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Validation Study on the MCC-based Technology

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1. Introduction

KEPRI and M&D Corporation has developed a methodology, called the NEST I (Non-intrusive Evaluation of Stem Thrust), for determining the stem thrust for a Motor Operated Valve (MOV) based on the motor torque and the stem displacement. The motor torque is determined using another method called NEET (Non-intrusive Evaluation of Electric Torque) which uses the voltage and current data from three phases to obtain the motor torque. The stem displacement is obtained from the voltage and current data along with the nameplate information of the motor, actuator and stem. [1]

The motor data (voltage, current and coil current) are measured using MOVIDS (Motor Operated Valve Intelligent Diagnostic System). The motor torque is determined using a NEET algorithm and the stem thrust is calculated using the NEST I method.

The goal of this testing was to obtain data from operation of a MOV and to compare the actual measured thrust with the thrust calculated using the NEET / NEST I methods and therefore validate the NEET / NEST I methods.

2. Overall Approach

The selected Motor Operated Valve is a 14" 1500# wedge gate valve with a SMB-3-150 Limitorque actuator designated as SI-614. The motor rpm was 1620, the actuator overall gear ratio was 43.83 and the stem diameter was 3.071". The motor operated valve is illustrated in Figure 1. This test specimen had a Teledyne Quick Stem Sensor (QSS) installed on the stem by Wyle Laboratories for measurement of stem thrust and stem torque during the QME-1 qualification program. The QSS installation is illustrated in Figure 2.

The overall approach was to measure the MOV performance using the MOVIDS. The stem thrust and torque data from the QSS was also measured by the MOVIDS equipment. This gave M&D Corporation, the baseline data required to set up their algorithm – three phases of motor current, three phases of motor voltage, coil current and stem thrust and stem torque.

Subsequent testing of the MOV during the ASME QME-1 program was then performed using the MOVIDS equipment, including QSS measurement. However, only the motor current and voltage and coil current data was sent to M&D Corporation. This data was used by M&D Corporation to calculate the stem thrust using the NEST I methodology.

Finally, this NEST I stem thrust was compared to the actual stem thrust measured using the MOVIDS equipment.

Figure 1. MOV test specimen

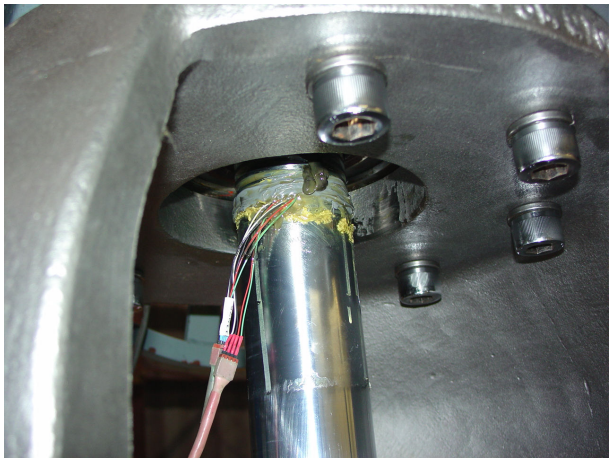

Figure 2. QSS on the stem

3. Test Procedure

The following test procedure was developed for each test performed using the MOVIDS equipment:

Step 1: Measure the motor winding resistance prior to testing and record on the Data Sheet.

Step 2: Connect the QSS system to the MOVIDS system to allow thrust and torque measurement.

Step 3: For the M&D test, run the valve open-to-close-to-open three times and collect all the MOVIDS data. This test is performed with no pressure in the valve body and with a nominal voltage in the 460 to 500 range.

Step 4: Record the test data file names on the Data sheet.

4. Data Analysis

For data comparison, the following approach was used: The difference between the NEST I calculated stem thrust and the actual offset stem thrust was determined throughout the stroke for both the opening and closing direction.

For each of the strokes, the following plots are presented:

- The NEST I calculated thrust for the closing and opening stroke
- The actual stem thrust for the closing and opening stroke (following offsetting performed by the MOVIDS software)
- The thrust difference for the closing direction.
- The thrust difference for the opening direction.

The plots are presented in Figures 3 through 6. Since the NEST I algorithm is valid from the stem engaging to the maximum thrust due to inertia for closing and from the stem engaging to the switch off for opening, only this portion of the stroke is shown for the thrust difference closing and opening plots:

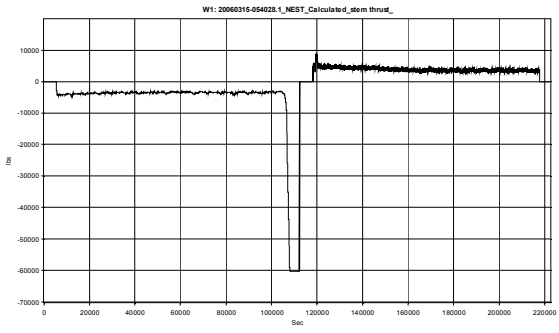

Figure 3. Estimated stem thrust by NEST I

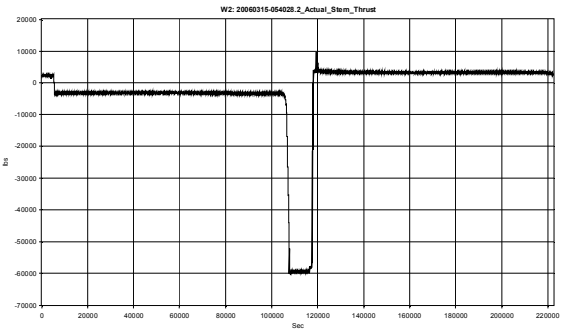

Figure 4. Measured off-set stem thrust

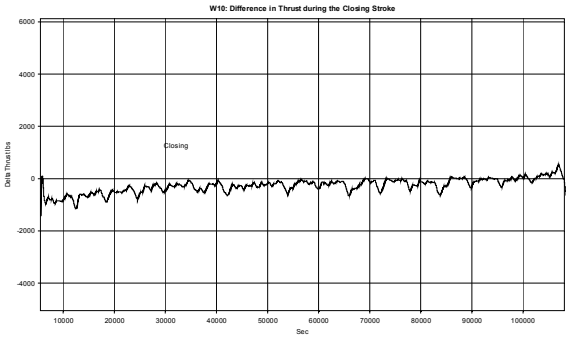

Figure 5. Difference between the estimated and the measured stem thrust on closing stroke

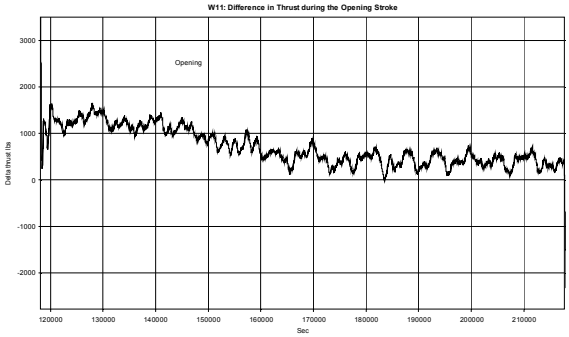

Figure 5. Difference between the estimated and the measured stem thrust on opening stroke

5. Conclusion

Based on M&D Corporation, the stated uncertainty for the NEST I is 5.03% of reading plus 2.6% of full scale, where full scale thrust is calculated to be 148,124 lbs. The stated uncertainty for the QSS equipment is 8.2% of reading. Since the MOVIDS equipment and QSS equipment are independent, the combined accuracy of the equipment can be determined by the square root of the sum of the squares of the uncertainty. This results in an overall accuracy of 9.62% of reading plus 2.6% of full scale.

Since 2.6% of the full scale thrust of 148,142 lbs is 3848 lbs, and the plots show that the difference between the actual thrust and the NEST I calculated thrust is less than 3848 lbs throughout the stroke in all cases, it can be concluded that the testing shows that the actual data is within the stated accuracy claim of M&D Corporation.

REFERENCES

[1] J. Chai, S. Park, S. Kang, S. Hong, C. Yim, "New Development of MCC-based Non-Intrusive MOV Diagnostic Method," 9th EPRI Valve Technology Symposium, Electrical Power Research Institute, 1(1).

[2] Wyle Lab., "Quality Assurance Program Manual," Rev 2.