NIAGARA MOHAWK POWER CORPORATION

NUCLEAR ENGINEERING DEPARTMENT

NINE MILE POINT NUCLEAR STATION UNIT 2

ENGINEERING SPECIFICATION #NMP2-386M

REVISION 1

TITLE: DYNAMIC FLOW TESTING OF SAFETY RELATED MOTOR OPERATED VALVES TO COMPLY WITH GL 89-10

	NAME	DATE
Prepared By:	R.W. Mindak for J.J. Parchison	7-21-93
Reviewed By:	Sunil V. Patel	7-21-93
Approved By:	Sanjiv Ghosh for JMH	7-21-93

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1.0 BACKGROUND AND SCOPE

Over the years, problems relating to various aspects of the design, operation, and testing of motor operated valves have occurred. These problems have included incorrect torque, torque bypass, and limit switch settings; excessive wear of valve disks; and improper protection against thermal overload of the motor. Significant plant transients and events have resulted from these problems.

In an effort to address these problems, the NRC has issued IE Bulletin 85-03, "Motor Operated Valve Common Mode Failures During Plant Transients Due To Improper Switch Settings". This document provided for the establishment of a program to ensure proper switch settings for MOVs in certain safety related systems. Safety related MOVs in those systems as well as MOVs without a specific safety function but capable of being mispositioned were addressed in this document. Generic Letter 89-10, "Safety Related Motor Operated Valve Testing and Surveillance," extended the scope of the Bulletin 85-03 program to include MOVs in all safety related systems. The NRC believes that the program established by these two documents will help provide confidence in the continuing ability of MOVs and their associated safety systems to perform their functions.

As part of the recommendations outlined in GL 89-10, the subject MOVs should be demonstrated to be operable by testing at the design basis differential pressure and/or flow (dynamic test). Additionally, GL 89-10 recommends that each MOV should be stroke tested to verify that the MOV is operable at no-pressure or no-flow conditions (static test).

The purpose of this specification is to provide requirements to verify, by dynamic testing, an MOV's ability to function under design basis conditions and to ensure that any activities which could affect an MOVs ability to function have proper review and disposition by Mechanical Design Engineering.

The intent of these requirements is to assure a consistent and standardized approach to implementing the dynamic test requirements mandated by GL 89-10. Specifically, the principal purposes of this document are to:

1. Provide the requirements for an MOV in situ test in which the valve is stroked open and closed with flow and differential pressure (DP) and give guidance on conducting and documenting such tests. This test covers valves which are required to be dynamically tested in order to comply with NRC Generic Letter 89-10.

2. Provide guidance on selecting "parent" valves to be flow tested in order to qualify "candidate" valves for which maximum delta pressure testing has been concluded to be impractical or undesirable.

3. State MOV activities which will require Mechanical Design Engineering review to ensure that the activity will not detrimentally affect the valves ability to function.

Any deviations from the requirements within this specification shall be brought to the attention of Mechanical Design Engineering.

1.1 Responsibilities

The organizations/groups listed below will be involved in the dynamic testing program and will have the following responsibilities:

A. Operations/System Engineering:

1. Prepare new test procedures or modify existing surveillance procedures.

2. Perform dynamic testing.

3. Complete dynamic test data sheet and transmit data sheet and VOTES traces to Mechanical Design Engineering.

4. Work with Mechanical Design Engineering to identify parent MOVs as well as their candidate counterparts.

B. Plant Maintenance:

1. Support System Engineering activities related to dynamic testing by using VOTES diagnostic systems for data collection.

2. Install I&C test equipment.

C. Mechanical Design Engineering:

1. Identify valves which cannot practicably be tested at design basis differential pressure and offer means of assuring functionality in lieu of testing each MOV.

2. Identify parent MOVs and their candidate counterparts.

3. Justify and document each GL 89-10 MOV's ability to function in the diagnostic test report prepared in accordance with NEG-2M-008.

2.0 DEFINITIONS

2.1 Accuracy: The combined error of nonlinearity, repeatability, and hysteresis of an instrument expressed as a percent of full scale output of the instrument.

2.2 Baseline: An MOV test under static conditions (no DP or flow).

2.3 Candidate Valve Assembly: A valve assembly to be qualified by dynamic testing of an equivalent parent valve assembly.

2.4 Design Basis Differential Pressure: The difference between the line pressure and the downstream pressure achieved during either normal operation, accident conditions, or during an inadvertent operation condition.

2.5 DP Thrust: The (valve factor) x (mean seat contact area) x (DP) + (other dynamic factors). Note that this definition does not include the piston effect or static packing load.

2.6 Dynamic Test: An MOV test performed during differential pressure (DP) and/or fluid flow conditions.

2.7 G.L. No. 89-10 MOV: An MOV that is within the scope of the Generic Letter 89-10 program as defined in NER-2M-001.

2.8 Instrument Response Time: The minimum time required for the output of a transducer or transmitter to reach a specified fraction of its new value after application of a step input or disturbance.

2.9 Line Pressure: The fluid pressure in the pipeline containing the MOV under test.

2.10 LVDT: Linear variable differential transformer.

2.11 Mean Seat Contact Area: The area of the valve disk on which pressure acts. This is usually based on the average or mean seat diameter.

2.12 Parent Valve Assembly: A valve assembly which has been dynamically tested and will qualify equivalent candidate valve assemblies.

2.13 Piston Effect: The component of total stem thrust caused by the internal line pressure acting on the stem area.

2.14 Reduced Port Valve: A valve in which the flow area is less than the nominal pipe flow area.

3.5 NMP2 Drawing Series EP410.

3.6 NRC IE Bulletin 85-03, "Motor Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings."

3.7 NEG-2M-008, MOV Diagnostic Report Preparation Guideline.

3.8 NMP2 MOV Program Plan, 2PPD-GL-89-10, Rev. 1.

3.9 Differential pressure testing acceptance criteria for MOV's, BWR Owners Group, January 1993.

3.10 NER-2M-003, Generic Letter 89-10 Dynamic Testing Valve Grouping. 

4.0 MOV IN SITU TESTING

4.1 Test Procedure Preparation by Plant Personnel:

Plant specific valve test procedures shall be developed based on the guidance provided in this document, and in accordance with plant administrative, system operating, maintenance, surveillance testing, or other applicable procedures. Plant personnel should review existing plant periodic test/surveillance procedures to determine if they may be modified to incorporate MOV dynamic test requirements. Test conduct should be determined to be within all plant licensing criteria (e.g., verify that the test conduct does not constitute an unreviewed safety question as described in 10CFR50.59). The test procedure should be reviewed according to standard plant practices.

The procedural steps should be sufficiently detailed to ensure methodical, repeatable, and consistent valve performance testing. The test procedure should be flexible to allow for repeat valve stroking under a given set of test conditions. The procedure should incorporate the data sheets and guidelines provided in Appendix A of this document.

4.2 Records Review:

Recent plant records associated with the MOV under test, including maintenance activities and work requests, should be reviewed prior to MOV testing. The intent is to identify valve or motor operator repairs or modifications which might affect the measured valve performance data.

4.3 System Lineup:

MOV in situ tests should be performed under flow conditions using installed system or auxiliary subsystem process pumps. System alignment and valve, pump, or equipment sequencing should be controlled by plant or system procedures or a special test procedure. The flow path from pump to MOV is dependent on system design and is not specified in this document. However,

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the test procedure should be reviewed to ensure that the chosen flow path will not influence the interpretation of recorded test parameters in an unknown manner (e.g., unknown valve flow rates due to diverging flow paths between the valve and the flow meter). The chosen flow path should be documented in the MOV test procedure. The MOV dynamic test program shall not modify (cut) system piping, over pressurize system piping, or place equipment in a situation where it could be damaged.

4.4 Data Acquisition System Instrumentation:

The following describes the requirements for the data acquisition system instrumentation to be used during MOV testing. The parameters to be measured during MOV testing are indicated in Appendix A and include:

- Stem Thrust (rising stem valves only)
- Stem Torque
- Upstream Line Pressure
- MOV Differential Pressure
- Flow Rate
- Motor Voltage
- Motor Current (or alternatively, Motor Power)
- Motor Operator Limit and Torque Switch Contact Actuation
- Stroke Direction
- Stroke Time
- Fluid Temperature

Refer to Appendix B for a typical test instrumentation diagram.

A. Instrument Selection:

1. Time History Measurements: Instruments which provide time history measurements of the monitored parameter should interface with data recording equipment as described at the end of this section.

2. Single Point Measurements: Instruments which provide single point measurements during valve testing should provide direct visual indication of the monitored parameter.

3. Stem Thrust Measurement (for rising stem and rising/rotating stem valves): Time history stem thrust measurements should be made external to the valve motor operator.

4. Pressure Measurement: Time history pressure/DP measurements should be made using pressure/DP transducers connected to existing system penetrations (e.g., instrumentation taps, vent lines, drain lines). Valve upstream line pressure and valve differential pressure should be measured. Locations of pressure

measurement instruments are based on an allowable 5% pressure drop in the pipeline between the pressure instruments and the MOV under test. In addition, there should be no system components such as heat exchangers, orifices, tanks, pumps, high resistance valves, or throttle valves between the pressure measurement instruments and the MOV under test. Acceptable components between the pressure measurement instruments and the MOV include piping, elbows, bends, reducers, fully open valves or other simple pipeline elements.

5. Temperature Measurement: Single point temperature measurement instruments should be used to measure either fluid or pipe temperature at or as near as possible to the MOV during testing. Appropriate instruments include installed thermocouples or RTDs in thermowells, indicating thermometers, or strap-on thermocouples or RTDs.

6. Flow Rate Measurement: Time history and single point flow rate measurement instruments should be used to measure fluid flow rate through the valve during testing. Appropriate instruments include installed orifice or venturi tube flow instruments, or clamp-on ultrasonic meters. Liquid flow measurements should be obtained at any location upstream or downstream of the MOV under test which is compatible with setup of the instrument being used and which does not place a branching flow path or a source or sink of fluid between the valve and the flow measuring instrument. Gas or steam flow measurements should be obtained as close as possible to the MOV under test and at a location which does not place a branching flow path or a source or sink of fluid between the MOV and the flow measuring instrument.

7. Motor Voltage Measurement: Single point voltage measurement instruments should be used to measure rms voltage (line-to-line for three phase systems) at the valve motor during testing. Voltage measurements may be taken at the motor control center (MCC) provided a line voltage drop calculation has been performed by Electrical Design Engineering to account for voltage drop from the MCC to the valve motor. An appropriate instrument for voltage measurement would be a voltmeter either permanently or temporarily installed in the system.

8. Motor Current (or Motor Power) Measurement: Time history motor current measurement instruments should be used to measure motor current (rms) at the valve motor controller during

testing. Appropriate instruments include current transducers or clamp-on ammeters. Motor power may be recorded in lieu of current.

9. Motor Operator Control Switch Contact Actuation: Time history measurements of control switch contact actuation should be made to determine the open/close state of the motor operator torque and limit switch contacts during MOV testing. Only those contacts which control valve motion (including torque switch bypass) should be monitored. Appropriate instruments include external circuits for measuring voltage changes in the switch circuits (or spare contacts) during MOV operation.

10. Time History Data Recording: Output (either analog or digital) from the thrust, pressure, flow rate, current, and contact actuation measurement instruments described above should be input to multichannel data recording devices which are capable of referencing all input signals to a common point in time.

B. Instrument Accuracy:

1. Stem Thrust Measurements: The indicated value of stem thrust should be accurate to within $\pm 10\%$ of reading under all test conditions and over the full range of indicated values. The effects of hysteresis, repeatability, instrument error, installation methods, and other common sources of error should not cause the indicated values to be in error by more than $\pm 10\%$. Documentation should be available to validate the accuracy of the thrust measurement instrument. Calibration of thrust measurement equipment should be in a manner that can be directly related to the as-installed configuration of the equipment on the valve. Careful attention should be given to installation and removal of the instrumentation so as to ensure consistent accuracy.

2. Pressure Measurements: Pressure measuring instruments should be accurate to within $\pm 2\%$ of full scale.

3. Temperature Measurements: Temperature measuring instruments should be accurate to within $\pm 5°F$ of the measured temperature.

4. Flow Rate Measurements: For installed flow measuring instrumentation, accuracy should be within $\pm 5\%$ of full range. If clamp-on ultrasonic flow measuring equipment is used, the following accuracy requirements should be met. At fluid

velocities greater than 4 ft/sec, flow rate measuring equipment should be accurate to within ±5% of the actual flow velocity. At fluid velocities less than or equal to 4 ft/sec, flow rate measuring equipment should be accurate to within ±0.2 ft/sec of the actual flow velocity.

5. Voltage and Current Measurements: Voltage and current measuring instruments should be accurate to within ±2% of full scale.

C. Instrument Range:

Pressure, voltage, flow rate, and current (or power) measuring instrumentation should have a range that is less than two times the maximum expected reading during MOV testing.

D. Instrument Response Time:

Instruments for measuring stem thrust motor current (or power), and motor operator control switch actuations should have response times of no more than 1 millisecond. Instruments for recording flow rate, line pressure, and differential pressure should have a response time of no more than 100 milliseconds.

The data recording devices should be compatible for interface with the instruments described above. In particular, the recorders should be capable of accepting the output from the instruments (e.g., 0-5 VDC, 0-20 mA) over the full range of the parameter being measured. For digital recorders, the individual channel sampling rates should meet or exceed the response times listed above based on the connected measuring instruments. For analog recorders, the channel frequency responses should meet or exceed the response times listed above based on the connected instruments.

E. Instrument Calibration:

Instruments used in measuring and recording test data should be covered by a formal calibration program meeting the QA requirements of 10CFR50, Appendix B. All instruments should be checked for calibration prior to conduct of testing. Calibration records should be available which document that the equipment accuracy is within the limits stated in Section 4.4.B.

For fluids other than water, pressure drop calculations shall be performed by Mechanical Design Engineering to demonstrate that losses between the pressure measurement instrument and the MOV under test do not exceed 5% of the maximum test pressure. The calculation should be included as an attachment to the test documentation package.

4.5 Test Performance/Sequence:

This section includes requirements concerning the conduct and performance of MOV in situ tests. An in situ test shall include static and dynamic tests in the following order:

- Static Test
- Dynamic Test
- Static Test (only if required by Mechanical Design Engineering)

A. Static Tests:

All MOV in situ tests should include a complete set of valve strokes (open-to-close and close-to-open) under static system conditions (i.e., no differential pressure or flow). Data recorded during the static strokes should include all the parameters measured during the dynamic test except for DP and flow. Refer to Appendix A. A static test shall be performed just before the test involving DP and/or flow. A static test shall be performed after the dynamic test if specified in the test procedure. The results of the static tests shall conform to the thrust acceptance criteria listed on the EP410 drawings. If performance of the static test cannot be performed just before and after the dynamic test, it must be verified and documented that the valve assembly is in an identical configuration for both the static and dynamic tests. It is especially important that the results of the two static tests reflect consistent data thereby confirming that the dynamic tests did not cause damage or reconfigure the subject MOV in any way.

B. Order of Dynamic Testing, Open to Closed - Closed to Open:

A valve stroke is defined as operation of the MOV from the open to the closed position, or from the closed to the open position. All tests of an MOV under a given set of system conditions should include both an opening and a closing stroke. However, it is essential that the sequence of valve strokes envelope the DBA operating scenario (refer to the MOV design basis). All required data described in Appendix A should be measured and recorded during both opening and closing strokes.

C. Minimum Required Number of Dynamic Tests:

A MOV insitu test should include data recorded at the maximum specified design basis condition. If the design basis condition is unattainable, the test should include data recorded at a minimum of two values of differential pressure as close as practicable to the specified design basis condition but with sufficient separation to qualify them as unique test points. These data points will then be extrapolated up to the design basis condition or the maximum achievable system test differential pressure, whichever is applicable, in order to verify operability. For extrapolated data, an explanation shall be included in the remarks section of the test data sheet.

D. Required Test Differential Pressure/Flow/Temperature:

The required maximum/minimum test differential pressure/flow shall be obtained from the MOV sizing calculations. An explanation shall be documented on the test data sheet remarks section (Appendix A) for any cases where testing with the design basis differential pressure or flow cannot practicably be performed. Examples of these cases are:

1. Where testing of these MOVs at design basis conditions is precluded by the existing plant configuration.

2. Where the design basis conditions as documented in the MOV sizing calculations do not reflect the as installed, tested and documented system design flows and pressures due to the difference between the design pump curve and the plant as tested pump curve, or overly conservative design basis assumptions.

3. Where the design basis differential pressure cannot be achieved, Mechanical Design Engineering shall be notified so that an alternative testing strategy can be developed.

4. The fluid temperature during the test is not required to meet the temperature documented in the MOV sizing calculations.

4.6 Test Documentation:

A dynamic test documentation package shall be completed and submitted to Mechanical Design Engineering. This package shall include (as a minimum) the following information:

	Item	Responsibility
A.	MOV Dynamic Test Data Sheet for each dynamic test	Plant System Engineering
B.	VOTES Traces for each static and dynamic test	Maintenance
C.	Test Procedure for each static and dynamic test	Plant System Engineering
D.	Time history measurements data for each dynamic test	Plant System Engineering

The above attachments should be sequentially numbered and added to the package as necessary.

5.0 DYNAMIC TEST ACCEPTANCE CRITERIA

Two categories of DP Testing Acceptance Criteria are provided to allow for timely/accurate operability determinations and detailed validations of engineering assumptions.

- Pre-Return to Service Test Review (Category 1 Review)

  The Pre-Return to Service Criteria is provided to allow for the determination of MOV acceptability based on review of a minimum number of performance indicators. The acceptability of these basic performance indicators ensures conditions adverse to quality do not exist for the current MOV setup. The Pre-Return to Service Test Review Criteria shall be satisfied prior to returning the valve to service.

- Post-Return to Service Test Review (Category 2 Review)

  The Post-Return to Service Test Review Criteria is provided to establish the acceptability of MOV performance as related to engineering assumptions utilized in determining recommended limit/torque switch setpoints. Completion of the Post-Return to Service Test Review Criteria will establish

MOV margin and predicted performance capabilities. This review will be performed by Engineering and documented as per NEG-2M-008 requirements and shall not be a restraint for returning the valve to service.

5.1 Pre-Return to Service Test Review Criteria

5.1.1 Test Data Completeness and Quality

It is important to record as much information as possible during the dynamic testing of a MOV. Information such as valve orientation, measured or estimated flow rate, and DP accuracy is important in reviewing test results and shall be documented on the MOV Dynamic Test Data Sheet (Appendix A). This information will be used to determine if the MOV is operable under design basis conditions, and if the specified thrust range setpoint limits conservatively describe the performance of the MOV under design basis conditions. Revisions to the assumptions made in the setpoint limits may be based on this recorded information. As such, it is important that all information be as accurate and detailed as possible. Information which is recorded should be independently verified.

5.1.2 The valve successfully strokes (at test conditions) as required to perform its design basis function (i.e. open, close/shut off flow).

5.1.3 Control switch trip thrust or torque (C14) is within setpoint limits established in the MOV sizing calculation and documented on the EP-410 series drawings.

5.1.4 Control switch trip thrust or torque does not exceed motor capability limits in the close direction at calculated degraded voltage.

5.1.5 Maximum closing thrust or torques (C16) shall not be exceeded. This includes:

- Actuator torque limits
- Actuator thrust limits
- Valve thrust limits

5.1.6 Maximum opening thrust or torques should not be exceeded. This includes:

- Actuator torque limits
- Actuator thrust limits

- Valve thrust limits
- Opening motor capability limits at degraded voltage

5.1.7 Motor run currents should not exceed OEM limits.

5.1.8 Verify that the open torque switch bypass is set in accordance with the appropriate ESK drawing.

NOTE:

Criteria specified in paragraphs 5.1.4, 5.1.6, and 5.1.7 have been considered in determining the acceptable setpoint thrust range in the MOV sizing calculation. This setpoint thrust range has been adjusted to account for diagnostic equipment inaccuracies and torque switch repeatability.

5.2 Post Return to Service Test Review Criteria

5.2.1 Valve Factor assumptions should be verified.

Valve factor should only be calculated for test DPs greater than or equal to 80% of design basis DPs. For the purpose of determining the actual valve factor, extrapolation of test results for DPs below 80% of design basis DP is not considered meaningful. Multiple point DP tests (when 80% of the design basis DP cannot be achieved) are also not considered meaningful.

When a higher than assumed valve factor is measured, the measured valve factor's impact on the minimum required thrust calculation should be considered to verify margins.

5.2.2 The maximum thrust up to and including hardseat contact (C11) is less than or equal to the minimum calculated required thrust for the DP at which the valve is tested. Refer to the minimum thrust of the thrust range in the MOV sizing calculation and the EP410 drawings.

5.2.3 Ensure that margin exists between thrust at control switch trip and extrapolated DP thrust. This margin could account for the following:

- Torque switch repeatability
- Lubricant degradation

5.2.4 Review DP test results against static (baseline) test results in order to determine rate of loading (ROL) effects. The static test shall have been performed at the same control switch setting. The time between the static test and the DP test should be minimized. Verify that the

difference in control switch trip thrust does not exceed load sensitive behavior limits once uncertainty due to equipment inaccuracy and torque switch repeatability are taken into account.

Note: A significant change could be wholly attributable to equipment inaccuracy for the static and the DP tests and torque switch repeatability.

6.0 REQUIREMENTS FOR MOV RE-EVALUATION

Certain changes to motor operated valves which have been dynamically tested or are considered qualified by a parent dynamic test, require evaluation by Mechanical Design Engineering to determine whether functionality verification should be reanalyzed. The following activities or situations will require review by Mechanical Design Engineering.

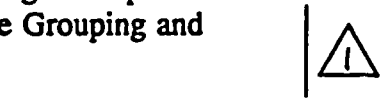
1. Design modifications affecting motor operated valves within the scope of G.L. 89-10.

2. Design modifications which add new motor operated valves which fall into the scope of G.L. 89-10.

3. Motor operated valves which have critical dimensions changed due to in service wear.

The above items are not intended to be all inclusive. All engineering or plant activities that could affect the operability of a previously tested MOV shall be evaluated by Mechanical Design Engineering for potential retesting.

7.0 SELECTION OF PARENT VALVE FOR TESTING

It is recognized that due to plant conditions, certain valves will not be dynamically tested. In these cases, the untested valves may be considered to be enveloped by the dynamic test results of a similar "parent" valve assembly. In order that these "candidate" valves be considered to be covered by the dynamic testing of a "parent" valve, they must meet certain parent valve similarity criteria. Valve Grouping and selection is detailed in NER-2M-003. 

8.0 QUALITY ASSURANCE REQUIREMENTS

8.1 Copies of test documentation shall be assembled as per test documentation requirements outlined in paragraph 4.6.

8.2 Completed and approved test documentation shall be transmitted to Document Control in accordance with NEG-2M-008 and NIP-RMG-01.

APPENDICES

Appendix A1 - MOV Dynamic Test Data Sheet

Appendix B1 - Typical Test Instrumentation Diagram A

Appendix B2 - Typical Test Instrumentation Diagram B

APPENDIX A-1

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT- UNIT 2

MOV DYNAMIC TEST DATA SHEET

Unit No.	Valve ID	WO No.	Date
Test Procedure No.		Dwg. No.	

Test Data: (Attach all associated VOTES traces & data collected during test)

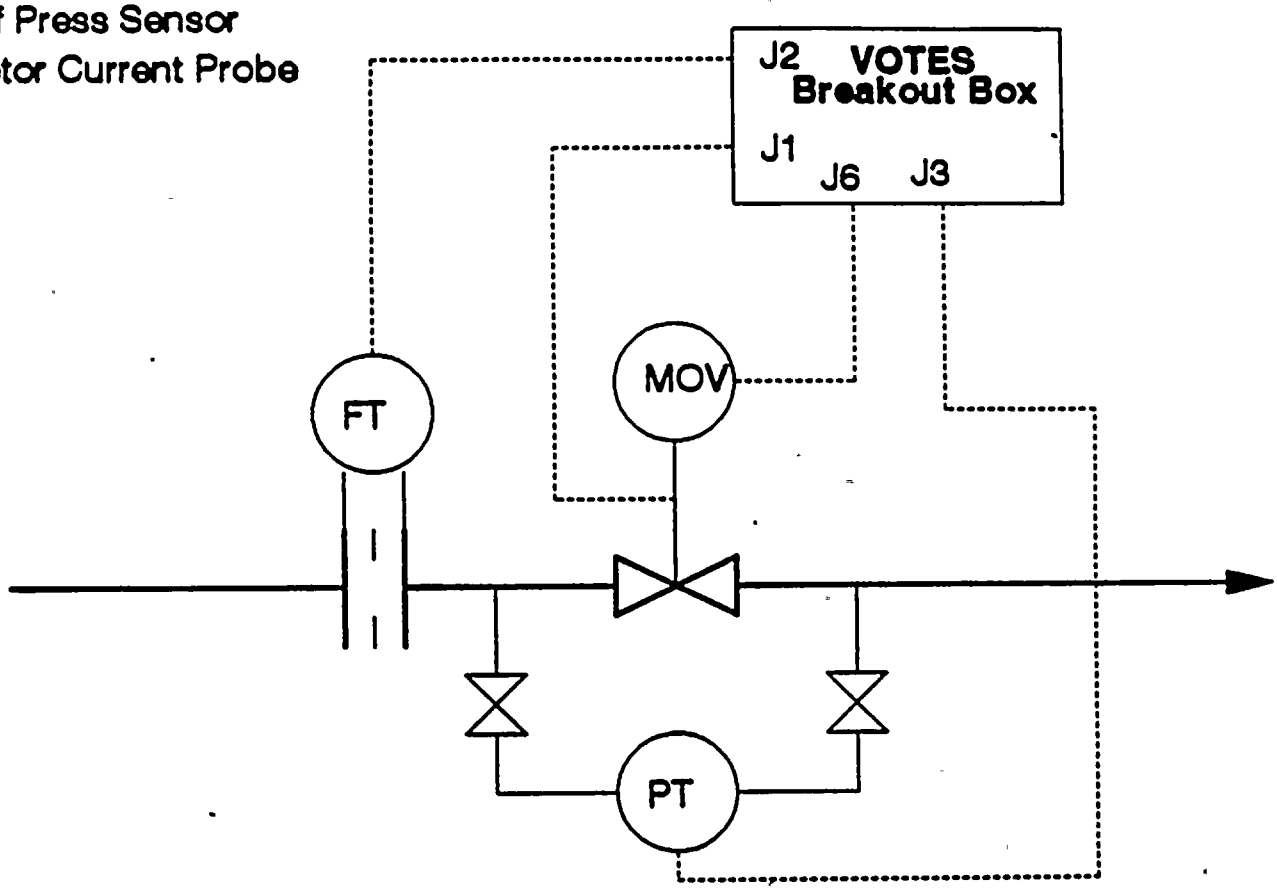
1. Test Type: C-O/O-C/Both	**8. Thrust Measuring Technique:**
2. Test DP (psi): C-O O-C Is Head Corrected For Elev?(Y/N)	**9. Thrust Reqd To Overcome DP:** (C) At Flow Cutoff: (C) At Torque Switch Trip: (O) At Disk Pullout:
3. Max Line Pressure (psig): Is Head Corrected For Elev?(Y/N)	**10. Pressure Source:**
4. Flow Rate: C-O O-C	**11. Stroke Time/Direction:**
5. Motor Current : Run Start (O-C) Start (C-O)	**12. Torque Switch Setpoint:**
6. Supply Voltage:	**13. Fluid Temperature:**
7. Fluid (Stm,Wtr,Other):	**14. Valve Orientation:**

Remarks:

Signoff:

Test Engineer	Date
Reviewer	Date
Approval	Date

J1 Force Sensor
J2 Flow Sensor
J3 Diff Press Sensor
J6 Motor Current Probe



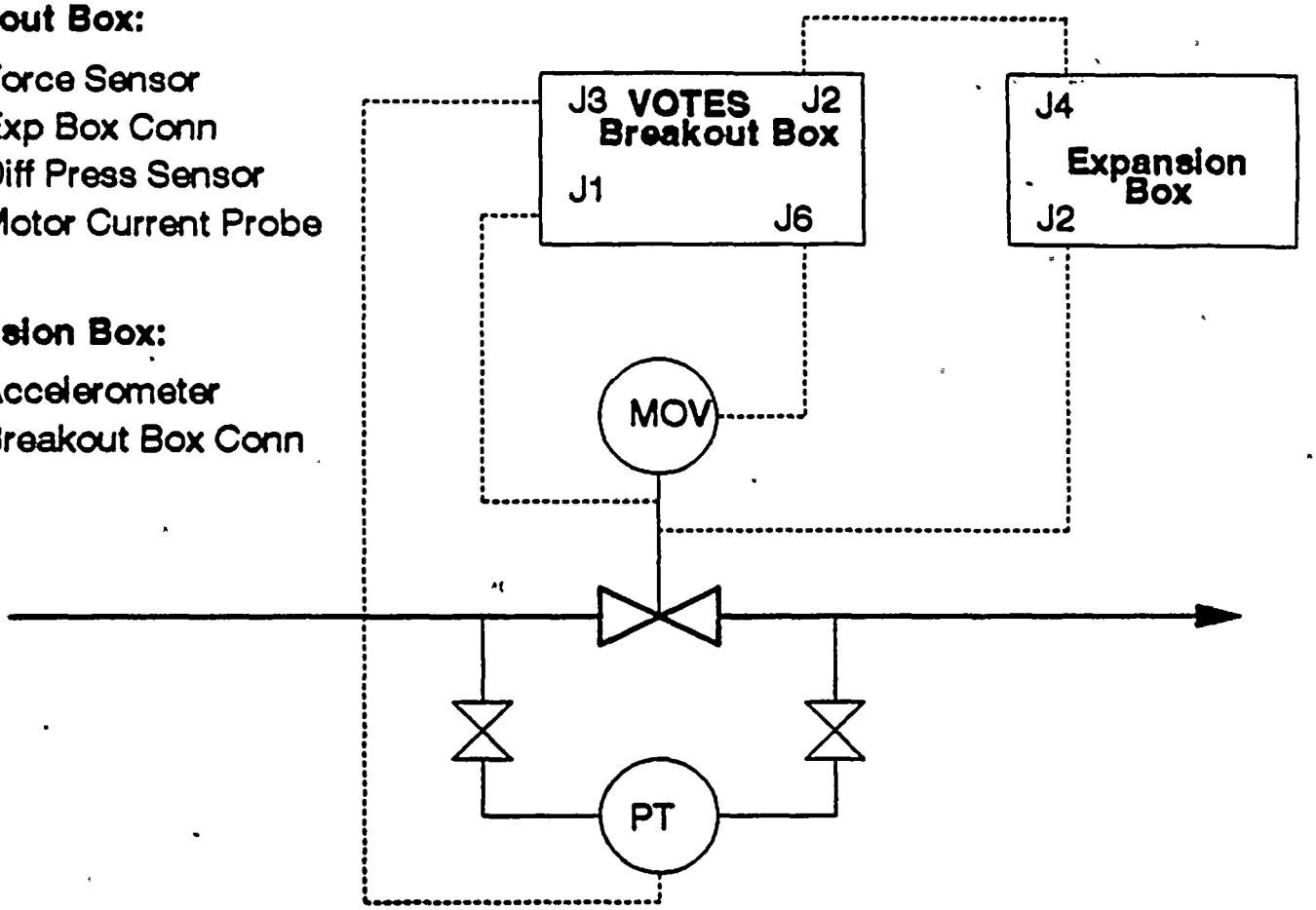
Typical Test Instrumentation Diagram A

Breakout Box:

J1 Force Sensor
J2 Exp Box Conn
J3 Diff Press Sensor
J6 Motor Current Probe

Expansion Box:

J2 Accelerometer
J4 Breakout Box Conn



Typical Test Instrumentation Diagram B