Commonwealth Edison
1400 Opus Place
Downers Grove, Illinois 60515

February 20, 1995

U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Document Control Desk

Subject: Braidwood Station Units 1 and 2
Byron Station Units 1 and 2
Dresden Station Units 2, and 3
LaSalle County Station Units 1 and 2
Quad Cities Station Units 1 and 2
Zion Station Units 1 and 2

Supplement to: Commonwealth Edison Submittal of Information Pertaining to Motor Operated Valve Testing as Specified in NRC Generic Letter 89-10 and the Subsequent Supplements to the Generic Letter

NRC Dockets 50-456 and 50-457
NRC Dockets 50-454 and 50-455
NRC Dockets 50-237 and 50-249
NRC Dockets 50-373 and 50-374
NRC Dockets 50-254 and 50-265
NRC Dockets 50-295 and 50-304

References: (1) USNRC Generic Letter 89-10 (With Supplements), "Safety Related Motor Operated Valve Testing and Surveillance"

(2) M. J. Vonk (ComEd) letter to USNRC dated February 16, 1995, "Commonwealth Edison Submittal of Information Pertaining to Motor Operated Valve Testing as Specified in NRC Generic Letter 89-10 and the Subsequent Supplements to the Generic Letter"

Due to a copying error some pages in Attachment 5 of Reference 2 were omitted from the previous transmittal. This letter provides a corrected copy of that Attachment as Attachment 1 to this letter.

A064

If there are any questions concerning this matter, or need for further clarification, please contact this office.

Sincerely,

Martin J. Vonk
Licensing Administrator

Attachments:

Attachment 1: MPR Associates Letter to Paul Dietz dated December 6, 1994, "Review of White Paper WP-129, "MOV Design Margin Evaluation and Diagnostic Test Feedback Evaluation""

cc: J. Martin, Regional Administrator - RIII
G. Dick, ComEd Generic Issues Project Manager - NRR

ATTACHMENT

1

MPR
ASSOCIATES INC.
ENGINEERS

December 6, 1994

Mr. Paul Dietz
Commonwealth Edison Company
1400 Opus Place, Suite 400
Downers Grove, IL 60515

Subject: Review of White Paper WP-129, "MOV Design Margin Evaluation and Diagnostic Test Feedback Evaluation"

Enclosure: Review Report for Review of Commonwealth Edison WP-129

Dear Mr. Dietz:

Enclosed is a report of our review of the subject white paper. Based on our review of this white paper and our discussions with Mr. I. Garza and Mr. B. Bunte, we conclude that the December 15, 1993 version of the paper (which we reviewed) needs substantial upgrading and improvement to:

(1) reflect the way that MOV margin evaluations are actually being performed;

(2) clarify the definitions of terms and describe how values for the terms are determined;

(3) clarify the criteria which are used to determine which margin category an MOV belongs to; and

(4) justify the approach that the conservatisms in the "design parameters" used in the evaluations are sufficient to exclude considerations of random uncertainties in operability evaluations.

Based on our discussions with Mr. Garza and Mr. Bunte, it appears that a considerable amount of work has been done in the above areas, and we understand that the white paper is in the process of being revised. The information in the enclosure can be used to assist in the revision process.

Please call if you have any questions or comments.

Sincerely,

Mitchell Albers

Mitchell Albers

cc: I. Garza (w/encl.)
B. Bunte (w/encl.)

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MPR ASSOCIATES INC.
ENGINEERS

Enclosure to
MPR Letter Dated
December 6, 1994

REVIEW REPORT
FOR REVIEW OF COMMONWEALTH EDISON WP-129

OVERVIEW

This review report documents the approach and conclusions of an independent review of Commonwealth Edison Company (CECo) White Paper WP-129, "MOV Design Margin Evaluation and Diagnostic Test Feedback Evaluation." The review was conducted using Revision 0 (December 15, 1993) of White Paper WP-129, which is included as Attachment A.

SCOPE OF WP-129

White Paper WP-129 addresses evaluation of the operability and design margin of a motor operated valve (MOV). This paper provides technical bases for an approach to evaluate margin, which is to be used whenever information is obtained (e.g., from diagnostic testing or from industry sources) that indicates the existing margin may be reduced. Within the position paper, the results of the margin evaluations are placed in four categories including high, medium, low and no margin. High margin MOVs are acceptable and no further action is required. Medium, low and no margin MOVs require disposition, which is covered by a separate position paper (WP-130).

WP-129 provides prioritized guidance on which sources of information should be considered in determining valve factor in margin evaluations. Also, guidance is provided on how to determine the key parameters for the margin evaluations based on three different possibilities for the test status of an MOV:

- No diagnostic test performed
- Static diagnostic test performed
- Dynamic and corresponding static diagnostic test performed

Information from MOV dynamic testing is identified as the most preferred source.

According to WP-129, the key to calculating the MOV design margin is establishing the thrust values associated with the current control switch setting, the minimum required thrust, and the maximum allowable thrust. Techniques for establishing these thrust values are described which are based on the best available information. Design parameters used in establishing the design margin thrusts (such as line pressure and differential pressure) are stated to be biased in the conservative direction. WP-129 indicates that this conservative biasing provides calculational margin to cover the effects of random uncertainties such as torque switch repeatability and diagnostic equipment accuracy, which are not included in the margin calculations done to support operability evaluations.

CONCLUSIONS AND RECOMMENDATIONS FROM REVIEW

A detailed review of WP-129 has been performed. Specific comments from this review are described later in this document on a section-by-section basis. The following are overall conclusions and recommendations resulting from review of WP-129.

Purpose of WP-129

- The purpose statement of WP-129 implies that the white paper is for use in evaluating the design margin for any MOV. However, based on our review of WP-129, we conclude that it is only applicable to gate valves and to rising, non-rotating stem globe valves with flow under the seat. Further, the white paper is geared toward valves which are torque switch controlled in the closing direction and are limit switch controlled in the opening direction. These limitations should be stated.

Technical Position

- As written the document is difficult to follow. The document can be made more coherent and readable by including an overview and/or flowchart which shows how margins are calculated and identifies which section of the white paper supports each stage of the process. All terms and acronyms should be defined, particularly those used in the design margin calculations (i.e, "MTC", "MGC", "OPT"). The approach for determining the values for these terms should also be included directly or by reference. All sources of additional information (such as other white papers) should be clearly referenced, including an identification of the applicability and limitations of the additional information sources.

- The method described in WP-129 makes use of information and calculational results which are generated through a number of other white papers including:

    - WP-107, Guideline for Determining Target Thrust Windows
    - WP-124, Load Sensitive Behavior/Rate of Loading
    - WP-131, Minimum Required Thrust and Valve Factor Calculation Methodology
    - WP-146, Disc Unwedging Factor

  The technical positions presented in these other white papers were not reviewed and evaluated as a part of review of WP-129.

- The design margin evaluation methods described in WP-129 make use of the best available information pertaining to the current setup of an MOV. Results of dynamic testing are typically considered the best available information. Use of data from other similar valves is permitted for determining valve factor when the specific

MOV has not been tested. However, the method by which valve factor is determined from other data is not addressed. For example, use of data from an isolated valve test may be inappropriate (non-conservative) since considerable valve-to-valve variations are known to occur. Methods which consider a range of data such as those described in WP-154 and WP-160 should be specified.

- Figure 1 of WP-129 indicates that a risk-based approach is used for prioritizing the safety importance of each MOV included in the Generic Letter 89-10 scope. However, prioritization of MOVs based on risk importance is not discussed in WP-129. The white paper where this prioritization is justified should be referenced.

- The criteria by which the margin is classified as high, medium, low or none needs to be definitively stated. For example, WP-129 states, "A high margin valve would typically have greater than 35 percent margin to the minimum required thrust and greater than 10 percent margin to the maximum allowable thrust." It is not clear whether the 35 percent and 10 percent values are hard criteria for determining high margin or whether they are simply indicative yardsticks. Our understanding is that these are the criteria for use in WP-129. If so, they should be clearly stated to be the criteria.

- There are a total of twenty-one different design margin calculations identified in WP-129 (Section 4, items 4a through 4u). It is not clearly stated whether all of these twenty-one calculated design margin values need to satisfy specific criteria for the design margin to be acceptable, or whether (in some cases) only some of the calculated margin values need to meet criteria. The position needs to be clarified.

  Figure 1 of this review report illustrates the twenty-one different design margin calculations identified in WP-129. A diagram similar to Figure 1 should be included in the white paper to more clearly illustrate the set of design margin calculations described.

- The method described in WP-129 allows for determination of the operability and design margin of an MOV from which no test data have been obtained (i.e., neither static nor dynamic tests have been performed). This is accomplished by using default values for some parameters which are typically determined through testing. Because of the considerable uncertainties in quantifying operator output at control switch trip without a test (which are not addressed nor quantified in WP-129), we consider that this approach for assessing MOV operability without test data is not acceptable. We suggest that this option be deleted from the white paper or that, if it is retained, a justification be provided to show that the uncertainties are acceptable or are accounted for.

Technical Justification

- WP-129 recognizes that there are random sources of error associated with MOV operability determination, such as torque switch repeatability, diagnostic equipment accuracy, and spring pack testing uncertainty. It is CECO's position that allowance for these sources of random error can be provided (for operability evaluations) by the conservatism in the values of MOV design parameters (such as line pressure, differential pressure, motor capability, etc.) used in the design margin calculations. It is possible that conservative design parameter values can provide allowance for random sources of error. However, CECo should provide a demonstration of this approach, such as through example margin calculations. These example calculations would need to show that the overall magnitude of the random error is comparable to the amount of margin introduced by the conservatisms in typical design parameter values.

REVIEW APPROACH

The MPR review approach is as follows:

- Review the white paper purpose to ensure that it is unambiguously and completely stated.

- Review the statement of position to ensure that it:

  - addresses the purpose;

  - is unambiguous and complete; and

  - includes all appropriate restrictions and limitations with regard to its use.

- Review the technical justification to ensure that it:

  - logically presents a case which defends the stated position;

  - makes proper technical use of the theory and data which are referenced;

  - does not exclude references to key data requirements;

  - provides a sufficient technical basis for the stated position; and

  - is written in a way which provides a convincing justification.

DETAILED REVIEW COMMENTS

Section B.1 describes the CECo technical position regarding evaluation of MOV design margin. Specific comments on this section are:

- On page 3 of 16 it is stated that the design margin of a particular MOV will be evaluated whenever system operating conditions are changed such that the assumed voltage at the MOV motor terminals decreases, the assumed differential pressure increases, or the design ambient temperature increases. The list of conditions should be expanded to include increases in line pressure.

- On page 3 of 16 reference is made to "Adequate Design Margin calculations" as determined by the "MOV target thrust window (TTW)." A source and definition of these terms should be provided.

Section B.2 (page 5 of 16) describes the method for determining an appropriate valve factor if it has not been verified by in situ testing. Specific comments on this section are:

- The document states that use of valve factors for similar valves tested at other utilities or by EPRI is acceptable, after adjustment for any differences in the methodology for determining valve factor. As opposed to saying "adjustments" we suggest the document indicate that valve factors should be determined in a manner consistent with the CECo method from WP-131.

- The document states that if a more appropriate value can not be determined, the following valve factors should be used:

    - for flexible wedge gate valves, at least 0.5
    - for double disc gate valves, at least 0.35
    - for globe valves, at least 1.1

  A basis for these values should be provided.

Section B.3 (page 5 of 16) describes methods for feedback of diagnostic test results to the MOV design margin evaluation. A specific comment on this section is:

- Three categories of testing status for an individual MOV are identified including: 1) no diagnostic test performed, 2) static test performed, and 3) dynamic and corresponding static test performed. The system operating conditions obtained during a "dynamic" test can range from near static conditions to near design basis conditions. An indication of what is considered acceptable "dynamic" test conditions (e.g., at least some percentage of design basis differential pressure is achieved) should be provided.

Section B.3.b (page 6 of 16) describes assumptions to be made when performing a design margin evaluation on an MOV that has been static tested only. Specific comments on this section are:

- Use of the measured value of stem coefficient of friction is specified, except that a value no less than 0.08 should be used. A basis for this minimum value of stem coefficient of friction should be provided.

- Use of appropriate, justified values for valve factor and rate-of-loading effect are specified. Additional description regarding the meaning of "appropriate" and "justified" should be provided.

Section B.3.c (page 6 of 16) describes assumptions to be made when performing a design margin evaluation on an MOV that has been tested under both static and dynamic conditions. Specific comments on this section are:

- Use of the measured value of stem coefficient of friction from the dynamic test is specified, except that a value no less than 0.08 should be used. A basis for this minimum value of stem coefficient of friction should be provided.

- Use of the measured value of stem thrust/torque at control switch trip from the static test is specified, along with a correction factor for rate-of-loading which is calculated from the dynamic and static test data. Use of the measured value of stem thrust/torque at control switch trip from the dynamic test would be preferable to using the results from the static test.

Section C.1 (page 7 of 16) describes the method for determining the thrust associated with the current torque switch setting of an MOV. Specific comments on this section are:

- The document states that spring pack testing uncertainty and spring pack curve uncertainty are assumed to be random with the bias being zero. Therefore, these uncertainties are not included in the operability evaluation. CECo should provide a justification including a quantification of these uncertainties, both to demonstrate that they have zero bias, and to demonstrate that they can be compensated for by conservatism in the specification of MOV design basis parameters.

- The preferred method of determining the control switch setting thrust is through the results of dynamic tests using Liberty test equipment. Many of the design margin calculations described later in the document then use this value of stem thrust at control switch trip (CSTT). CECo should provide a discussion of methods to adjust the measured value of CSTT from dynamic testing to account for dynamic test conditions which are less than the design basis conditions for a particular MOV.

- Section C.1 describes the method for determining the thrust associated with current limit switch settings. These methods, which are based on tests, are not meaningful because the thrust measured in a test of a limit switch controlled MOV may not have any relationship to the actuator output capability. In other words, CSTT does not have a relevant meaning for limit switch controlled MOVs. Values of CSTT and of margins considering CSTT should not be evaluated for limit switch controlled MOVs.

Section C.2 (page 8 of 16) describes valve design and operating parameters which are included in the calculation of MOV minimum required thrust (MRT). Specific comments on this section are:

- The document states that MRT values are calculated using the methodology of the T^2 program. A reference document describing this method should be identified.

- A list of valve design and operating parameters is included. This list should include rate-of-loading, which is apparently accounted for in the methodology.

- A discussion of MRT for the opening direction is provided, but none of the margins in Section 4 use MRT in the opening direction.

Section C.4 (page 9 of 16) identifies the calculations which are performed for each MOV to evaluate design margin. Specific comments on this section are:

- Several terms used in the design margin calculations require definition including motor gearing capability (MGC) and maximum thrust in the close direction (MTC). As previously mentioned, all terms should be defined along with a description (directly or by reference) of how the value of the parameter is determined.

- Design margin calculations are included for increased actuator torque margins to open and close based on Kalsi investigations. Although the Kalsi investigations conclude that increases in actuator thrust capability are permissible, corresponding increases in actuator torque output capability are not. These design margin calculations should be deleted.

- It is stated that design margin calculation 4l (motor thrust margin to open valve) is performed only for diagnostically tested valves, apparently because the calculation uses the value of open pull-out thrust which is determined from diagnostic testing. If this is the case, then design margin calculations 4m through 4q should also be identified as being performed only for diagnostically tested valves as these calculations also use the value of open pull-out thrust.

- Design margin calculation 4r (actuator torque limit to open) uses the value of calculated maximum torque associated with the open pull-out thrust. The document states that open pull-out thrust can be measured or calculated. Use of a calculated value of open pull-out thrust appears inconsistent with the previous design margin calculations which use only a diagnostically measured value of open pull-out thrust.

- There are twenty-one design margin calculations identified in Section C.4. The first eleven design margin calculations identified are closing stroke design margins. The next nine are opening stroke design margins. The last design margin calculation (corrected dynamic test margin) is a closing stroke design margin. It would be more appropriate to include this last design margin calculation with the closing stroke design margins.

Section D (page 14 of 16) provides justification of the methodology presented in WP-129. Specific comments on this section are:

- It is stated that the effect of random uncertainties is not included, but that this is compensated for by the conservatisms in the definition of the design parameters. Adequate justification is not provided to support this conclusion. Justification should include example margin calculations which show that this conclusion is supported.

- As mentioned in the detailed comments above, additional justification is needed for several parameter values used in the WP-129 method (e.g., valve factors of 0.5, 0.35 and 1.1, and stem friction coefficients of 0.15 and 0.08). The justification section (Section D) should be expanded to cover all of the areas of WP-129 where justification is needed.

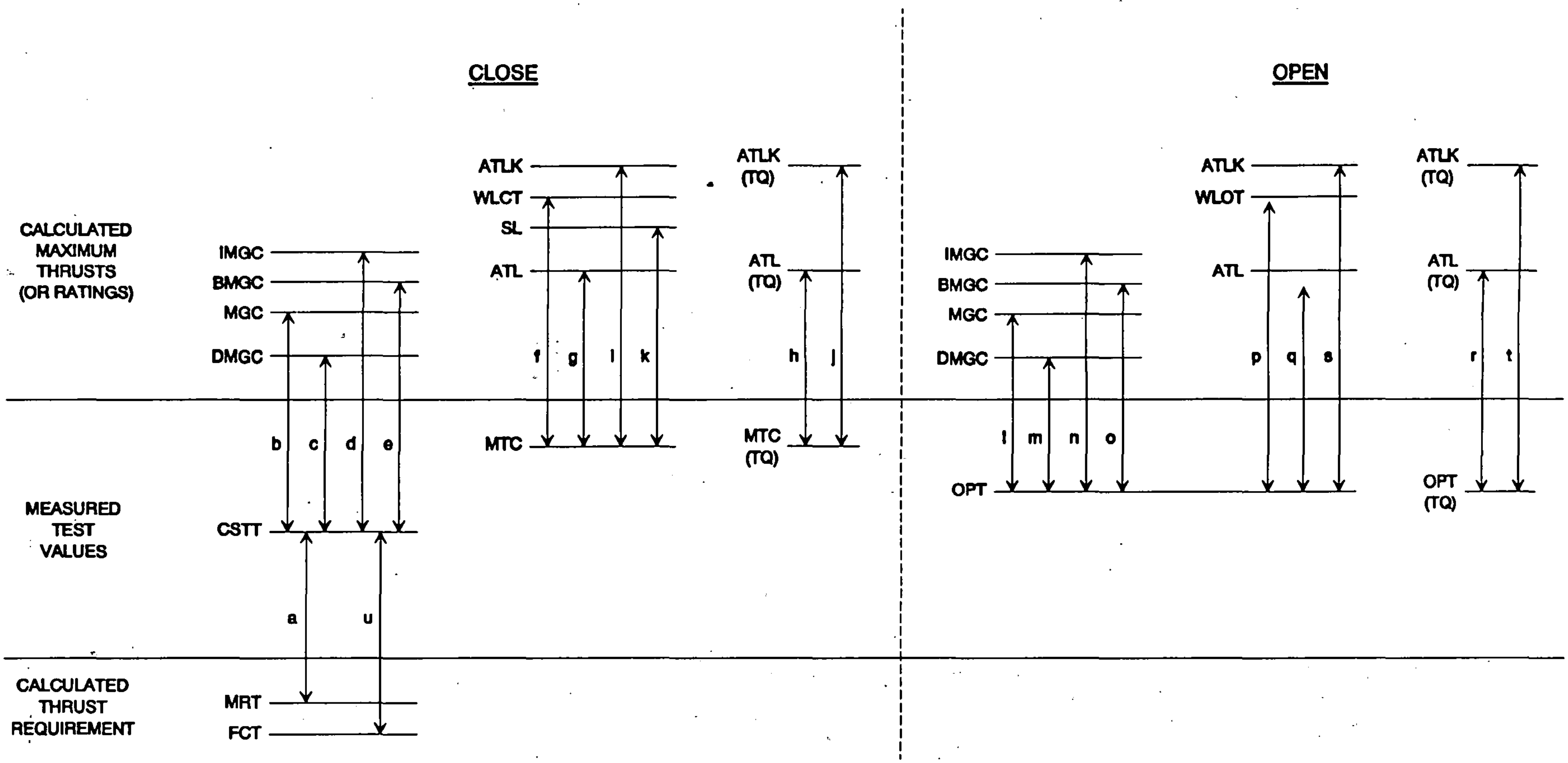

Figure 1. MOV Design Margin Calculations

MPR ASSOCIATES INC. ENGINEERS

Attachment A

White Paper WP-129, Revision 0 dated December 15, 1993

MOV Design Margin Evaluation
and
Diagnostic Test Feedback Evaluation

White Paper 129

MOV Design Margin Evaluation

and

Diagnostic Test Feedback Evaluation

Commonwealth Edison Company

Corporate MOV Program Support

Prepared by: ______________________
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MOV Program Support

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Pilot Site
MOV Project Manager

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White Paper 129

MOV Design Margin Evaluation and Diagnostic Feedback Evaluation

A. Purpose:

The purpose of this paper is to address how the operability and design margin of a motor operated valve (MOV) can be evaluated. MOV Design Margin is a measure of the MOV's current capability beyond that required to provide a reasonable assurance that the MOV will perform its specified safety function. Design margin measures the MOV's capability combined with it's current setup.

The evaluation discussed in this white paper is for use in evaluating the design margin for any MOV based on the best available information pertaining to the MOVs design requirements, existing hardware design, and current setup. Specific to this issue of determining the design margin for a given MOV is the use of best available information.

The methodology is appropriate for evaluating the operability of MOVs in the GL 89-10 program regardless of whether they have been tested.

B. Position:

1. Design Margin Evaluation

Design Margin is the difference between the field setting and the minimum thrust and torque required to provide reasonable assurance that the valve will perform its design function. Similarly, it is also the margin between the field setting and the capability of the motor, actuator or valve. Adequate design margin, for the purposes of this paper, exists when the MOVs current setup is within a design window with the appropriate uncertainties and current sizing parameters taken into account. A specific MOV which has adequate design margin is defined "high design margin" as shown on Figure 1.

The Design Margin will be evaluated whenever any of the following occur:

- control switch setting is changed

- static or dynamic test is performed and the as-left control switch setting is not within the target thrust window

- vendor information is received that changes any of the design assumptions such that the margin could be decreased

- dynamic or static test performed on a similar valve at another CECo station changes any of the design assumptions such that the margin could be decreased and that similar valve has not been statically or dynamically tested at the station

- if information is received from industry testing initiatives, such as Kalsi and EPRI, that changes any of the design assumptions such that the margin could be decreased

- operating conditions are changed such that the assumed voltage at the MOV motor terminal decreases, the assumed differential pressure increases, or the design ambient temperature increases

- the MOV hardware is modified or adjusted so that less thrust is available or more thrust may be required to operate the valve

- modifications to the system or operating procedures change the design basis operating conditions

MOV Design Margin is determined by calculating the difference or margin between the thrust associated with the current control switch setting and each of the following MOV design capabilities:

- minimum required thrust to close the valve

- maximum allowable thrust or torque to prevent motor damage, valve damage, or valve operator damage

The Design Margin also considers the difference between the thrust required to open the valve and the maximum allowable thrust or torque to prevent valve motor or actuator damage.

For operability evaluations the calculation for the minimum required thrust and the maximum allowable thrust or torque will not include an allowance for random uncertainties. In contrast, Adequate Design Margin calculations, as determined by the MOV target thrust window (TTW), include allowances for random uncertainties.

To allow prioritization of activities undertaken to improve MOV margin for individual valves, the following categories are established and shown on Figure 1:

- No Margin - The calculated MOV Design Margin is negative because the current MOV control switch setting is either less than the minimum required thrust or greater than the maximum allowable thrust or torque. A MOV identified as having a negative calculated margin represents a loss of reasonable assurance that the MOV will perform its specified safety function. The identified MOV problem will be resolved in accordance with the guidance provided in White Paper 130, "MOV Problem Resolution."

- High Margin - The current MOV control switch setting is in the established testable target thrust window with all uncertainties taken into account. A high margin valve would typically have greater than 35 percent margin to the minimum required thrust and greater than 10 percent margin to the maximum allowable thrust. Valves in this category are acceptable.

- Low Margin - The calculated MOV Design Margin is less than half of the margin that it would take to obtain a design TTW for either the minimum required thrust or the maximum allowable thrust. A low margin MOV would typically have less than 15 percent margin to the minimum required thrust or less than 5 percent margin to the maximum allowable thrust. Valves in this category are degraded but capable of delivering the minimum required thrust without damaging the actuator, motor or valve. Disposition of these valves will be in accordance with White Paper - 130, "MOV Problem Resolution".

- Medium Margin - The calculated MOV Design Margin is equal to or greater than half of the margin that it would take to obtain a design TTW for both the minimum required thrust and the maximum allowable thrust. A medium margin MOV would typically have greater than 15 percent margin to the minimum required thrust and greater than 5 percent margin to the maximum allowable thrust. Valves in this category are degraded but capable of delivering the minimum required thrust without damaging the actuator, motor or valve. Disposition of these valves will be in accordance with White Paper - 130, "MOV Problem Resolution".

2. Valve Factor

The key to performing an adequate evaluation of the MOV Design Margin for an individual MOV is the selection of the appropriate valve factor. If the valve factor has not been verified by appropriate in situ testing, an appropriate valve factor will be determined by the following in order of preference:

- valve factor measured for sister valves at the station
- valve factor measured for similar valves at the station
- valve factor measured for sister valves at another CECo station
- valve factor measured for similar valves at another CECo station
- valve factor measured for similar valves by CECo in a flow test loop
- valve factor measured for sister valves at another utility, after adjustment for any differences in the methodology for determining the valve factor
- valve factor measured for similar valves at another utility, after adjustment for any differences in the methodology for determining the valve factor
- valve factor measured for similar valves by EPRI, after adjustment for any differences in the methodology for determining the valve factor
- if a more appropriate value can not be determined, the following valve factors should be used:
    - for flex wedge gate valves, at least 0.5
    - for double disc gate valves, at least 0.35
    - for globe valves, at least 1.1

3. Diagnostic Test Feedback

The testing status for an individual MOV can be any of the following:

- no diagnostic test performed
- static test performed
- dynamic and corresponding static test performed

3a. No diagnostic test performed

The MOV Design Margin Evaluation is performed using the following assumptions and information:

- stem coefficient of friction - 0.15
- packing load - 1000 lb per stem diameter inch
- valve factor - appropriate, justified value
- control switch trip thrust/torque - based on generic spring curve or spring pack test results
- rate of loading - appropriate, justified value
- if a sister valve has been tested, values from that test should be used, as appropriate

3b. Static test performed

The MOV Design Margin Evaluation is performed using the following assumptions and information:

- stem coefficient of friction - measured value but no less than 0.08
- packing load - measured value
- control switch trip thrust/torque - measured value marked at control switch trip (C14)
- Maximum thrust/torque - measured value marked at C16
- Maximum pullout thrust - measured value marked at O9
- valve factor - appropriate, justified value
- rate of loading - appropriate, justified value

3c. Dynamic and corresponding static test performed

The MOV Design Margin Evaluation is performed using the following assumptions and information:

- stem coefficient of friction - measured value from dynamic test but no less than 0.08
- packing load - measured value from static test

- control switch trip thrust/torque - measured value from static test marked at control switch trip (C14)
- valve factor - calculated value from dynamic test and corresponding static test
- rate of loading - calculated value from dynamic test and corresponding static test

C. Discussion

1. Control Switch Setting Thrust

The thrust associated with the current torque switch setting can be determined but is not limited to the following methods: (Note: the methods are ordered by preference.)

a. results of dynamic test using Liberty test equipment

b. results of static test using Liberty test equipment

c. results of static test using MOVATs test equipment

d. calculated using torque switch setting, assumed stem coefficient of friction of 0.15, and results of a spring pack test

e. calculated using torque switch setting, assumed stem coefficient of friction of 0.15, and generic spring pack torque curve

Note: Spring pack testing uncertainty and spring pack curve uncertainty are assumed to be random with the bias being zero. Therefore, these uncertainties are not included in the operability evaluation.

For limit controlled valves, the thrust associated with current limit switch settings can be determined with the following methods: (Note: the methods are ordered by preference.)

a. results of dynamic test using Liberty test equipment

b. results of static test using Liberty test equipment

c. results of static test using MOVATs test equipment

d. calculated using limit switch setting, assuming generic stem nut deflection constants

2. Minimum Required Thrust

The minimum required thrust (MRT) is a function of the valve design. In the closing direction, MRT is a function of the thrust required to close the valve. The following are included in the calculation of MRT to close: (Note: the values are calculated using the methodology of the T^2 program updated for the latest position papers.)

- design differential pressure
- line pressure
- valve disc area
- packing load
- valve factor
- valve condition factor
- stem piston area

In the opening direction, MRT is a function of the thrust required to pull the valve out of the closed seat. The thrust associated with opening can be determined with the following methods: (Note: the methods are ordered according by preference.)

a. the largest result of static and dynamic testing using votes test equipment (i.e. the pull-out or O9 thrust)

b. calculated using the following equation from WP-107 (Reference 4)

Pull-out = 0.8 * Inertia * CSTT

CSTT = Control Switch Trip Thrust

Inertia Factor assumed

3. Maximum Allowable Thrust

The maximum allowable thrust (MAT) is a function of the motor's capability to generate torque and the valve and actuator's ability to transmit and absorb thrust and torque. The following limiting conditions are evaluated:

- seismic limit for the valve (the maximum closing thrust combined with the seismic thrust)

- actuator thrust limits
- actuator torque limits divided by stem factor
- valve structural limits (both opening and closing)
- motor degraded voltage thrust capability
- motor degraded temperature thrust capacity
- increased motor capability (interim position discussed in White Paper 125)
- motor thrust capability decreased due to motor brakes

4. Margin Calculations

The following calculations are performed to evaluate margin:

4a. Thrust to close

$$\frac{CSTT - MRT}{MRT} * 100 \text{ percent}$$

CSTT = control switch trip thrust

MRT = minimum required thrust

4b. Motor Gearing Capability to close valve

$$\frac{MGC - CSTT}{MGC} * 100 \text{ percent}$$

CSTT = control switch trip thrust

MGC = Motor Gearing Capability (All motor capability calculations include under-voltage effects)

4c. Decreased Motor Gearing Capability to close valve

$$\frac{DMGC - CSTT}{DMGC} * 100 \text{ percent}$$

CSTT = control switch trip thrust

DMGC = Motor Gearing Capability Decreased not only for voltage but also for ambient temperature

4d. Increased Motor Gearing Capability to close valve using White Paper - 125

$$\frac{IMGC - CSTT}{IMGC} * 100 \text{ percent}$$

CSTT = control switch trip thrust

IMGC = Increased Motor Gearing Capability

4e. Motor Gearing Capability to close valve using White Paper - 125 temperature effects and motor brake applied

$$\frac{BMGC - CSTT}{BMGC} * 100 \text{ percent}$$

CSTT = control switch trip thrust

BMGC = Motor Gearing Capability to close valve using White Paper - 125 temperature effects and motor brake applied

4f. Valve Weak Link Margin to close

$$\frac{WLCT - MTC}{WLCT} * 100 \text{ percent}$$

MTC = maximum thrust in close direction

WLCT = Valve Weak Link Closing Thrust

4g. Actuator Thrust Margin to Close

$$\frac{ATL - MTC}{ATL} * 100 \text{ percent}$$

MTC = maximum thrust in close direction

ATL = Actuator Thrust Limit

4h. Actuator Torque Limit to close

$$\frac{ATL(torque) - MTC(torque)}{ATL(torque)} * 100 \text{ percent}$$

MTC(torque) = maximum torque in close direction trip thrust

ATL(torque) = Actuator Torque Limit

4i. Kalsi Increased Actuator Thrust Margin to Close

$$\frac{ATLK - MTC}{ATLK} * 100 \text{ percent}$$

MTC = maximum thrust in close direction

ATLK = Actuator Thrust Limit increased using Kalsi

4j. Kalsi Increased Actuator Torque Margin to Close

$$\frac{ATLK - MTC(Torque)}{ATLK(Torque)} * 100 \text{ percent}$$

MTC(Torque) = maximum torque in close direction

ATLK(Torque) = Actuator Torque Limit increased using Kalsi

4k. Seismic Margin (only in the close direction)

$$\frac{SL - MTC}{SL} * 100 \text{ percent}$$

MTC = maximum thrust in close direction
SL = Seismic Limit

4l. Motor thrust margin to open valve (only calculated for diagnostically tested valves)

$$\frac{MGC - OPT}{MGC} * 100 \text{ percent}$$

OPT = Open Pull-out Thrust

MGC = Motor Gearing Capability

4m. Decreased Motor Gearing Capability to open valve

$$\frac{DMGC - OPT}{MGC} * 100 \text{ percent}$$

OPT = Open Pull-out Thrust

DMGC = Motor Gearing Capability Decreased not only for voltage but also for ambient temperature

4n. Increased Motor Gearing Capability to open valve using White Paper - 125

$$\frac{IMGC - OPT}{IMGC} * 100 \text{ percent}$$

OPT = Open Pull-out Thrust

IMGC = Increased Motor Gearing Capability

4o. Motor Gearing Capability to open valve using White Paper - 125 temperature effects and motor brake applied

$$\frac{BMGC - OPT}{IMGC} * 100 \text{ percent}$$

OPT = Open Pull-out Thrust

BMGC = Motor Gearing Capability to close valve using White Paper - 125 temperature effects and motor brake applied

4p. Valve Weak Link Margin to open

```
WLOT - OPT
---------- * 100  percent
   WLOT
```

OPT = Open Pull-out Thrust

WLOT = Valve Weak Link Opening Thrust

4q. Actuator Thrust Margin to Open

```
ATL - OPT
----------- * 100 percent
   ATL
```

OTC = Open Pull-out Thrust

ATL = Actuator Thrust Limit

4r. Actuator Torque Limit to open

```
ATL(torque) - OPT(torque)
-------------------------- * 100 percent
     ATL(torque)
```

OPT(torque) = calculated maximum torque associated with the measured or calculated open pull-out thrust

ATL(torque) = Actuator Torque Limit

4s. Kalsi Increased Actuator Thrust Margin to open

```
ATLK - OPT
----------- * 100 percent
   ATLK
```

OPT = Open Pull-out Thrust

ATLK = Actuator Thrust Limit increased using Kalsi

4t. Kalsi Increased Actuator Torque Margin to open

$$\frac{ATLK - OPT(Torque)}{ATLK(Torque)} * 100 \text{ percent}$$

OPT(torque) = calculated maximum torque associated with the measured or calculated open pull-out thrust

ATLK(Torque) = Actuator Torque Limit increased using Kalsi

4u. Dynamic Test Margin (corrected)

$$\frac{CSTT - FCT(design)}{FCT(design)} * 100 \text{ percent}$$

FCT = flow cutoff extrapolated to design pressures in accordance with White Paper 131

CSTT = control switch trip thrust

D. Justification:

The key to calculating the MOV Design Margin, a measure of the MOVs capability to provide a reasonable assurance that the MOV will perform its specified safety function, is establishing the thrust values associated with the current control switch setting, the minimum required thrust, and the maximum allowable thrust.

The certainty with which the thrust values, and therefore the MOV Design Margin, can be determined is a function of the accuracy and conservatism of the MOV design parameters, the repeatability of the MOV control system, and the accuracy of the diagnostic test equipment. The uncertainties associated with these values can be grouped into two types, bias and random. All of the design parameters, such as line pressure, differential pressure, valve disc active area, and motor capability, have been biased in the conservative direction. The calculation of the MOV's thrust values, includes no allowance for random uncertainties such as torque switch repeatability and test equipment accuracies. In contrast, adequate MOV design margin (High margin) as established by the MOV target thrust window (TTW) includes allowances for these random uncertainties as additional conservatism and margin. The exclusion of random uncertainties is justified because conservative bias included in the design parameters provide additional margin which reasonably assure that the valves will perform their safety function.

E. References

1. White Paper 124, "Load Sensitive Behavior (Rate of Loading)"

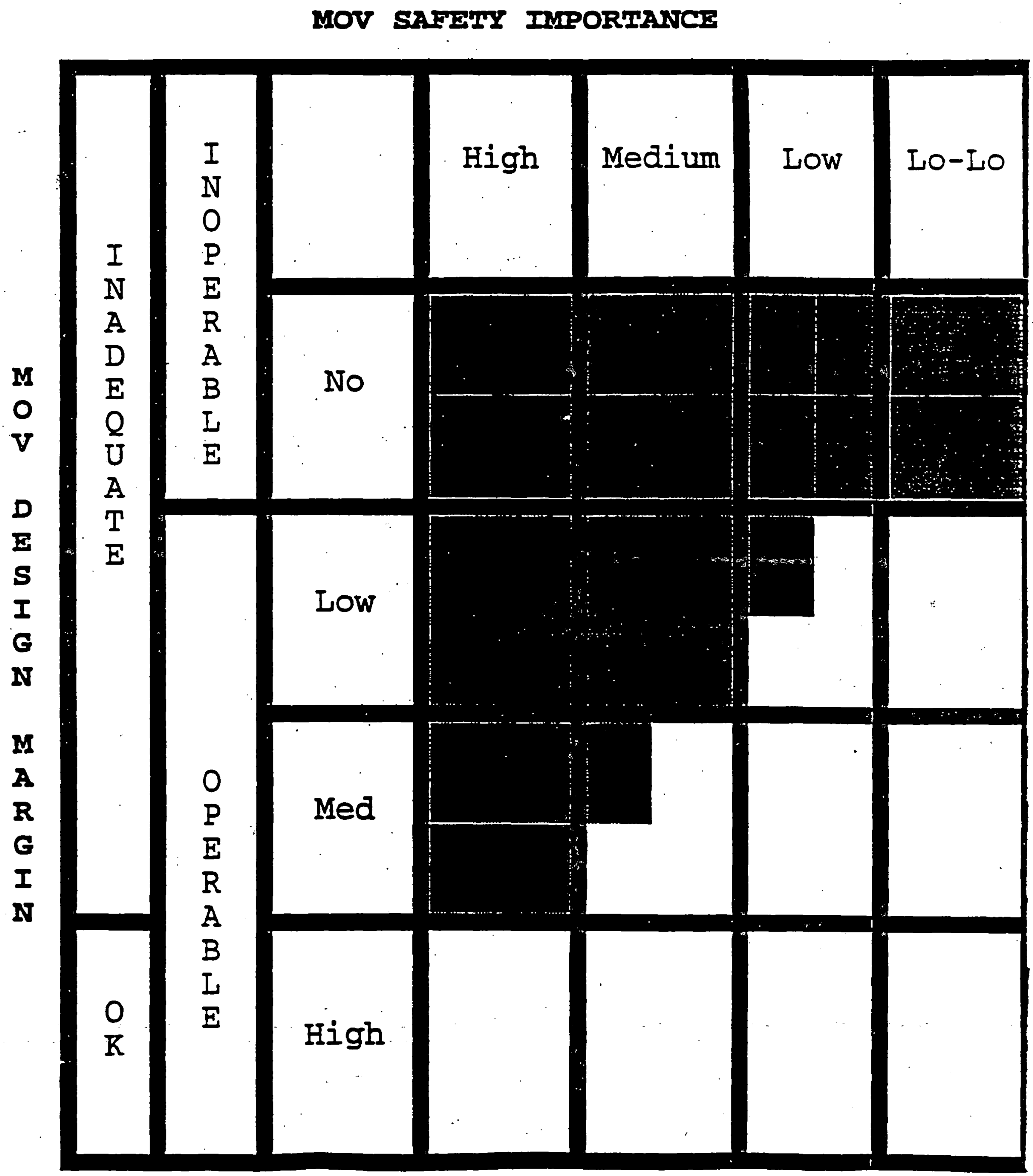
2. White Paper 125, "Increased Motor Capability"

3. White Paper 130, "MOV Problem Resolution"

4. White Paper 107, "Thrust Window Margins, Desired Thrust Windows, Target Thrust Methodology, and Operability Criteria"

5. White Paper 131, "Valve Factor Calculation Methodology"

Figure 1 - MOV Margin and Importance Matrix



Attachment A

MOV Margin Calculation Data Base
Paradox Program
Object PAL (Source Code)

LATER

Attachment B

MOV Margin Calculation Data Base

Paradox Program
Sample Reports

LATER