current methods for the prediction of globe valve performance are expected to be adequate based on industry experience. The current limited set of globe valve tests planned is considered adequate to confirm the adequacy of current prediction methods. If, based on test data obtained in the Program, or new industry experience this is shown not to be the case, additional globe valve testing will be considered.

14. **COMMENT:**

Licensees will be using the EPRI methodology as part of their GL 89-10 programs to demonstrate that MOVs for which design-basis testing is not practicable are capable of performing their design-basis functions. EPRI will need to ensure that all design-basis parameters (such as fluid temperature and flow, ambient temperature effects on the motor output and cable voltage losses, seismic/dynamic effects, and degraded voltage) consistent with the recommendations of GL 89-10 and its supplements are incorporated into the EPRI methodology.

RESPONSE:

The EPRI methodology will predict MOV performance considering fluid temperature, flow and system characteristics as well as valve design variations.

In addition, the methodology will have the capability of predicting MOV performance under reduced voltage conditions. Assessment of specific cable losses, seismic/dynamic effects as well as ambient temperature effects on operator performance are the responsibility of the utilities and outside the scope of the EPRI methodology.

15. COMMENT:

EPRI will need to demonstrate that the methodology provides for sufficient thrust to ensure that valve closure is adequate to maintain leakage control in accordance with applicable regulatory or safety analyses requirements.

RESPONSE:

The EPRI methodology will predict the thrust required to reach initial wedging for gate valves, hard seat contact for globe valves and the fully closed position for butterfly valves. Use of the EPRI methodology is not intended to replace leak testing currently being conducted by utilities to meet regulatory requirements.

16. COMMENT:

As discussed in the cover letter to these comments, EPRI has stated that the intent of its program is to allow the licensee to extrapolate the performance of its MOVs from static conditions to design-basis differential pressure and flow conditions. The staff believes that the wide range of MOV performance seen to date will mandate a large bounding margin being incorporated into the methodology to allow licensees to use the methodology to demonstrate that an MOV is capable of operating under design-basis conditions. Therefore, EPRI should consider developing means to allow a reduction of this mandatory margin through the use of pressurized static test data or intermediate differential pressure/flow test data for specific MOVs.

RESPONSE:

The EPRI Methodology does <u>not</u> extrapolate results from static testing to design basis conditions. The methodology will calculate the thrust which must be achieved in a static test in order to ensure that the proper thrust is available under design basis conditions (including consideration of effects such as rate of loading). The static test is performed to confirm that the required static thrust is actually achieved.

It is difficult to predict the magnitude of the conservatism which will result from use of the EPRI Methodology at this particular point in the Program. That will only be done with confidence once the Models have been fully validated and assessed against test data.

It is expected that the results from a reduced differential pressure test could be used in conjunction with the EPRI methodology to obtain a more accurate

prediction of MOV performance at design basis conditions. Procedures for utilizing such data are under development.

17. **COMMENT:**

EPRI has stated that it defines predictability of an MOV in terms of actual performance during its testing program, rather than internal damage to valve surfaces. EPRI will need to ensure that cumulative damage will not cause an MOV to become unpredictable and that leakage limits are not exceeded under differential pressure conditions with such cumulative damage.

RESPONSE:

At this time, EPRI has not clearly defined the exact circumstances under which the methodology would be incapable of predicting required thrust for a specific gate valve/flow condition combination. The Friction Separate Effects Program and the Gate Valve Design Effects Program will provide the data to make such a definition possible. Both programs investigate to some degree the cumulative effects of high contact stresses on surface damage and effective friction coefficient.

18. **COMMENT:**

EPRI has stated that its methodology will predict thrust requirements throughout the valve stroke for each MOV. In verifying the design-basis capability of a safety-related MOV, each licensee must demonstrate that the motor actuator can deliver sufficient torque without motor stall when opening or closing the valve. The conversion of torque to thrust in an MOV is dependent on the stem friction coefficient which does not remain constant throughout the valve stroke. EPRI should develop its methodology to provide both thrust and torque requirements throughout the valve stroke to assist licensees in demonstrating the design-basis capability of safety-related MOVs.

RESPONSE:

The EPRI Methodology will calculate the torque and the thrust required to operate a valve over its entire stroke. In order to do so, it must properly account for variations in stem factor which may occur during the stroke. Such variations have been seen to various degrees in flow loop test data and in the Operator Separate Effects Test Program being conducted by Battelle.

The source of these variations is not obvious at the present time. However, the test program which Battelle is executing has the objective of understanding and quantifying the phenomena. Once understood, the results will be incorporated into the MOV Methodology in such a way as to ensure that the effect of such

variations on the torque and thrust predictions made by the Methodology are appropriately addressed.

19. COMMENT:

Some licensees might not be able to obtain precise values for the parameters to be input into the EPRI methodology. Therefore, licensees may want to estimate certain parameters with best available information. EPRI should perform a sensitivity study of the model and identify the input parameters which have the greatest impact on the model's results. EPRI should then provide guidance to licensees on parameters that can be estimated and those that must be known precisely.

RESPONSE:

The Gate Valve Performance Prediction Methodology will require that the user provide basic valve dimensional information as input. Typical dimensions required include such things as guide length, mean seat diameter and clearance between the disk guides and the body rails.

While the list of required dimensions is, at present, quite extensive, EPRI has held discussions with the valve vendors and they have agreed that they are able to provide both nominal values and tolerances for all dimensions. Further, EPRI has developed a specification which will be used by the utilities to procure from the valve vendors, all required information.

The Methodology will be implemented in such a way that the dimensions and range of tolerances from the vendor will be combined in development of needed input values to produce a conservative prediction. A sensitivity analysis is being performed in order to determine what combination of dimensions results in a conservative result. In addition, the results of this sensitivity study will show which parameters most strongly affect valve performance.

If a user wishes to reduce the amount of conservatism in the Methodology for an analysis conducted using nominal dimensions, he has several options, one of which is to obtain actual dimensions for a specific valve and use that data as input to the model. The results of the sensitivity analysis will provide guidance to the utility in determining how accurately such measurements should be made and which dimensions are most critical.

20. **COMMENT:**

EPRI has agreed to allow the staff to observe its MOV tests on a periodic basis and to review test data. The staff may request EPRI to provide test setup and performance information as well as raw data from selected tests.

RESPONSE:

The NRC staff is welcome to observe MOV testing.

EPRI has agreed to provide test setup and performance information as well as raw data (i.e. plots of test results as well as engineering unit data in digital format) from selected tests. This data will be available when the test report for each test loop is complete. At that time, as-tested facility configuration information will have been assembled into a presentable form and test data will have been certified.

The first report which covers tests conducted in the Huntsville pumped flow loop is scheduled for distribution to Program participants in March, 1993.

21. **COMMENT:**

The staff noted a concern with EPRI's selection of a pressure measurement location in determining stem rejection load. The staff referred EPRI to Figure 33 of NUREC/CR-5720 for a comparison of pressure measured at three different locations. EPRI agreed to review the issue and resolve the concern.

RESPONSE:

The staff concern is assumed to relate to our use of valve upstream pressure for calculating stem rejection loads when determining apparent disc coefficients of friction.

The apparent disc coefficient of friction calculated from the flow loop data are <u>not</u> intended to represent true friction coefficients. The purpose of calculating an "apparent" disc μ in presenting the results of the flow loop gate valve tests is <u>only</u> to provide a straight forward basis for comparing measured thrusts at various points in the valve stroke to the single thrust prediction from the NMAC equation. In order for this comparison to be meaningful, the NMAC equation must be applied as it would be for design purposes, i.e., the stem rejection load is computed by multiplying the design basis upstream pressure (P_{up}) by the stem cross-sectional area (A_s).

It is recognized that under various flow conditions and stroke positions the product of $P_{up} \times A_s$ may not accurately predict the true stem rejection force. In the implementation of the methodology, an appropriate pressure will be used to ensure a conservative result.

22. **COMMENT:**

The staff is aware of three areas of significant disagreement that remain between EPRI and INEL with respect to the NRC-sponsored MOV tests (including results) performed by INEL. In summary, these areas are (1) the difference in the predictions of required thrust by the Limitorque, EPRI and INEL equations, (2) the selection of the point of flow isolation during valve closure, and (3) the behavior of INEL Valve 2 during flow tests. With respect to the EPRI MOV Performance Prediction Program, the staff believes that these areas of disagreement need to be resolved only to the extent that the disagreement might affect the staff's determination of the reliability of the EPRI MOV Performance Prediction Methodology. For example, the selection of the point of flow isolation might be used to predict the amount of thrust necessary to close a valve. Although this point might be adequate for the particular valve tested, it might not predict the thrust required to isolate flow for another valve because of concerns such as the difficulty in precisely determining this point from test data and the difference in internal clearances between similar valves.

RESPONSE:

EPRI agrees that these areas of disagreement need to be resolved only to the extent that such disagreement might affect the staff's determination of the reliability of the EPRI MOV Performance Prediction Program.

The first area of disagreement, potential differences in Limitorque, NMAC and INEL thrust equations, is not relevant to the EPRI methodology and no further discussion should be necessary.

The second area of disagreement, selection of the point of flow isolation, is not relevant to the EPRI methodology since the point of flow isolation will not be predicted by the model.

The third area of disagreement, potential causes for behavior of INEL valve 2, may become relevant based on the results of our separate effects and modeling activities. Further discussion of this issue should be deferred pending completion of these activities.

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TABLE 1

EPRI MOV PERFORMANCE PREDICTION PROGRAM PRODUCTS

Document	Estimated Completion Date
Flow Loop Test Reports	
Huntsville Low Pressure Loop Test	March 1993
Huntsville High Pressure Loop Test Report	July 1993
Norco Loop Test Report	September 1993
Siemens/KWU Loop Test Report	November 1993
In Situ Test Report	July 1993
Gate Valve Dimensional Specification	December 1992
Gate Valve Model Report	September 1993
Butterfly Valve Model Report	June 1993
System Model Report	April 1993
Operator Model Report	April 1993
Globe Valve Model Report	September 1993
CFD Analysis Report	April 1993
Friction Test Report	May 1993
Operator Test Report	April 1993
Gate Valve Design Effects Report	May 1993
Stem Nut Lubricant Test Report	December 1992
Integrated Methodology Assessment Report	April 1994
Analysis Code User Manual	April 1994
Model Implementation Guide	April 1994
MOV PPP Topical Report	November 1993 to February 1994

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FIGURE 1

EPRI Gate Valve Test Analysis Data Sheet

Valve # ____________ **Test Date** ____________ **Test Time** ____________

Test # ____________________ **Stroke Direction** ____________________

Test Description ____

Valve Mean Seat Diameter ________________ **in.**

Data File ____________________ **Data Set** ____________________

Motor Current Start Time* ____________

Motor Current Stop Time* ____________

Contactor Dropout Time* ____________

Packing Load at Running ____________ lb.

Closed to Open								
	Time (sec)	Thrust (lb.)	Torque (ft-lb)	SPDISP (in.)	Mean Upstream Press (psig)	Mean DP PSID	App Disk μ	App Stem μ
A. At cracking*					----	----	----	
B. Just after cracking								
C. Max after cracking								
D. Running (No DP)							----	
E. Limit SW Trip		----	----	----	----	----	----	----
F. At Flow Initiation**								

Open to Closed								
	Time (sec)	Thrust (lb.)	Torque (ft-lb)	SPDISP (in.)	Mean Upstream Press (psig)	Mean DP PSID	App Disk μ	App Stem μ
A. Running (No DP)							----	
B. Max prior to initial wedging								
C. At initial wedging								
D. TS Trip*					----	----	----	
E. Max after wedging					----	----	----	
F. Final					----	----	----	
G. At flow isolation**								

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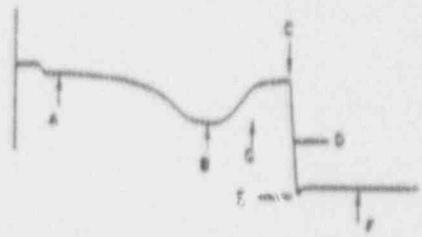
** Values to nearest .001 second, all other values to nearest .01 second.*

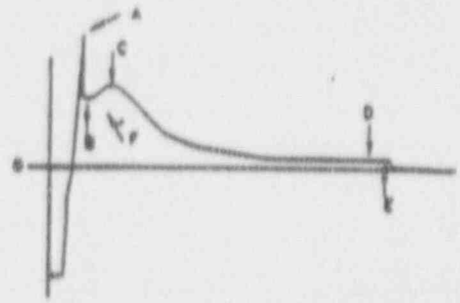
*** Determined by flowrate measurement.*

FIGURE 2
Flow Loop Data Analysis Definitions



Typical Closing Thrust Trace

$$T = T_A - P_A A_s + P_c A_s + \mu \Delta P_c A_o / (\cos\theta - \mu \sin\theta)$$



Typical Opening Thrust Trace

$$T = T_D + P_D A_s - P_B A_s + \mu \Delta P_B A_o / (\cos\theta + \mu \sin\theta)$$

Opening Stroke

T = Stem Thrust, lb.
P = Upstream pressure, psi
A_s = Stem area, in.^{2}
A_o = Disk mean seat area, in.^{2}

ΔP = Different pressure, psi
μ = Disk coefficient of friction
θ = Half disk angle

Stem μ = (24FS cos α - d cos α tan a)/(24FS tan a + d)

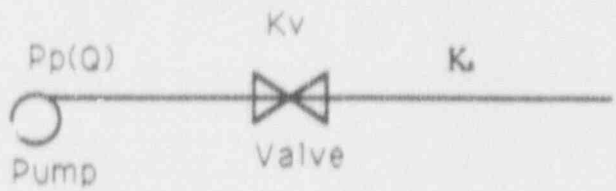
FS = Torque/thrust, ft.
d = Stem OD - P/2, in.
p = Pitch, in.

α = Half thread angle
a = Thread lead angle
Stem μ = Stem coefficient of friction

ATTACHMENT 1

Analysis of ΔP Across Valve vs. Flowrate

Consider the following system:



where $P_p(Q)$ = Pump Pressure = f (flowrate)

K_v = Valve Loss Coefficient

K_s = System Loss Coefficient

where:

$\Delta P_i = K_i Q^2$

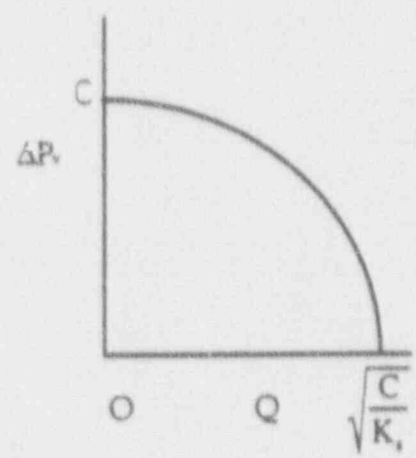
Q = Flowrate

$$P_p(Q) = \Delta P_{valve} + \Delta P_{system}$$
$$= K_v Q^2 + K_s Q^2$$

ΔP across the valve is $\Delta P_v = P_p(Q) - K_s Q^2$

Case 1: $P_p(Q) = \text{Constant} = C$

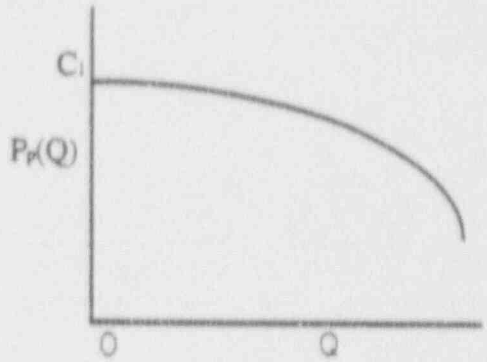
$$\Delta P_v = C - K_s Q^2$$



Case 2: $P_p(Q) = C_1 - C_2Q^2$

i.e., Pump curve is quadratic in Q.

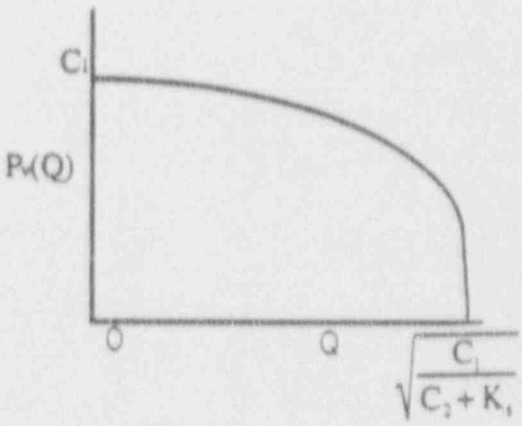
For example:



then,

$$\Delta P_v = P_{pump} - \Delta P_{system}$$

$$\Delta P_v = C_1 - C_2Q^2 - K_sQ^2$$



NOTE:

$$Q_{max} = \sqrt{\frac{C_1}{C_2 + K_s}}$$

$$\Delta P_{v_{max}} = C_1$$

SO:

$$\Delta P_v = C_1 - (C_2 + K_v)Q^2$$
$$= C_1 - C_1 \frac{Q^2}{Q^2_{max}}$$

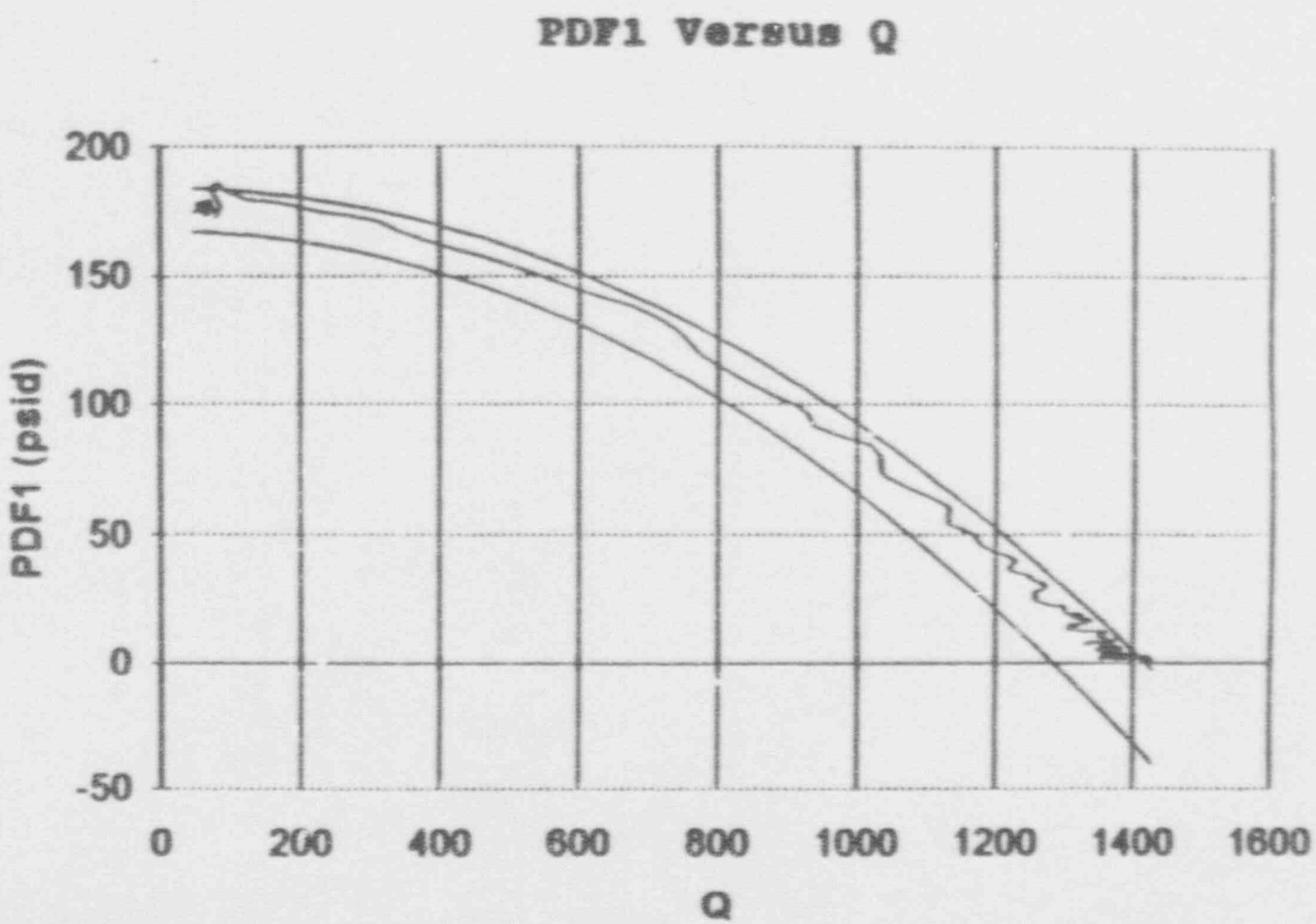
$$\boxed{\frac{\Delta P_v}{\Delta P_{v_{max}}} = 1 - \frac{Q^2}{Q^2_{max}}}$$

where Q_{max} = Flowrate extrapolated to 0 pump head (using $P_p = C_1 - C_2Q_2$)

RESULT:

The simple result is that, for a constant pressure source or for any pump curve which can be approximated by a quadratic function of flowrate, the normalized differential pressure across the valve has the above simple form.

FIGURE 3


PDF1 Versus Q
200
150
100
50
0
-50
PDF1 (psid)
0
200
400
600
800
1000
1200
1400
1600
Q

ENCLOSURE 2

NRC STAFF COMMENTS ON THE EPRI MOV PERFORMANCE PREDICTION PROGRAM
AND STATUS OF STAFF COMMENTS
(December 1992)

1. EPRI should release the results of its motor-operated valve (MOV) tests on a regular basis for use by licensees in their Generic Letter (GL) 89-10 programs in sizing and setting MOVs for which design-basis testing is not practicable. EPRI will need to provide the basis for valve or stem friction coefficients determined from the test results. This information should include valve disk position used to select the thrust required to close the valve such that the design requirements of the MOV are satisfied. At the October 1992 meeting, EPRI and NUMARC stated that guidance would be developed for use of preliminary EPRI test data by licensees.

   STATUS

   At the December 3, 1992, meeting, EPRI stated that it would produce the reports for Huntsville low pressure loop tests, Huntsville high pressure loop tests, Norco loop tests, and Siemens/KWU loop tests as promptly as resources would allow. EPRI does not plan to release data sheets for individual tests before completion of the test report for those series of tests. For example, EPRI will not release any data sheets for low pressure tests at Huntsville until the Huntsville low pressure loop test report is completed. Because EPRI does not plan to finalize each test report until many months after completion of all the tests at the specific test loop, the staff believes that licensees could obtain useful information on a more timely basis from individual test data sheets that are considered by EPRI to be complete. EPRI stated that it would release specific test data in advance of the finalized test report upon request of an individual licensee. This response is not completely acceptable since other licensees may also benefit from this information. The staff will continue to discuss with EPRI the schedule for the release of important test information.

2. EPRI should notify licensees, as quickly as feasible, if it finds that certain types or sizes of MOVs do not behave predictably and must be excluded from the EPRI program.

   STATUS

   In the letter dated November 30, 1992, EPRI commits to notify participating utilities if it finds that the methodology will not be applicable to any particular valves. NUMARC had agreed in an earlier meeting to distribute certain information to non-participating utilities. The staff will discuss this in more detail at subsequent meetings.

3. EPRI has stated that it does not plan to develop criteria by which a licensee can verify that the performance prediction model is applicable to each specific MOV installed in the licensee's nuclear plant. EPRI stated that it assumes that the model is applicable to any MOV if the model predicts that the MOV will exhibit predictable behavior. The staff considers the absence of such criteria to be a potential weakness in the implementation of the EPRI model.

   STATUS

   At the December 3 meeting, EPRI asserted that its testing program will identify all required parameters without the need for performance-based criteria. EPRI stated that, because many MOVs can be tested only under static conditions, the licensee may have only physical parameters to determine the applicability of the methodology to a particular MOV. The staff noted that there have been cases where valves that appear to be physically identical demonstrated significantly different thrust requirements to operate. The staff stated that, if the EPRI methodology predicts a low thrust requirement for a particular valve, then licensees might find instances where the methodology underpredicts thrust requirements. In such instances, the staff and licensees will question the validity of the EPRI methodology. EPRI stated that it would provide its acceptability criteria at the next meeting.

4. The EPRI friction test program includes the development of a model to replicate the surface-to-surface contact conditions wear patterns that have been observed on valve internal parts resulting from MOV tests. EPRI will need to ensure that the model can account for orientation and lubrication. EPRI will also need to consider whether surface conditions of the valve internal parts (such as corrosion) can affect friction; particularly when MOVs will be installed in nuclear plant system environments detrimental to specific valve materials.

5. The focus of the EPRI program is on the initial qualification of the MOVs installed in nuclear power plants. EPRI will also need to address the effects of aging or degradation over the interval between preventive maintenance (such as cumulative corrosion of parts and reduction of actuator/stem lubrication).

6. Long term aging can affect MOV performance. Ten explicit examples of these aging mechanisms are identified as common MOV degradation conditions and are contained in the list of 33 items included as Attachment A to GL 89-10. These examples are numbered 9, 10, 11, 12, 13, 14, 16, 20, 22 and 23. The recommendations in GL 89-10 for the periodic verification of MOV capability are intended to address these types of aging concerns. EPRI will need to develop appropriate methodologies to model and/or monitor (detect and trend) these effects such that licensees can satisfy their commitments to GL 89-10. The staff does not have adequate information to determine whether EPRI's plan to study aging through the testing of a few older MOVs installed in nuclear plants will provide sufficient information to address all of the staff's concerns.

STATUS OF STAFF COMMENTS 4, 5 AND 6

In the November 30 letter, EPRI states that an evaluation of aging mechanisms is outside the scope of its MOV performance methodology development program. EPRI also states that the development and implementation of MOV preventative maintenance and periodic testing programs are the responsibility of each licensee and are not within the scope of the EPRI program. At the December 3 meeting, the staff noted that the EPRI program will provide information on the thrust requirement to operate valves only for an initial test and not include aging effects. Consequently, the EPRI program might not assist licensees in meeting their commitments to periodically verify the design-basis capability of safety-related MOVs in response to Generic Letter 89-10. At the December 3 meeting, EPRI stated that its use of in-situ test data as part of the validation of its methodology may help indicate whether aging effects are significant. EPRI stated that it was cleaning and degreasing internal valve parts before reassembly and that it was stroking valves many times in an effort to remove the oxide layer from the disk and guides before obtaining thrust requirements. EPRI has indicated that the increase in thrust requirements can be significant from this pre-conditioning. The staff considers the increase in thrust requirements with stroking to emphasize the need to periodically verify the design-basis capability of MOVs. Although the staff acknowledged the problem with including aging effects specifically in the current EPRI MOV Performance Prediction Program, the staff encouraged EPRI to begin now to consider and identify important aging parameters. This encouragement was offered because of the planned in-situ MOV tests to be performed at selected plants. These in-situ tests present an opportunity to start developing a database upon which aging effects can be detected and quantified. EPRI stated that its in-situ test guide provides information on the collection of data for evaluation of aging effects. The staff will review the guide and provide comments to EPRI. The staff also has aging programs in progress and will be discussing this issue with NUMARC and EPRI in the future.

In Question 4, the staff states that the EPRI friction test program includes the development of a model to replicate the surface-to-surface contact conditions wear patterns that have been observed on valve internal parts resulting from MOV tests. EPRI will need to ensure that the model can account for orientation and lubrication. EPRI's answer to Questions 4, 5 and 6 pertains to the evaluation of aging mechanisms. This portion of Question 4 remains open and will be discussed with EPRI at the next meeting.

7. EPRI has stated that its actuator tests will use the Torque Thrust Cell (TTC) developed by ITI-MOVATS for diagnostic data. EPRI also has stated that thrust and torque measurements will be obtained during the MOV differential pressure and flow tests using Smart Stems developed by Teledyne. EPRI will need to ensure that the accuracies of the TTC and Smart Stems are validated for the actual thrust and torque ranges required to open and close the valve. This effort will need to include resolution of any accuracy issues raised by the testing of the TTC and

Smart Stems by the MOV Users Group.

STATUS

In the November 30 letter, EPRI states that the Torque Thrust Cells and Smart Stems used in its program are calibrated over the full range of thrust and torque requirements. EPRI states that its reports will provide analyses of the TTC and Smart Stem accuracies. The staff considers EPRI's response acceptable. The staff has recently learned of a concern about the accuracy of the TTC at the Turkey Point nuclear plant. EPRI should ensure that the concern is resolved before relying on the TTC data in its reports.

8. In studying load sensitive behavior (i.e., rate of loading effects), EPRI should determine whether the reduction in actuator output resulting from this phenomenon is important for both opening and closing the valve.

STATUS

In the November 30 letter, EPRI states that it would evaluate load sensitive behavior in both the valve opening and closing directions. The staff considers EPRI's response acceptable.

9. EPRI has stated that preliminary testing indicates a small reduction in torque delivered by the actuator under loaded conditions as compared to unloaded conditions. EPRI should continue to evaluate this phenomenon to determine its potential effect on the capability of MOVs to perform their safety functions under design-basis conditions.

STATUS

In the November 30 letter, EPRI states that its test results to date have indicated minimal torque variations. EPRI states that it would assess torque variations in its program. The staff considers EPRI's response acceptable.

10. EPRI should provide a detailed description of its method for simulating pump flow to the staff as soon as possible. The staff will review this method of simulating pump flow and will provide EPRI with any concerns regarding the method.

STATUS

In the November 30 letter, EPRI provides a description of its method for simulating pump flow. The staff considers EPRI's response acceptable, but noted at the December 3 meeting that EPRI should ensure that the flow rates are appropriate for MOVs installed in nuclear plants.

11. At a May 1992 meeting, EPRI presented its matrix and schedule for testing 60 MOVs in test facilities or at nuclear plants, under various differential pressure, temperature, and flow conditions to validate its

model. At the October 1992 meeting, EPRI stated that those tests may be used to refine the methodology. The staff does not consider tests used to refine the methodology appropriate for use in validating the methodology. EPRI will need to select additional MOVs to be tested to validate the methodology.

STATUS

At the December 3 meeting, EPRI stated that the valve and operator models in its program would be based on first principles of engineering. EPRI stated that it was using separate effects testing to refine the models and would use the loop and in-situ test data to validate the models. EPRI stated that, in certain instances, it might need to use loop or in-situ data to refine the models, but would notify the NRC staff in those instances. The staff believes that EPRI should attempt to use test data to validate the realistic model to ensure its first principles analysis is appropriate. The staff does not have a philosophical problem with EPRI using limited aspects of its loop and in-situ data for model refinement. However, the staff considers the acceptability of the use of loop and in-situ test data for model refinement will depend on the specific circumstances.

12. At the October 1992 meeting, EPRI indicated that it is planning to test fewer MOVs at test facilities than stated in May 1992. EPRI plans to test more MOVs at nuclear plants to maintain the total of 60 MOVs tested. The staff is concerned that testing MOVs at nuclear plants will limit the range of test conditions and reduce the amount of test data obtained. The staff also is concerned about the small amount of testing under steam and high pressure/temperature conditions. In this regard, EPRI identified some of these tests as "Option 3" which might not be conducted. The reduction in the test database appears to result in the EPRI program covering a smaller population of MOVs. The staff is concerned that some licensees will have many MOVs outside the scope of the EPRI program and that completion of their GL 89-10 programs might be delayed.

STATUS

In the November 30 letter, EPRI states that no reduction has been made to the range of MOV designs to be covered by the testing program. EPRI acknowledges that in-situ testing generally limits the testing to only a single differential pressure condition as opposed to the range of differential pressure conditions possible during loop testing. EPRI also states in the letter that it was not planning to change the number of steam flow tests. However, EPRI also states that these tests will be completed contingent on funding availability. At the December 3 meeting, EPRI stated that those tests will be performed. The staff is concerned about the limitations in the scope of applicability of the EPRI methodology with the reduction in the range of differential pressure test conditions from in-situ testing and the potential omission of the steam flow tests. In response to these concerns, EPRI committed to provide the staff with a comparison of the scope of its testing

program with the population of valves installed in safety-related applications in nuclear plants. The staff will review that comparison and will discuss this concern with EPRI at future meetings.

EPRI will not be testing each type and size of MOV currently installed in nuclear plants. Even though EPRI might not test a particular type and size of MOV, EPRI stated at the December 3 meeting that licensees would be allowed to apply the EPRI methodology to that MOV unless specific information disqualifies that MOV from application of the methodology. EPRI is relying on licensees to identify valves that do not perform as predicted by the EPRI methodology. Therefore, licensees will need to record test data and dimensional information in a manner that can be compared to the EPRI methodology. At the December 3 meeting, NUMARC stated that it is working with the industry in an effort to develop a test database for sharing information between licensees. The staff will continue to discuss with NUMARC the need for an industry-wide test database.

13. The staff noted in the matrix of valves to be tested by EPRI that only one parallel disk gate valve would be tested at a test facility and that the valve is a new design. EPRI stated that it would test one parallel disk gate valve at a nuclear plant. The staff noted that the test matrix included only a small number of butterfly valves and one over-the-plug globe valve. Further, the test matrix included one new design of split-wedge gate valve. EPRI may need to test additional valves to complete the validation for valve types that are minimally tested.

STATUS

In the November 30 letter, EPRI states that its model will predict the performance of solid/flexible wedge gate valves. EPRI states in the letter that its data from testing other gate valves (such as parallel disk gate valves) will be used by licensees directly. At the December 3 meeting, EPRI stated that the two parallel disk gate valves to be tested are designs currently used in nuclear plants. In the November 30 letter, EPRI states that globe valve testing is being conducted to verify current performance prediction methods. At the December 3 meeting, EPRI stated that it will conduct sufficient testing on butterfly valves to include those valves in its methodology. The staff remains concerned about the scope of applicability of the EPRI methodology. Many licensees have installed or are considering installation of parallel disk gate valves. Testing performed in Europe has revealed that the performance of parallel disk gate valves is similar to flexible wedge gate valves. This information casts doubt on assertions by valve vendors for many years that parallel disk gate valves have significantly lower thrust requirements than flexible wedge gate valves.

At the May 1992 meeting, EPRI requested data from NRC-supported butterfly valve tests completed in the mid-1980s. The NRC Office of Nuclear Regulatory Research subsequently agreed to provide the data to EPRI and instructed the Idaho National Engineering Laboratory (INEL) to

coordinate the effort. At the December 3 meeting, INEL provided a status of this effort. INEL stated that progress has been made and that the data are being assembled in the agreed format.

14. Licensees will be using the EPRI methodology as part of their GL 89-10 programs to demonstrate that MOVs for which design-basis testing is not practicable are capable of performing their design-basis functions. EPRI will need to ensure that all design-basis parameters (such as fluid temperature and flow, ambient temperature effects on the motor output and cable voltage losses, seismic/dynamic effects, and degraded voltage) consistent with the recommendations of GL 89-10 and its supplements are incorporated into the EPRI methodology.

    STATUS

    In the November 30 letter, EPRI states that its methodology will predict MOV performance considering fluid temperature, flow, system characteristics, and degraded voltage. EPRI states that an assessment of cable losses, seismic/dynamic and ambient temperature effects are the responsibility of licensees and are outside the scope of the EPRI methodology. The staff would like information on whether the EPRI methodology will accept plant input for those items considered to be outside the scope of the methodology to assist in evaluating MOV capability.

15. EPRI will need to demonstrate that the methodology provides for sufficient thrust to ensure that valve closure is adequate to maintain leakage control in accordance with applicable regulatory or safety analyses requirements.

    STATUS

    In the November 30 letter, EPRI states that its methodology will predict thrust requirements for achieving initial wedging for gate valves, hard seat contact for globe valves, and fully closed positions for butterfly valves. EPRI states that its methodology is not intended to replace leak testing to meet regulatory requirements. The staff considers EPRI's response on the objective of its program and the limitation regarding leakage to be acceptable.

16. EPRI has stated that the intent of its program is to allow the licensee to extrapolate the performance of its MOVs from static conditions to design-basis differential pressure and flow conditions. The staff believes that the wide range of MOV performance seen to date will mandate a large bounding margin being incorporated into the methodology to allow licensees to use the methodology to demonstrate that an MOV is capable of operating under design-basis conditions. Therefore, EPRI should consider developing means to allow a reduction of this mandatory margin through the use of pressurized static test data or intermediate differential pressure/flow test data for specific MOVs.

STATUS

In the November 30 letter, EPRI asserts that its methodology does not extrapolate but rather will calculate the thrust that must be achieved during a static test to have confidence that the MOV will operate under design-basis conditions. EPRI states that, at this time, it cannot predict the amount of conservatism that will be needed. However, EPRI states that a reduced differential pressure test could be used in conjunction with its methodology to obtain a more accurate prediction of MOV performance at design-basis conditions. EPRI states that procedures for utilizing partial differential pressure test data are under development. The staff is concerned that the mandatory margin in using the EPRI methodology when testing only under static conditions may be severe. In regard to this staff concern, EPRI stated at the December 3 meeting that it would respond to staff questions on EPRI's plans for providing the required margin. The staff questions are as follows:

(a) How will EPRI assess degraded voltage capability if the methodology provides only a required thrust?

(b) How will the EPRI testing demonstrate the predictability of the stem friction coefficient from static to dynamic conditions?

(c) For each MOV for which the EPRI methodology is to be applied, will the EPRI methodology include the comparison of stem friction coefficient determined from the static test of the MOV in question to the assumption for stem friction coefficient in the MOV sizing and setting calculations?

(d) How will EPRI demonstrate that its measurement of stem friction coefficient after the disk has seated under static conditions (with reduced stem velocity) is representative of the stem friction coefficient at the point of initial wedging (or higher thrust-required positions caused by flow) under dynamic conditions (with normal stem velocity)? Initial INEL testing has indicated that the stem friction coefficient may be much lower at the point selected by EPRI for measurement compared to the stem friction coefficient when the disk is closing against flow. If an MOV failed to close during a dynamic test because of load sensitive behavior, the stem would be traveling at normal velocity (immediately before failure) with a higher stem friction coefficient than at EPRI's measurement point for stem friction coefficient with the reduced stem velocity.

(e) Has EPRI determined the cause of high stem friction coefficients that have been seen in some MOVs tested under static conditions in plants and how such instances will be addressed in developing the EPRI methodology?

(f) How does EPRI plan to address the large differences in stem friction coefficient observed in various stem and stem nut combinations?

(g) How will the EPRI methodology address the determination of stem friction

coefficients for MOVs that are not designed to hard seat and what criteria will be used to assess the capability of the MOV?

(h) Will the conversion of static test results to dynamic conditions also account for the type of stem grease being used, the stem nut speed, the overall actuator ratio, the column stiffness of the operator, and other characteristics of the unit?

17. EPRI has stated that it defines predictability of an MOV in terms of actual performance during its testing program, rather than internal damage to valve surfaces. EPRI will need to ensure that cumulative damage will not cause an MOV to become unpredictable and that leakage limits are not exceeded under differential pressure conditions with such cumulative damage.

STATUS

In the November 30 letter, EPRI states that, at this time, it has not clearly defined the exact circumstances under which its methodology would be incapable of predicting thrust requirements for a specific valve and flow condition. The staff will review the EPRI criteria when developed.

18. EPRI has stated that its methodology will predict thrust requirements throughout the valve stroke for each MOV. In verifying the design-basis capability of a safety-related MOV, each licensee must demonstrate that the motor actuator can deliver sufficient torque without motor stall when opening or closing the valve. The conversion of torque to thrust in an MOV is dependent on the stem friction coefficient which does not remain constant throughout the valve stroke. EPRI should develop its methodology to provide both thrust and torque requirements throughout the valve stroke to assist licensees in demonstrating the design-basis capability of safety-related MOVs.

STATUS

In the November 30 letter, EPRI states that its methodology will calculate torque and thrust required to operate a valve over its entire stroke. EPRI stated that its testing program has the objective of understanding and quantifying the variations in stem friction coefficient over the entire stroke to ensure that its methodology adequately predicts torque and thrust. The staff will review EPRI's consideration of stem friction coefficient variations when completed.

19. Some licensees might not be able to obtain precise values for the parameters to be input into the EPRI methodology. Therefore, licensees may want to estimate certain paramoters with best available information. EPRI should perform a sensitivity study of the model and identify the input parameters which have the greatest impact on the model's results. EPRI should then provide guidance to licensees on parameters that can be estimated and those that must be known precisely.

STATUS

In the November 30 letter, EPRI states that its methodology will include conservatism to account for the manufacturing tolerances of valve dimensions. EPRI states that licensees will have the option of obtaining actual dimensions to reduce the amount of conservatism. The staff will review EPRI's determination of the amount of required conservatism when completed.

20. EPRI has agreed to allow the staff to observe its MOV tests on a periodic basis and to review test data. The staff may request EPRI to provide test setup and performance information as well as raw data from selected tests.

STATUS

In the November 30 letter, EPRI states that detailed test data will be available when the test reports are finalized. At the December 3 meeting, EPRI provided information on the planned testing for the spring of 1993 which the staff might decide to observe. The staff will discuss with EPRI the need for specific test data and its plans for observing tests.

21. The staff noted a concern with EPRI's selection of a pressure measurement location in determining stem rejection load. The staff referred EPRI to Figure 33 of NUREG/CR-5720 for a comparison of pressure measured at three different locations. EPRI agreed to review the issue and to resolve the concern.

STATUS

At the December 3 meeting, EPRI stated that it would use upstream pressure for determining stem rejection load if the error resulting from the use of pressure measurements at this location is not significant. The staff will evaluate EPRI's determination of stem rejection load during its review of the EPRI methodology.

22. The staff is aware of three areas of significant disagreement that remain between EPRI and INEL with respect to the NRC-sponsored MOV tests (including results) performed by INEL. In summary, these areas are (1) the difference in the predictions of required thrust by the Limitorque, EPRI and INEL equations, (2) the selection of the point of flow isolation during valve closure, and (3) the behavior of INEL Valve 2 during flow tests. With respect to the EPRI MOV Performance Prediction Program, the staff believes that these areas of disagreement need to be resolved only to the extent that the disagreement might affect the staff's determination of the reliability of the EPRI MOV Performance Prediction Methodology. For example, the selection of the point of flow isolation might be used to predict the amount of thrust necessary to close a valve. Although this point might be adequate for the particular valve tested, it might not predict the thrust required to isolate flow for another valve because of concerns such as the difficulty in

precisely determining this point from test data and the differences in internal clearances between similar valves.

STATUS

In the November 30 letter, EPRI agrees that these areas of disagreement need only be resolved with respect to the reliability of the EPRI MOV Performance Prediction Program. EPRI states that the area of disagreement on the differences in the various thrust equations is not relevant to the EPRI methodology. EPRI states that the area of disagreement on the point of flow isolation is not relevant to the EPRI methodology because the methodology will not predict the point of flow isolation. EPRI states that the area of disagreement on the behavior of INEL valve 2 might become relevant based on separate effects tests and modeling. If this area of disagreement does become relevant, EPRI states that it will discuss this issue with the staff. The staff considers EPRI's response acceptable unless future information causes these areas of disagreement to become relevant.

NEW COMMENTS

23. At the December 3 meeting, EPRI stated that it would perform a small amount of actuator testing in determining output capability. However, EPRI stated that it would be using the Limitorque standard equation with some adjustments. The staff would like to know the extent to which the EPRI program will provide reliable information on the output capability of Limitorque actuators in comparison to the standard Limitorque equation.

24. The staff does not understand the extent to which MOVs controlled by the use of limit switches (for example, most butterfly valves, many parallel disk gate valves, and rotating rising stem valves) will be addressed by the EPRI program. This is important because of the significant number of MOVs that are presently controlled by limit switches or might be controlled by limit switches in the future.

25. EPRI should develop a program to provide for continuing updating of its methodology to incorporate new information or to correct deficiencies in the methodology found through future MOV tests.

26. In the November 30 letter, EPRI includes Figure 1, "Gate Valve Test Analysis Data Sheet," identifying specific information to be recorded from each MOV test. The staff indicated that some of the abbreviations are not clear. Because these data sheets may be used by valve engineers in setting up similar MOVs, it is important that the data be clearly defined. NUMARC agreed to follow-up on this staff concern.

27. Will EPRI evaluate any load sensitive behavior in the performance of motor-operated butterfly valves?

28. The EPRI methodology will be applicable to any MOV that can pass the design similarity analysis. Design features not currently being

addressed could present problems, such as encountered with the Burg-Warner test valve. How will EPRI account for future design similarity analysis problems?

ENCLOSURE 3

ATTENDANCE AT PUBLIC MEETING TO DISCUSS THE MOV PERFORMANCE PREDICTION PROGRAM BY EPRI ON DECEMBER 3, 1992

NAME	ORGANIZATION
J. Norberg	NRC/NRR/DE/EMEB
E. Sullivan	NRC/NRR/DE/EMEB
T. Scarbrough	NRC/NRR/DE/EMEB
D. Fischer	NRC/NRR/DE/EMEB
R. Kiessel	NRC/NRR/DORS/OGCB
G. Weidenhamer	NRC/RES
J. Jacobson	NRC/NRR/DRIS/SIB
E. Brown	NRC/AEOD
P. K. Eapen	NRC Region I
M. D. Hunt	NRC Region II
W. J. Hall	NUMARC
C. Callaway	NUMARC
J. Hosler	EPRI
K. Wolfe	EPRI
J. Allen	TVA
M. Eidson	Southern Nuclear
P. Damerell	MPR
R. Steele	INEL
J. Watkins	INEL

ENCLOSURE 3

ATTENDANCE AT PUBLIC MEETING TO DISCUSS
THE MOV PERFORMANCE PREDICTION PROGRAM BY EPRI ON DECEMBER 3, 1992

NAME	ORGANIZATION
J. Norberg	NRC/NRR/DE/EMEB
E. Sullivan	NRC/NRR/DE/EMEB
T. Scarbrough	NRC/NRR/DE/EMEB
D. Fischer	NRC/NRR/DE/EMEB
R. Kiessel	NRC/NRR/DORS/OGCB
G. Weidenhamer	NRC/RES
J. Jacobson	NRC/NRR/DRIS/SIB
E. Brown	NRC/AEOD
P. K. Eapen	NRC Region I
M. D. Hunt	NRC Region II
W. J. Hall	NUMARC
C. Callaway	NUMARC
J. Hosler	EPRI
K. Wolfe	EPRI
J. Allen	TVA
M. Eidson	Southern Nuclear
P. Damerell	MPR
R. Steele	INEL
J. Watkins	INEL