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EPRI – NEI – NRC Meeting to Discuss MOV Topical Reports

March 3rd, 2009

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Purpose of Today's Meeting

- Discuss the following potential topical reports prior to submitting them for NRC staff review:
  - EPRI Report 1015069, "Use of MCC-Based Motor-Torque Measurements for Periodic Verification of Motor-Operated Valves."
  - EPRI Report 1018298, "EPRI Motor Operated Valve Performance Prediction Program: Addendum 8 to EPRI TR 103237-R2: "PPM Version 3.4 Software Changes."

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Agenda

- EPRI Report 1015069, “Use of MCC-Based Motor-Torque Measurements for Periodic Verification of Motor-Operated Valves.”
  - Technical overview
- EPRI Report 103237, “EPRI Motor-Operated Valve Performance Prediction Program, Revision 3.4.”
  - Technicial overview
- Topical reports
  - Schedule
  - Future Licensing Actions and/or Relationship to Other Ongoing Industry Efforts
  - Fee waiver request basis
- Meeting Summary – Public Comments

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Use of MCC-Based Motor Torque Measurements for Periodic Verification of MOVs

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March 3, 2009

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Contents

- Background
- Overview
- Applicability
- Implementation Approach
- Validation
- Conclusions

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Background

- GL 96-05 requires periodic static testing to verify the capability of safety-related MOV actuators
- Currently this is done using time consuming at-the-valve diagnostic test systems
- An optional non-intrusive testing approach for defining MOV margin based on MCC based motor torque measurements has been developed, justified and validated using plant data
- EPRI Motor Torque Periodic Verification (MTPV) Methodology (EPRI 1015069)

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Development Team

- EPRI research conducted by Crane Nuclear and MPR Associates
  - David Graf and W. Darmetko (Crane Nuclear)
  - Jeff Gratz , Paul Damerell and M. Frey (MPR Associates)

- Utility Technical Advisory Group
  - Chad Smith (Duke Energy)
  - Tim Chan (TVA)
  - Ted Neckowicz (Exelon)
  - Sam Gates, Jerry Daniels and G. Warren, SNOC

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Methodology Overview

- Requires a “Baseline Parallel” test
  - Direct thrust measurement
  - Corresponding MCC-based motor torque measurement using system with known measurement accuracy
- Allows subsequent static testing for MOV verification using MCC motor torque measurements alone
- Requires justified uncertainties for key MOV parameters (ROL, TS Repeatability, measurement system accuracy, etc)

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Methodology Applicability

- MTPV Method Applicability
  - Closing strokes
  - Rising stem valves (not rising/rotating)
  - Torque-switch controlled MOVs
  - AC motors

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Thermometer Figure Discussion

- Shows relationship between direct stem thrust measurements and motor torque measurements in determination of MOV upper and lower setup limits
- Rigorous consideration of uncertainties

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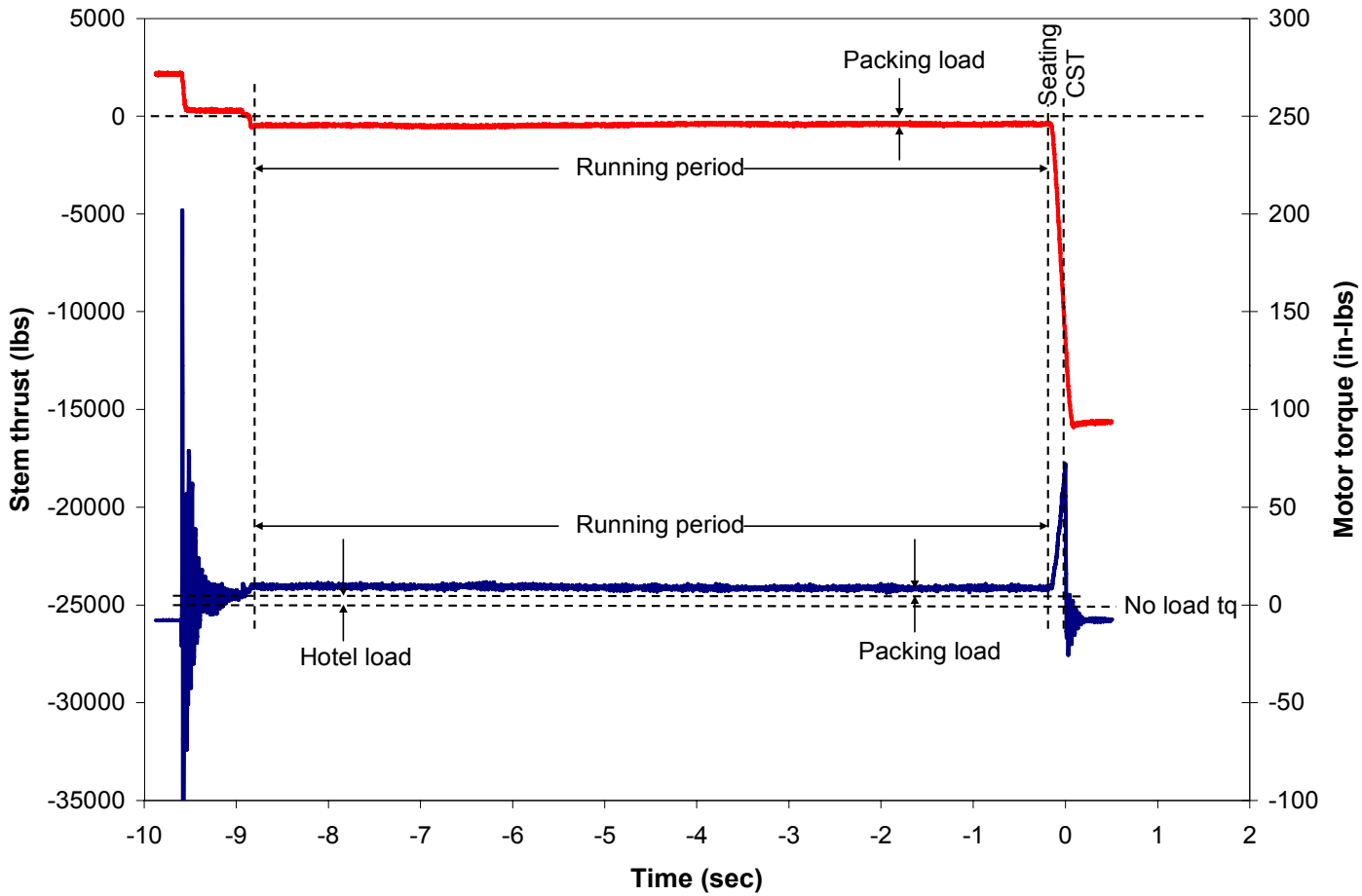
Methodology Implementation



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Methodology Implementation

- MTPV Method requires a baseline "parallel" test which includes:
  - Motor Control Center (MCC) based motor torque measurements
  - Direct (at-the-valve) stem thrust measurements
- Baseline test data used to develop parameters to relate motor torque to stem thrust
  - Motor Torque Hotel Load (MT_{HOTEL})
    - Motor torque required to engage actuator gearing and stem nut without any load on stem (i.e., zero stem thrust and stem torque)
  - MOV Factor at CST (F_{MOV})
    - Ratio of measured motor torque to measured stem thrust at control switch trip (CST)
  - Inertial Thrust
    - Additional thrust developed after CST due to inertia of moving parts

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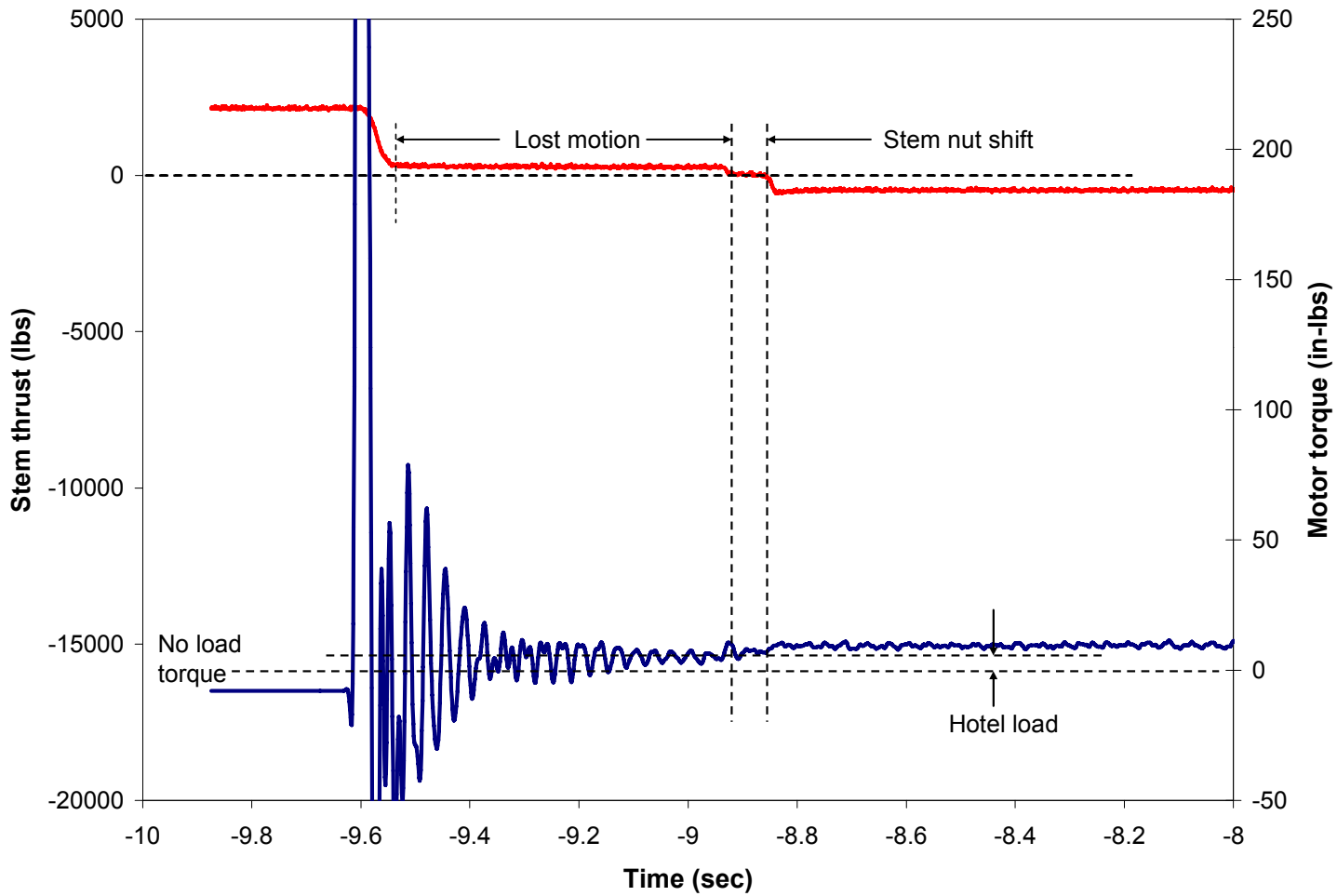
Methodology Implementation



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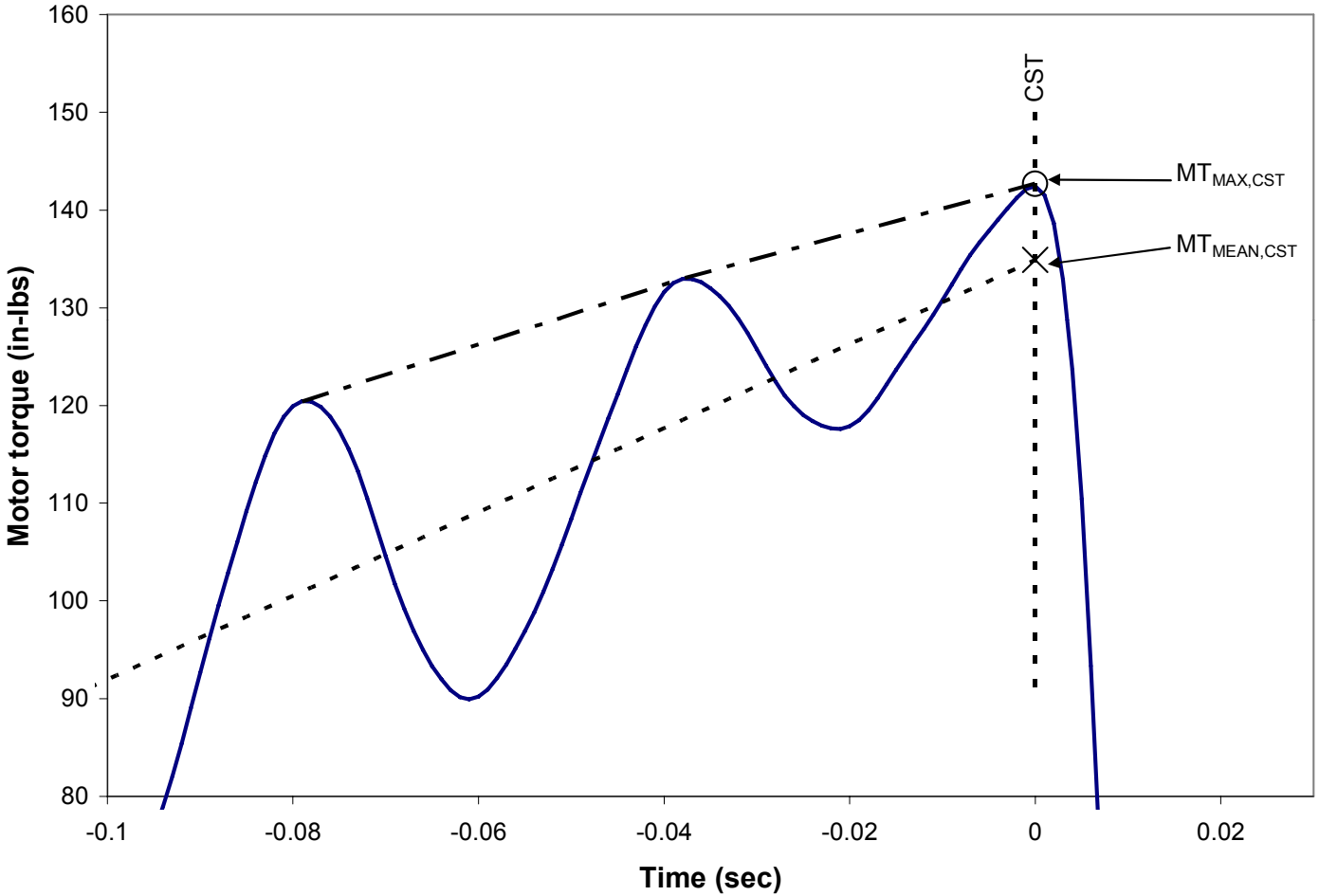
Methodology Implementation



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Methodology Implementation

- Existing "Raw" MOV thrust limits converted to motor torque limits using F_{MOV}
  - Lower Motor Torque Limit – based on the required thrust
  - Upper Motor Torque Limit
    - MOV mechanical limit
    - Reduced voltage motor torque capability
- "Raw" motor torque limits adjusted for uncertainties, such as (but not limited to):
  - Torque switch repeatability
  - Thrust measurement uncertainty
  - Motor torque measurement uncertainty
  - Stem factor uncertainty
  - Actuator efficiency uncertainty
    - Justified value based on plant MOV data in EPRI 1015069
  - Inertial thrust uncertainty
  - Rate of loading (ROL)

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Methodology Implementation

- PV tests performed after baseline "parallel" test only require measurements at MCC
- Based on the MCC-only data, the following analyses are performed
  - MCC-test Acceptance Criteria

$$\left(\frac{MT_{2nd\ TEST} - MT_{BASELINE}}{MT_{BASELINE}}\right) \leq 20\%$$

Where MT = $MT_{MEAN,\ CST} - MT_{HOTEL}$

  - Setup Window Criteria
    - **Mean** Motor Torque at CST compared to Lower Limit ($MT_{LL,CST}$)
    - **Maximum** Motor Torque at CST compared to Upper Limit ($MT_{UL,CST}$)
    - Operational Margin is quantified as

$$MARGIN = \frac{(MT_{MEAN,CST} - MT_{LL,CST})}{(MT_{LL,CST} - MT_{HOTEL,\ 2nd\ TEST})}$$

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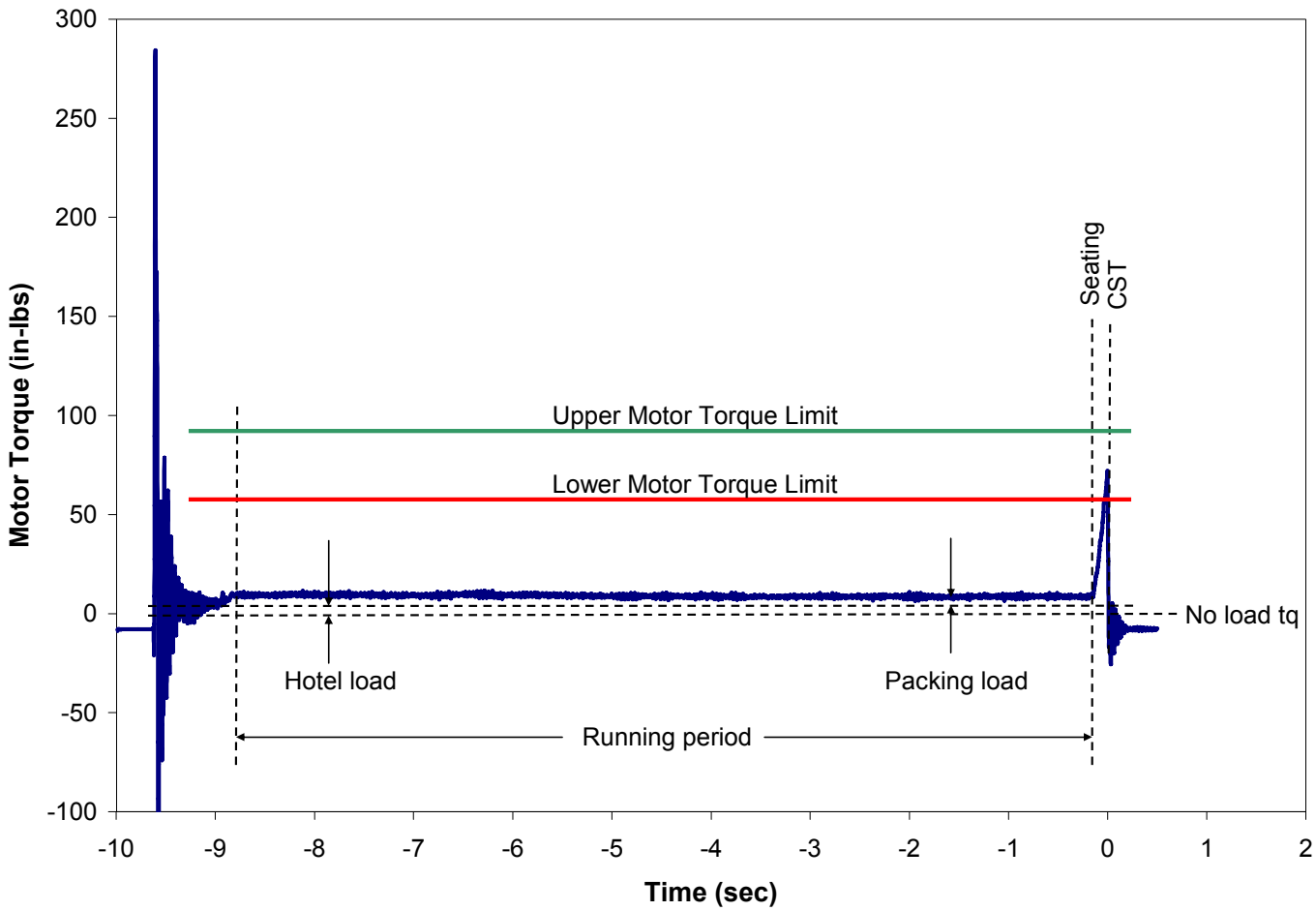
Methodology Implementation



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Methodology Implementation

- Key parameters derived from baseline “parallel” test may be used as long as the setup and general conditions of the MOV do not change significantly.

- Significant changes that require a new baseline test be performed
  - Change to torque switch setting
  - Motor replacement
  - Actuator refurbishment, gear ratio change, or replacement
  - Valve replacement
  - Change in stem lubricant (from one lubricant to another)

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Methodology Validation

- Validation is based on Measured Thrust at CST vs. Predicted Thrust at CST based on measured motor torque
- 15 valves from 3 nuclear plants met the MTPV applicability requirements and had sufficient test data for the validation
- All validation data from parallel tests (Both direct thrust and MCC MT data)

Parameter	Range
Valve Types	Flex wedge gate, double disk gate, globe
Valve Sizes	1 – 14”
Actuators	SMB-0, SMB-00, SMB-000
Motors	5 – 25 ft-lbs (460V and 575V)
Time between 1st and 2nd tests	16 months – 5 years

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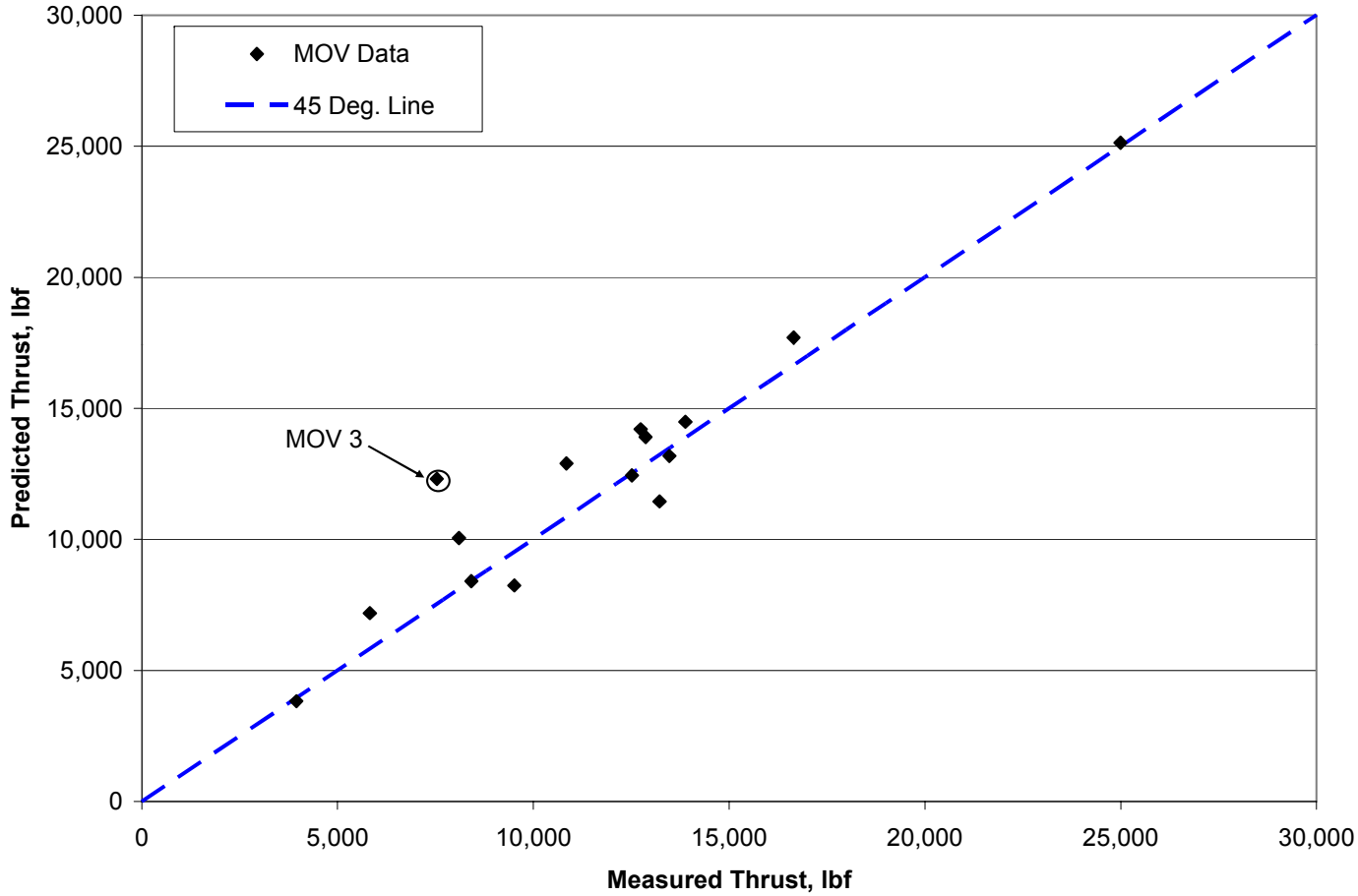
Methodology Validation



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Methodology Validation

- For 14 of 15 MOVs, maximum deviation is within uncertainty associated with measurement of motor torque and stem thrust

- For MOV 3, measured motor torque at CST changed by 41% between the baseline and second test
  - Fails MCC-test acceptance criteria (Change > +/-20%)
  - Further engineering evaluation or an at-the-valve test required to satisfy periodic verification requirements

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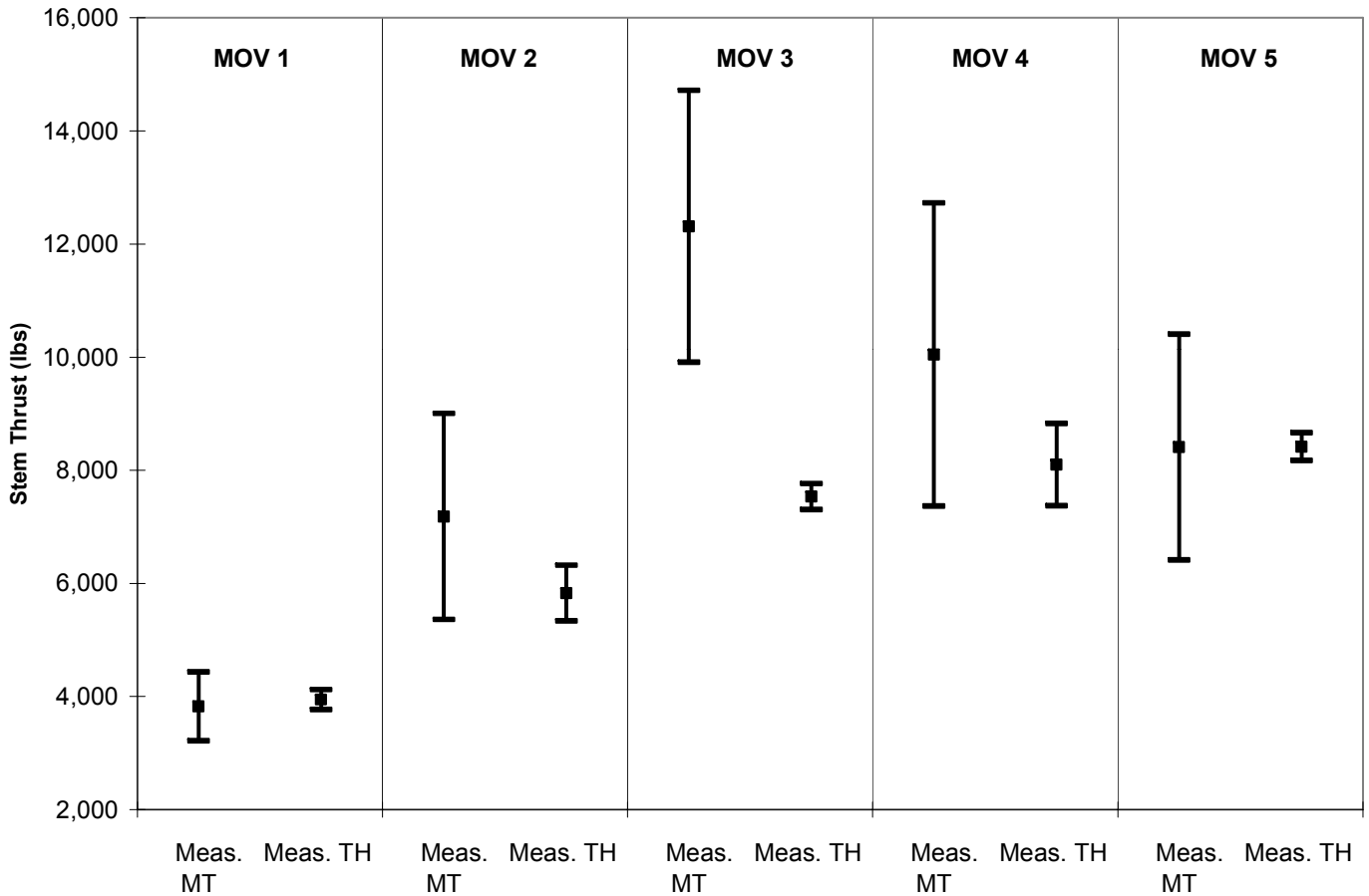
Methodology Validation



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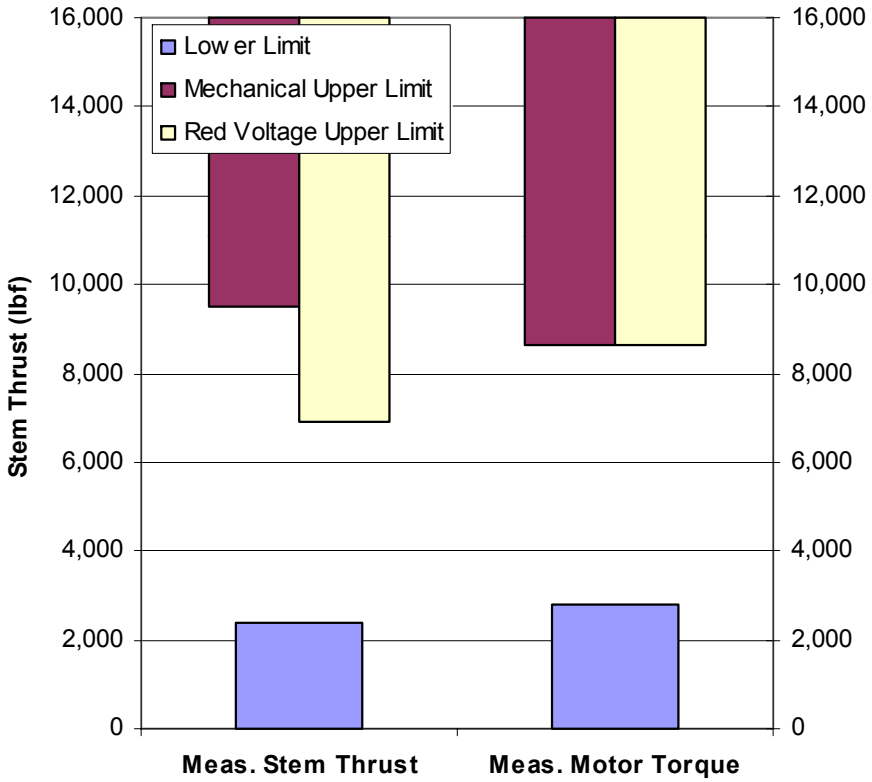
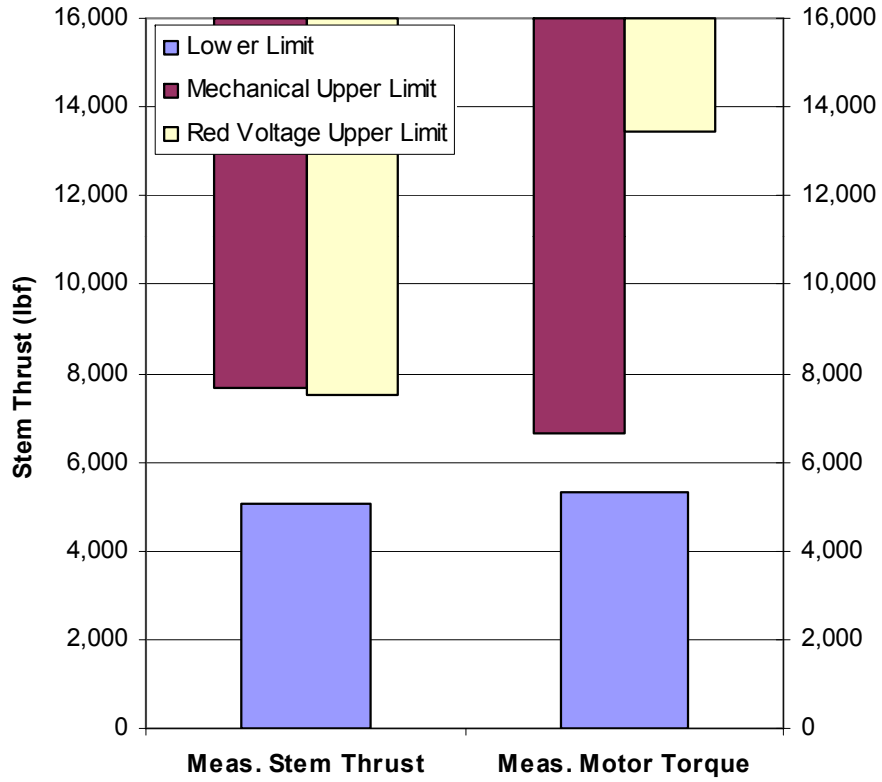
Effect of MTPV on MOV Setup Limits

Example 1



Example 2



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Conclusions

- MTPV Method satisfactorily determines Motor Torque Upper and Lower Limits and Operational Margin for use in PV programs in response to GL-96-05

- Compared with Direct Stem Thrust measurements
  - MTPV more restrictive mechanical upper limit, lower limit, and operational margin
  - MTPV typically less restrictive upper limit based on reduced voltage motor capability

- Based on the validation, the MTPV method would be most beneficial for MOVs which are setup with the following
  - Current operational margin (lower limit) of at least 25%
  - Current structural margin (mechanical upper limit) of at least 25%
  - Current upper limit margin based on motor capability at degraded voltage

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