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DATE OF MEETING
09/20/2000

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Docket Number(s)	PROJECT NO. 669
Plant/Facility Name	EPRI
TAC Number(s) (if available)	MA6484
Reference Meeting Notice	8/28/00, REVISED 9/11/00
Purpose of Meeting (copy from meeting notice)	TO DISCUSS ADDENDUM 2 TO EPRI TOPICAL REPORT ON MOTOR-OPERATED VALVE PERFORMANCE PREDICTION PROGRAM

NAME OF PERSON WHO ISSUED MEETING NOTICE	TITLE
L.N. OLSHAN	PROJECT MANAGER

OFFICE
NRR

DIVISION
DLPM

BRANCH
PD II-1

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EPRI PPM Thrust Uncertainty Method

NRC Meeting Agenda

September 20, 2000

1:00 pm	**Introductions and Meeting Objectives**
1:15 pm	**Description of Thrust Uncertainty Method**
1:45 pm	**Discussion of NRC Comments and Proposed EPRI Responses**
3:30 pm	**Schedule for Written Responses**
4:00 pm	**Adjourn**

Gate Valve Thrust Uncertainty Method For EPRI MOV Performance Prediction Methodology (PPM)

MPR Associates, Inc.
September 20, 2000

MPR

Outline

- Introduction
- Description of Method
- Applicability
- Example
- Method Justification
- Method Validation
- Summary

Introduction

- PPM is a validated method for predicting thrust and torque requirements
  - Gate valves
  - Globe valves
  - Butterfly valves
- For gate valves, thrust predictions are bounding with margin
  - Variability of COF for Stellite (seat material)
  - Valve must be tested with DP to determine actual COF
  - Difference between PPM prediction and actual thrust requirement is an uncertainty

Introduction (con't)

- Thrust Uncertainty Method (TUM)
  - Determines average conservatism in PPM gate valve thrust prediction
  - Treats conservatism as an uncertainty that is statistically combined with other uncertainties (e.g., ROL)

Description of Method

- Use PPM to predict bounding required thrust, T_{PPM}
- Calculate nominal required thrust, T_{NOM}
  - Adjust PPM thrust prediction for packing and stem rejection loads to determine DP thrust component
  - Multiply DP thrust component by Average Prediction Ratio (APR)
  - APR is 0.697 for cold water (less than 100F) with flows up to 50 ft/sec; 0.775 for hot water (100-550F) with any flow rate
  - Adjust result for packing and stem rejection loads

Description of Method (con't)

- Calculate thrust prediction uncertainty, U_{TPU}

$$U_{TPU} = \frac{T_{PPM} - T_{NOM}}{T_{NOM}} * 100$$

- Calculate the minimum required thrust at control switch trip

$$T_{CST} = T_{NOM}(1 + \sum B + \sqrt{\sum R^2 + U_{TPU}^2})$$

- where B represents bias and R random uncertainties

Description of Method (con't)

- EPRI-recommended bias and random uncertainties due to rate-of-loading can be used, or plant data can be evaluated to determine plant-specific values

Applicability

- Gate valves
  - Solid and flexible wedge, except Borg-Warner (PPM software)
  - Westinghouse (EPRI hand calculation)
  - Double disk and split wedge, flow isolation only (EPRI hand calculation)
- Must meet PPM applicability requirements
- Closing strokes
- Cold water (<100F) with flows up to 50 ft/sec
- Hot water (up to 550F) at any flow rate

Example

- Example inputs
  - Temperature: 98F
  - PPM thrust prediction: 25,000 lbs
  - Packing load: 2,000 lbs
  - Stem rejection load: 2,000 lbs
  - ROL bias: 3%
  - ROL random uncertainty: 18%
  - Thrust measurement uncertainty (random): 10%
  - Torque switch repeatability (random): 5%
  - TUM prediction ratio: 0.697

Example (con't)

- Implementation of TUM:

$$T_{NOM} = (25000 - 2000 - 2000) * .697 + 2000 + 2000 = 18{,}637 \text{ lbs}$$

$$U_{TPU} = \frac{25{,}000 - 18{,}637}{18{,}637} * 100 = 34.14\%$$

$$T_{CST} = 18637(1 + .03 + \sqrt{.3414^2 + .18^2 + .10^2 + .05^2}) = 26{,}685 \text{ lbs}$$

Method Justification

- Use of SRSS to combine random uncertainties is a commonly accepted approach for valve setup
- APRs are based on comparison of PPM predictions to EPRI flow loop test results
  - Values determined for high and low temperature since Stellite friction varies with temperature
  - Borg-Warner valves excluded because of high seat friction -- method N/A for Borg-Warner valves
  - EPRI flow loop valves were "pre-conditioned" prior to testing so APRs include the effect of preconditioning

Method Validation

- Validated against applicable EPRI flow testing
  - 19 strokes from 12 valves
- TUM implemented to determine min thrust at CST
- Test data evaluated to determine if valve would have closed with torque switch set at minimum value
  - Stem thrust plotted against spring pack displacement for DP and static tests
  - Minimum thrust at CST correlated to a specific spring pack displacement for static test
  - Thrust for DP test at that spring pack displacement determined and compared to thrust required to close valve

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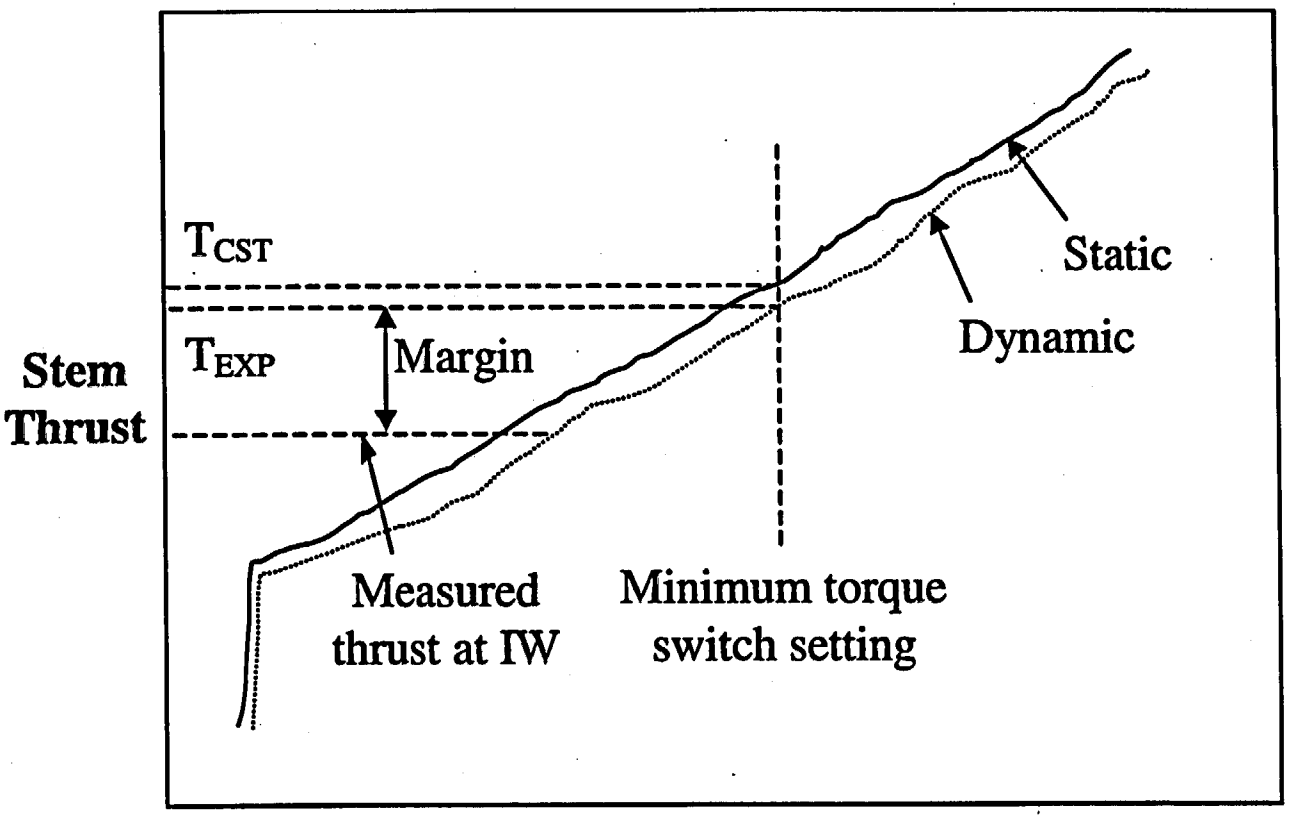
Method Validation (con't)



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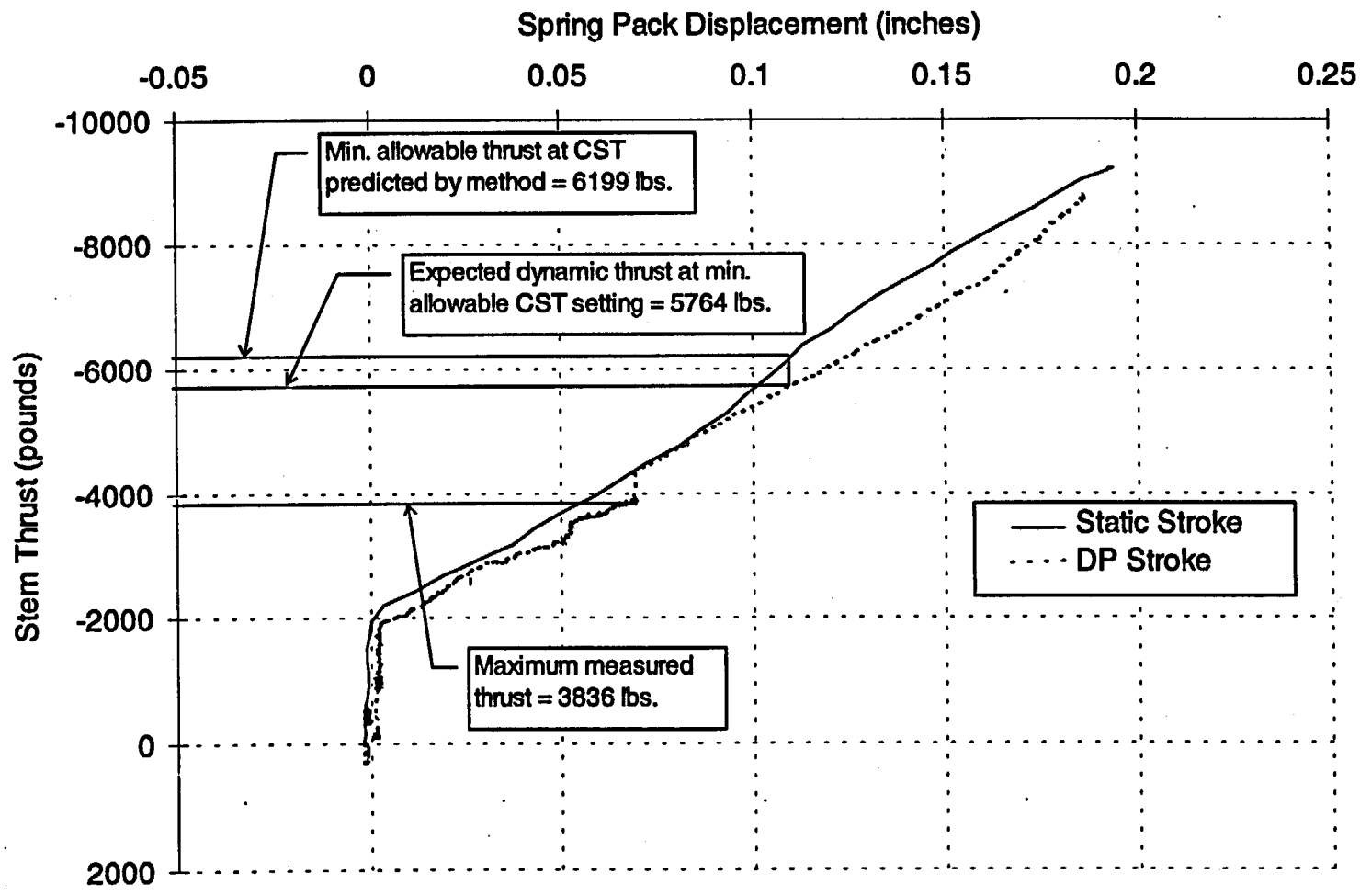
Method Validation (con't)



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Method Validation (con't)

- Prediction ratio (PR) calculated for each stroke
  - Required thrust divided by available thrust
  - Value less than 1.0 indicates TUM conservatively calculates required thrust at CST

Method Validation (con't)

Valve Description	Valve Manufacturer	Test Conditions	Prediction Ratio	
			TUM	Assessment
3" 300# Gate	Anchor/Darling	15 fps, 84°F water	0.67	0.69
6" 900# Gate	Anchor/Darling	50 fps, 63°F water	0.87	0.94
		blowdown, 517°F water	0.74	0.82
10" 300# Gate	Anchor/Darling	15 fps, 48°F water	0.52	0.55
10" 900# Gate	Anchor/Darling	15 fps, 82°F water	0.62	0.66
2.5" 1500# Gate	Velan	15 fps, 70°F water	0.86	0.77
		50 fps, 72°F water	0.72	0.76
		blowdown, 659°F water	0.76	0.82
6" 900# Gate	Crane	15 fps, 69°F water	0.63	0.70
6" 900# Gate	Velan	15 fps, 86°F water	0.78	0.82
		50 fps, 73°F water	0.69	0.82
		blowdown, 524°F water	0.79	0.91
10" 300# Gate	Velan	15 fps, 55°F water	0.71	0.74
6" 900# Gate	Walworth	15 fps, 72°F water	0.63	0.67
		blowdown, 527°F water	1.05	1.03
12" 150# Gate	Walworth	15 fps, 55°F water	0.62	0.71
6" 900# Double Disk	Anchor/Darling	15 fps, 59°F water	0.74	0.78
		15 fps, 59°F water	0.80	0.78
3" 1500# Gate	Velan	50 fps, 82°F water	0.71	0.66

Method Validation (con't)

- Validation results
  - Method is bounding for 15 of 15 cold water strokes and 3 of 4 hot water strokes; PRs range from 0.52 to 1.05
  - Prediction ratios for 15 of the 19 strokes are lower than the prediction ratios from PPM assessment (shown **bold** in table)
    - The conservatism in the TUM is similar to (or more than) the conservatism in the PPM gate valve thrust predictions

Method Validation (con't)

- Validation results (con't)
  - PR for hot water blowdown stroke of Valve 30 was 1.05
    - Valve 30 had high seat friction (0.53 for 550F closing stroke)
    - ROL high at minimum thrust at control switch trip value (about 16%)
    - Assessment PR for this stroke was 1.03; therefore, TUM validation results are consistent with PPM assessment -- the PPM is 3-5% non-conservative for this stroke

Summary

- The TUM is a satisfactory predictor of minimum required thrust at control switch trip for gate valves
- The method has been successfully validated against EPRI flow testing

Example Comparison

- Inputs
  - Closing stroke
  - 6960 lb packing load
  - 3" diameter stem
  - 11.917 inch mean seat diameter
  - 464 psig upstream pressure and DP
  - 3% bias and 18% random ROL
  - 5% torque switch repeatability
  - 10% measurement uncertainty

Example Comparison (con't)

- Calculate required thrust using PPM and minimum thrust at CST without using TUM
  - Required thrust is 47,466
  - Total uncertainty is 24%
  - Min thrust at CST 58,948
- Calculate required thrust using PPM and minimum thrust at CST using TUM
  - Required thrust is 47,466
  - Total uncertainty is 41%
  - Min thrust at CST 50,911

Example Comparison (con't)

- For comparison, a plant might evaluate this valve with a 0.6 valve factor (and no TUM)
  - Required thrust is 41,292
  - Total uncertainty is 24%
  - Min thrust at CST 51,280

NRC STAFF QUESTIONS ON EPRI TOPICAL REPORT TR-103237, ADDENDUM 2

1. The Electric Power Research Institute (EPRI) indicated during the NRC staff review of the EPRI Motor-Operated Valve (MOV) Performance Prediction Methodology (PPM) that the scope of the valves to be included in the EPRI valve testing program was not intended to constitute a statistical database, but rather was selected to provide a reasonable validation of the EPRI MOV PPM. Explain the basis for applying the Thrust Uncertainty Method described in Addendum 2 of EPRI Topical Report TR-103237 (and the specific test data used in its support) to all gate valves within the scope of the EPRI MOV PPM.

2. Has EPRI evaluated the change in reliability in MOVs that might result from application of the Thrust Uncertainty Method?

3. The Joint Owners Group (JOG) Program on MOV Periodic Verification references the EPRI MOV PPM in establishing margins and testing schedules for MOVs within the scope of Generic Letter (GL) 96-05, "Periodic Verification of the Design-Basis Capability of Safety-Related Motor-Operated Valves." Has EPRI evaluated whether any changes would be needed to the use of the EPRI MOV PPM in GL 96-05 programs where the Thrust Uncertainty Method is applied?

4. Explain why certain data in Table 1 of Appendix B to EPRI Topical Report TR-103237, Addendum 2, are different from the original test data in previously published EPRI test reports. For example, see the data in EPRI TR-103674-V9P1, "EPRI MOV Performance Prediction Program - High Pressure Cold and Hot Water Blowdown Facility Test Report, Volume 9, Part 1: Test Results for MOV #24."

5. EPRI Topical Report TR-103237, Addendum 2, assumes that the EPRI MOV PPM thrust predictions for gate valves are conservative. However, the overall test data obtained by EPRI (including data used to support the Thrust Uncertainty Method) indicate low to moderate friction coefficients for the test valves. Further, low loading conditions applied to the valves during testing might result in significant scatter in the test data. Explain the basis for the assumption that the EPRI test valves were fully preconditioned in light of this information.

6. Discuss the linear relationship between the prediction ratio (actual required differential-pressure thrust requirement to EPRI MOV PPM differential-pressure thrust prediction) and friction coefficient which suggests that the Thrust Uncertainty Method could become less conservative (and possibly non-conservative) if the friction coefficient increases as the valves age.

7. EPRI Topical Report TR-103237, Addendum 2, indicates that the Thrust Uncertainty Method is intended to be applicable to Aloyco split-wedge gate valves. In a safety evaluation (SE) dated February 20, 1997, the NRC staff stated that users of the EPRI model for Aloyco split-wedge gate valves must justify input of friction coefficients other than EPRI's default friction coefficients. Explain the application of the Thrust Uncertainty Method in light of this concern.

8. EPRI Topical Report TR-103237, Addendum 2, applies the bounding values for load sensitive behavior derived from the EPRI tests in support of the acceptability of the thrust prediction provided by the Thrust Uncertainty Method. Explain the basis for applying the EPRI load sensitive behavior prediction values rather than the load sensitive behavior of the specific test valves used in support of the Thrust Uncertainty Method.

9. Describe the basis for the use of the estimated stem rejection load rather than actual valve thrust data in evaluating the Thrust Uncertainty Method.

10. Explain the basis for comparing a prediction ratio based on dynamic thrust predictions from the EPRI MOV PPM to a prediction ratio based on thrust predicted to be delivered at torque switch trip (including random and bias uncertainties) to support the Thrust Uncertainty Method.

11. Explain the basis for determining an average prediction ratio for the EPRI MOV PPM to support the Thrust Uncertainty Method rather than evaluating the uncertainty in data obtained from the Stellite separate-effects friction tests conducted by EPRI.