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ATTACHMENT 4

MOVATS, INC. DIFFERENTIAL PRESSURE THRUST CALCULATION METHODOLOGY

Description

The MOVATS differential pressure (DP) test data base contains the results of MOVs that have been tested under DP conditions. If sufficient data points for a particular type of valve are included in the data base, they can be used to predict thrust requirements for valves of that particular type, in lieu of performing DP testing to determine the thrust requirements. This approach is incorporated in the Union Electric Company (Callaway) response to IEB 85-03, which has been tentatively accepted by the NRC.

The Calleway response specified that if there are 4 or more data points from valves of the same type, manufacturer, orifice diameter, and stem diameter; or if there are 20 or more data points from valves of the same type; then further DP testing is not required for those categories of valves if 1) the data points are used themselves to calculate required thrust statistically or 2) the data points verify that a particular calculation method is conservative.

With regard to the MOVATS, INC, methodology, linear regression is performed on the DP test data points to find the equation for the "best-fit" line through the data. After a thrust value is predicted for the valve using the "best-fit" equation, a 90% confidance band, or tolerance is calculated and then added to the predicted thrust to obtain the thrust, above running load, required by the valve to be able to operate against differential pressure, (DP Thrust Requirement). Standard statistical analysis methods are applied for deriving the confidance interval.

To obtain the minimum target thrust, which is the value used to set the torque switch during MOVATS® testing, the "DP Thrust Requirement" is multiplied by a factor that accounts for torque switch repeatability and accuracy of the MOVATS® valve analysis system instruments.

MOV's for which closing control is by position (limit) only should not be set, under static conditions, to close with the calculated Delta P thrust requirement unless the operator and valve are qualified to handle thrust loads in excess of two times this value plus any and all running loads. Theoretically, the Delta P thrust requirement should be compared to the operator capability (at reduced voltage), minus the present running load and error potential.

Note that all calculations provided are based on the MOVATS® DP data base as of the date on which the calculations were performed. Because the calculations are performed using actual data from the data base, the calculation results can change as data is added to the data base. In general, as more data points are added, the confidence bands will decrease which should result in a decrease in the calculated thrust values. All data used in the calculation is available for review at MOVATS, Inc. in Marietta, Georgia.

LIMITATIONS

To use the MOVATS® calculations, the minimum target thrust must be less than the upper limit specified by the valve and/or actuator manufacturer. This limit may be set by the yield strength of the valve or actuator components, or the actuator's output capability under the reduced voltage condition.

Component Stress Limits

If the calculated value is greater than the actuator or valve stress limits, and the operator proves capable, there are two options. 1) A stress analysis can be performed to determine the effects of the higher thrust levels on long-term operability of the motor operated valve or 2) the valve can be tested under full or partial pressure.

1) Perform Stress Analysis

In general, valves and actuators operating within normal stress limits may be operated many times without excessive wear and damage. When applied thrust levels are increased beyond documented thrust limits, a valve or actuator may still perform without damage, but accelerated wear and fatigue of critical components can occur.

If the valve is not stroked frequently and/or the target thrust values are not significantly higher than the documented allowable limits of the valve or actuator, a stress analysis is likely to show that the useful life of a MOV is not significantly shortened by the higher thrust conditions. In this case, performing a stress analysis may be the best available method for verifying operability.

2) Perform Partial Pressure Testing

If the decision is made that a valve is not adequately represented in the DP test data base, then the valve may be tested under pressure to determine the actual thrust required or to verify that a particular calculation method is conservative for that valve type. Testing may be performed at several reduced pressure points and the required thrust calculated by extrapolating the test data to the maximum pressure.

The procedure for calculating the confidence band for the extrapolated thrust values is the same procedure used to calculate thrust using data points from the DP data base.

The magnitude of the confidence band is influenced by the number and value of test data points as follows:

1. The greater the difference between the actual test pressures and the maximum expected pressure, the lower the confidence.

2. The greater the number of tests performed at different pressures, the higher the confidence. Testing at a minimum of two different pressures is required in order to calculate a confidence band for the extrapolated thrust values.

3. The greater the scatter of data points, the lower the confidence.

If the valve can only be tested at one pressure point, consider the following:

1. The test results may be compared to the calculated thrust requirement for the reduced pressure. If the calculated value proves to be conservative, the calculational method can be used with relative confidence when computing thrust required at full differential pressure.

2. Theoretically, a thrust value obtained by extrapolating from a single data point is more reliable than a value obtained from a generic thrust equation alone, because the extrapolated value is based on empirical data from the specific valve in its actual condition, rather than on values judged to be applicable to all similar valves.

3. A statistically valid confidence band cannot be computed without at least two test points (in addition to the zero point). Therefore, engineering judgement must be used when using the one point extrapolation approach.

In conclusion, if a valve cannot be tested under its maximum differential pressure conditions, the next best option is to test the valve at a minimum of two different pressures. If data can only be obtained at one pressure value, this data point may be used to verify the manufacturer's thrust calculation method. As a minimum, the one data point will add a value to the industry database, and combined with the rest of the data, may allow for validation of a generic calculational method for that particular valve type.

Operator Capability Limits

In the cases where the thrust requirement exceeds or too closely approximates the operator's calculated reduced voltage stall thrust value, a stall thrust test can be conducted to increase the 100% voltage stall thrust and, consequently, the reduced voltage capability. Please note that care should be taken prior to performing this test to ensure that operator or stem limits are not exceeded without having a plan in place for justifying it. Occasionally this operation, combined with the previously mentioned stress analysis, may be beneficial.

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DIFFERENTIAL PRESSURE THRUST CALCULATIONS FOR UNITED STATES NUCLEAR POWER STATIONS

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OBJECTIVES

1. Establish the operator thrust load requirements for valve operation against the predetermined maximum expected differential pressure.

2. Determine the operator output thrust capability, including the possible reduced voltage condition.

ASSUMPTIONS

1. It is assumed that the valve is in good working order, however, MOVATS thrust calculations are based on a differential pressure test data base that includes valves of differing ages and conditions.

2. No foreign internal obstruction to valve travel is assumed.

3. Maximum expected differential pressures are assumed to include the affects of the velocity head when this head is large enough to be of consequence.

4. The coefficient of friction that dictates the operator's torque to thrust conversion (stem factor) is assumed to remain constant over time.

5. Seismic disturbance considerations are not included.

6. The calculated yield values of valve and operator components are assumed to be greater than the operator's commercial rating.

7. Thermal transients are assumed not to affect the thrust required to open valves of all types.

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   If the valve is not stroked frequently and/or the target thrust values are not significantly higher than the documented allowable limits of the valve or actuator, a stress analysis is likely to show that the useful life of a MOV is not significantly shortened by the higher thrust conditions. In this case, performing a stress analysis may be the best available method for verifying operability.

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Iowa Electric Light and Power Company

January 15, 1988
NG-88-0001

Mr. A. Bert Davis
Regional Administrator
Region III
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49
Final Report Pursuant to IE Bulletin 85-03

References:
1) Letter, R. McGaughy to J. Keppler, "Preliminary Response to IE Bulletin 85-03, Item e," NG-86-1475, May 28, 1986
2) Letter, R. McGaughy to J. Keppler, "Supplemental Response to IE Bulletin 85-03", NG-86-3044, October 1, 1986
3) Letter, R. McGaughy to H. Denton, "Integrated Plan, Schedule B Change", NG-86-4410, December 22, 1986

File: A-278, A-101a

Dear Mr. Davis:

Enclosed is our final report on the program carried out in response to IE Bulletin 85-03: Motor Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings.

Reference 2) responded to Bulletin item a, identified the HPCI and RCIC valves covered by the Bulletin, and stated the maximum expected differential pressures during opening and closing of those valves. The maximum expected differential pressures for seven of those valves have been revised. These changes are discussed in the enclosed report.

Implementation plans and schedules for completion of Bulletin items b, c and d were addressed in the References listed above. Verification of completion of these bulletin items is provided in our enclosed report.

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Summaries of the findings as to valve operability prior to any adjustments, in accordance with Bulletin Table 2 ("Suggested Data Summary Format"), are provided as Tables B through I to our enclosed report.

Please contact this office if there are any questions concerning this matter.

IOWA ELECTRIC LIGHT AND POWER COMPANY

BY William C. Rothert

William C. Rothert
Manager, Nuclear Division

Subscribed and sworn to Before Me on
this 15th day of January 1988.

Kathleen M. Furman

Notary Public in and for the State of Iowa

WCR/EFB/pjv*.

Enclosure: Iowa Electric Light and Power Company Ouane Arnold Energy Center (DAEC) Final Report Pursuant to IE Bulletin 85-03

cc: E. Borton
L. Liu
L. Root
R. McGaughy
R. Gilbert (NRC-NRR)
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