UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 17, 1997

MEMORANDUM TO: David B. Matthews, Chief
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

FROM: Claudia M. Craig, Senior Project Manager Claudia M. Craig
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MEETING WITH THE BOILING WATER REACTORS OWNERS GROUP (BWROG) AND THE WESTINGHOUSE OWNERS GROUP (WOG) TO DISCUSS THE JOINT EFFORT ON PERIODIC VERIFICATION OF MOTOR-OPERATED VALVES

On January 14, 1997, members of the NRC staff met with representatives of the Boiling Water Reactor (BWR) and Westinghouse Owners' Groups to discuss a Joint BWR and Westinghouse Owners' Group (JOG) Program on Motor-Operated Valve (MOV) Periodic Verification which was submitted to the staff by letter dated January 9, 1997. The JOG Program on MOV Periodic Verification is being developed in response to Generic Letter (GL) 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," dated September 18, 1996. To allow for a consistent approach to GL 96-05 among their member licensees, the Owners' Groups plan to submit the program as a Topical Report in February 1997. Applicable licensees could then reference the JOG MOV Periodic Verification Program in the required 180-day response to GL 96-05 scheduled for mid-March 1997. The Owners' Groups requested the meeting with the NRC staff to discuss the JOG program and to obtain preliminary comments from the staff. Attachment 1 is a list of meeting attendees which included over 30 industry individuals and 6 NRC staff members. Attachment 2 is a copy of the viewgraphs used by the Owners' Groups.

In GL 96-05, the NRC staff requested that licensees establish a program, or ensure the effectiveness of their current programs, to verify on a periodic basis that safety-related MOVs continue to be capable of performing their safety functions within the current licensing basis of the facility. The BWR and Westinghouse Owners' Groups are jointly developing an MOV periodic verification program in response to GL 96-05 to obtain benefits from the sharing of information between licensees from programs originally developed in response to GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." The stated objectives of the JOG MOV Periodic Verification Program are (1) to provide an approach for member licensees to use immediately in their GL 96-05 programs, (2) to develop a basis for addressing the potential age-related increase in required thrust or torque under dynamic conditions, and (3) to use the developed basis to confirm, or if necessary to modify, the applied approach. Specific elements of the JOG program include:

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(1) providing an "interim" MOV periodic verification program for applicable licensees to use in response to GL 96-05, (2) conducting a dynamic testing program over the next 5 years to identify potential age-related increases in required thrust and torque to operate gate, globe and butterfly valves under dynamic conditions, and (3) evaluating the information from the dynamic testing program to confirm or modify the interim program assumptions.

During the meeting, the Owners' Groups presented a summary of the planned JOG MOV Periodic Verification Program. The stated benefits of the JOG program for licensees included conservation of resources, enhancement of program thoroughness and sharing of experience among the 87 plants within the two Owners' Groups (if all participate), and establishment of a solid technical basis for the long-term MOV periodic verification program from the large sample of shared MOV test data. The Owners' Groups suggested that benefits to the NRC included a generic approach that conserves NRC resources, implementation of a uniform approach to GL 96-05, and assurance that the test findings are shared across the industry.

The Owners' Groups described the objective of the interim MOV periodic verification program to be assurance that the MOVs remain setup consistent with GL 89-10 criteria with additional margin for age-related degradation during conduct of the JOG dynamic testing program. The elements of the interim program included: (1) continuation of ASME Inservice Testing (IST) Program stroke-time testing, and (2) performance of static diagnostic testing on a frequency based on functional capability (age-related degradation margin over and above margin for GL 89-10 evaluated parameters) and safety significance. The NRC staff has a number of questions regarding the JOG program criteria for establishing the frequency of static testing, and the Owners' Groups indicated that additional work in this area would be undertaken.

The Owners' Groups described the objectives of the JOG dynamic test program as determination of the degradation-related trends in dynamic thrust and torque, and use of dynamic test results to adjust the interim program if warranted. The elements of the JOG dynamic testing program included: (1) identification of conditions and features which could potentially lead to MOV degradation, (2) definition and assignment of valves for dynamic testing, (3) testing valves three times with at least a one-year interval between valve-specific tests according to a standard test specification over a five-year interval, (4) evaluation of results of each test, and (5) evaluation of collective test results.

In the last phase of the JOG MOV Periodic Verification Program, the Owners' Groups will evaluate the test results to validate the assumptions in the interim program to establish a long-term MOV periodic verification program to be implemented by their licensees. Although not clearly established, the Owners' Groups indicated that a feedback mechanism would be established to ensure timely sharing of MOV test results between licensees and prompt individual licensee actions to adjust their own MOV periodic verification program, as appropriate.

Attachment 3 is a copy of a survey forwarded by the Owners' Groups to their licensees to identify the population of GL 96-05 MOVs that require information on potential age-related degradation. Attachment 4 is a copy of test guidance to be used by individual licensees which will be included as Appendix E of the JOG MOV Periodic Verification Program description. The staff expressed interest in measures (many of which are in this appendix) to assure uniformity of approach by user licensees.

Although the JOG MOV Periodic Verification Program has not been finalized and could not be reviewed in detail, the NRC staff present at the meeting considered the program being developed by the Owners' Groups to represent a significant effort in establishing a consistent approach to ensure the long-term design-basis capability of safety-related MOVs. The NRC staff members considered the Owners' Groups to be proceeding in a reasonable manner to develop an industry-wide response to GL 96-05. The staff provided preliminary comments on the JOG program during the meeting. Attachment 5 summarizes the more significant general comments. Specific comments were also provided on individual aspects of the JOG program to the Owners' Groups. As a result of the discussion, the Owners' Groups indicated their intention to complete development of the JOG MOV Periodic Verification Program considering comments provided by the staff during the meeting. After undergoing licensee review, the Owners' Groups plan to submit their program for NRC review and approval as a Topical Report in February 1997.

The NRC staff commended the Owners' Groups for this precedent setting cooperative effort. The staff encouraged the BWR and Westinghouse Owners' Groups to include representatives of the CE and B&W Owners' Groups in their response to GL 96-05 to obtain even wider industry participation.

With the submittal of the required 180-day response to GL 96-05 scheduled for mid-March 1997, the Owners' Groups stated during the meeting that they might request a short extension of the deadline for the 180-day submittal to allow time for their licensees to incorporate the JOG MOV Periodic Verification Program into the plant-specific GL 96-05 program summaries. The NRC staff indicated that the Owners' Groups would be expected to present justification in their request for an extension to the GL 96-05 schedule supporting the safety basis for the delay in the 180-day submittal. Subsequent to the meeting, a representative of the Owners' Groups informed the NRC staff by telephone that the Owners' Groups had decided not to request a GL 96-05 schedule extension at this time.

Project Nos. 691 and 694

cc w/atts: See next page

Attachments:
1. Meeting Attendees
2. Viewgraphs
3. Survey
4. Test Guidance
5. Preliminary Comments on Joint Owners' Group MOV Periodic Verification Program

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BWROG/WOG/NRC MEETING
JOINT EFFORT FOR PERIODIC VERIFICATION OF MOVs
JANUARY 14, 1997 AT ROCKVILLE, MD

MEETING ATTENDEES

NAME	ORGANIZATION
Claudia Craig	NRC/NRR/PGEB
Thomas Scarbrough	NRC/NRR/EMEB
Dick Wessman	NRC/NRR/EMEB
G.H. Weidenhamer	NRC/RES/EMMEB
Frank Madero	HL&P/South Texas Project
Robert L. Justice	SCE&G/V.C. Summer Station
Ike Ezekoye	Westinghouse
Steven M. DiTommaso	Westinghouse
Steve Loehlein	WOG/Duquesne Light/Beaver Valley
Glenn Warren	SNC/BWROG
Wendell Fiock	GE/BWROG
Bob Lewis	PSE&G/Salem & Hope Creek
Bob Jaquitit	ABB/CEOG
Michael Rose	PP&L/SSES
Paul Swinburne	NYPA/FitzPatrick
Chad Smith	Duke Power Copmany
Stan Hale	Westinghouse/MOVATS
Tom Hoyle	Supply System
Norm Dingman	NPPD
Paul Damerell	MPR
Michael F. Farnan	RG&E/Ginna
Steve Queen	GPU Nuclear/TMI-1
Paul Brown	North Atlantic Services Co.
Stephen Tingen	NRC/NRR
Earl J. Brown	NRC/AEOD
Stan Guonas	Weisconsin Electric/Pt. Beach
Tom White	Boston Edison/Pilgrim
Karl Toth	AEP/Cook Nuclear Plant
Fred Martsen	New York Power Authroity
Greg Young	Carolina Power & Light
Tim Chan	TVA
Brian Bunte	Commonwealth Edison
Tom Lund	Wisconsin Public Service
Kevin Matthews	Duke Power
Charles Laverde	Con Edison
Lin Turner	TVA - Browns Ferry
Bob Harris	Northeast Utilities
P.C. Chiu	TU Electric/Comanche Peak
Ben Mays	TU Electric/CPSES

ATTACHMENT 1

PERIODIC VERIFICATION
(GL 96-05)

JOINT BWROG-VTRG/WOG PV
TASK FORCE
Presentation to NRC

January 14, 1997
Rockville, MD

Glenn Warren
Chairman, BWROG-VTRG
Southern Company

Steve Loehlein
Chairman, WOG-PV Task Team
Duquesne Light

Presentation Objectives

- Update NRC on joint BWROG/WOG (JOG) Periodic Verification (PV) effort

- Solicit NRC response to JOG proposed PV program

Benefits of Group PV Program Effort

For Participating Utilities:

- Joint approach to develop GL 96-05 response conserves resources
- "Standardized" program for 45 BWR & PWR utilities (87 plants) enhances thoroughness and sharing of experience
- Large sample of shared MOV test data provides a solid technical basis for final program

Benefits of Group PV Program Effort

For NRC:

- Generic approach conserves NRC resources in individual plant program reviews
- Consistent approach allows NRC to ensure uniform implementation of (and compliance with) GL 96-05 recommendations
- Use of large, shared base of MOV test data ensures that findings get recognized across the industry

Degradation

GL 96-05 defines MOV degradation in terms of:

- Decrease in output capability of motor actuator , and/or

- Increase in thrust or torque requirements to operate the valve

Decrease in Actuator Output

- Can be determined by static testing
- To be implemented by plant-specific PV programs
- Adjustments to account for this degradation made prior to calculating margin in JOG PV Program

Increase in Valve Thrust or Torque Requirements

- Limited to valve internals
- JOG dynamic test program objective is to determine degradation of dP thrust or torque component
- Degradation outside of dP thrust/torque (e.g., packing) to be covered by plant-specific programs
- Program criteria to be adjusted, if warranted, based on observed dP testing results

A Valve is A Valve

Important factors for age-related changes:

- Materials of construction
  - Hardfacing
  - Low alloy steel
- Fluid quality
- Service conditions
  - dP strokes
  - Static only

Summary of JOG PV Program

3 Elements

- "Interim" Utility PV Program
- JOG PV Dynamic Testing Program
- Test Data Evaluation, Analysis & Resolution (Final program)

"Interim" Utility PV Program

Objective: Insure MOV setups remain consistent with GL 89-10 criteria while providing additional margin for valve degradation during the conduct of the JOG PV dynamic test program.

Elements:

- Continue exercising MOVs per current IST program
- Static testing of MOVs on a frequency based on:
  - *Safety Significance (CDF Risk*)* using OG-specific/utility-specific risk criteria.
  - *Functional Capability (Valve Margin)* using JOG criteria.

* Would be another form of risk measurement for valves with no contribution to CDF.

"Interim" Utility PV Program

(Continued)

MARGIN Definition

(For both open and close operation)

For Gate and Globe valves

$$\text{Margin} = \frac{\text{(Adjusted Actu}}{} \quad \frac{\text{Output Thrust - Adjusted Required Thrust)}}{\text{Adjusted Required Thrust}}$$

Actuator Output Thrust

- **For torque switch (TS) controlled valves, is the thrust measured at CST.**
- **For non-TS valves, is the thrust capability of the motor, gearing and stem nut at design basis conditions, with consideration of weak-link.**

Required Thrust=Calculated stem thrust at design basis conditions (calculation of record)

"Adjustments" should consider:

- Test equipment inaccuracy
- Torque switch repeatability
- Rate of loading
- Spring pack relaxation
- Stem lubricant degradation

"Interim" Utility PV Program

(Continued)

MARGIN Definition

(For both open and close operation)

For Butterfly valves

$$\text{Margin} = \frac{\text{(Adjusted Actuator Output Torque - Adjusted Required Torque)}}{\text{Adjusted Required Torque}}$$

Actuator Output Torque

- **With no active torque switch, is the torque capability of the motor and gearing at design basis conditions, with consideration of weak-link.**
- **For valves with active torque switches, is the lesser of the value above and the stem torque measured at CST.**

Required Torque=Calculated stem torque at design basis conditions (calculation of record)

"Adjustments" should consider:

- Test equipment inaccuracy
- Torque switch repeatability
- Spring pack relaxation
- Seat degradation

"Interim" Utility PV Program

(Continued)

Criteria for Frequency of Static Testing

Risk	Low	Medium	High
H	1 cycle	2 cycles	3 cycles
M	2 cycles	4 cycles	6 cycles*
L	3 cycles	6 cycles*	6 cycles*

MOV Margin

*Not to exceed 10 years based on either 1-1/2 or 2 year operating cycle.

Where:
Low Margin = < 5%
Medium Margin = > 5% - < 10%
High Margin = > 10%

Margin represents values for valve internal age-related degradation only

Low Risk =
Medium Risk = Owners' Group/ Utility Specific
High Risk =

JOG PV Dynamic Test Program

Objectives:

- Determine degradation-related trends in dP thrust and torque under a range of operating conditions.

- Use dynamic testing results to adjust the interim PV program if warranted.

Elements of Dynamic Testing Program

- Identify conditions & features which could potentially lead to MOV degradation.
- Define and assign valve set for repeat dP testing by participating utilities.
- Test valves per standard test specification.
- Evaluate results of each test for degradation anomalies.
- Evaluate collective test results (static & dynamic) to evaluate validity of "interim program".

JOG PV Dynamic Test Program Plan

- Includes gate, globe & butterfly valves (Unbalanced disk globes have no identified degradation mechanisms *[Excused from dP testing])*

- Valves analyzed with the EPRI PPM assumed to have high margin if margin > 0.

- Dynamic testing to be completed within 5 years of response to GL 96-05.

JOG PV Dynamic Test Program Plan
(Continued)

- **Test valve set to include both BWR and PWR valves; size of test set based on consultant evaluation of utility valve candidates:**
  - Will include consideration for potential MOV degradation mechanisms
  - Will include consideration for mix of:
    + Valve type & manufacturer
    + Valve size & orientation
    + Valve dP stroke history
    + Valve environment
    + Valve material construction
    + Fluid medium and temperature
  - Accounts for expected valve attrition over course of program due to repair, replacement or required internal maintenance.

JOG PV Dynamic Test Program Plan
(Continued)

- Three dP test data points for each valve.

- Minimum of 1 year between successive tests.

Test Data Evaluation, Analysis & Resolution

- **Testing and data collection of test valves to be to "standard" methodology (i.e., test spec)**

- **Test results to be evaluated after each test by testing utility and shared among JOG**
  - Utility performing test evaluates their own test data
  - If degradation/anomalies found, utility to determine root cause/degradation rate and make judgment if corrective action warranted.
  - Any test result to be evaluated in view of "group" of valves it represents and applied to that group as deemed appropriate.
  - JOG to determine if mid-program corrective actions warranted based on individual test results.

JOG PV Program Position on ASME Code Case OMN-1

- OMN-1 consistent with GL 89-10
- OMN-1 goes beyond GL 96-05
- Utilities would need time to implement OMN-1 for GL 96-05
- GL 96-05 schedule (i.e., 180-days) does not allow OMN-1 to be a commitment for the JOG PV program
- OGs to review OMN-1/GL 96-05 relationship after 180-day responses
- Final implementation of OMN-1 to be individual utility commitment

Final JOG PV Program

Objective: Static test program that considers risk and margin to determine intervals for required periodic testing (i.e., Revised Interim Program)

Elements:

- Matrix

  Revised based on results of dynamic test program. Margins based on life of valve or interval to expected next dynamic test.

- Utility Programs

  Plant-specific programs that comply with the final JOG PV Program.

Summary

- All S/R MOVs covered in GL 89-10 program considered.
- Risk-based and margin criteria used to prioritize diagnostic testing.
- "Margin" defined to be above the minimum required under GL 89-10.
- Dynamic test valve set based on potential degradation mechanisms.

Summary
(Continued)

- All valves in dynamic test set to be tested three times by end of 5-year program.

- Individual test results to be evaluated for adverse trends; program to be adjusted as appropriate.

- Collective test results to be evaluated to quantify any degradation trends; program to be adjusted as appropriate.

SURVEY FOR POTENTIAL SOURCES
OF PERIODIC VERIFICATION TEST DATA
(Rev. 12/17/96)

Plant: _____ Completed by: _____

Unit(s): _____ Phone: _____

1. Diagnostic Test System(s) and Sensor(s) Commonly used.

□ MOVATS	□ VOTES	□OTHER
□ DMT	□ Yoke Strain	□ _____
□ SST	□ VTC	□ _____
□ QSS	□ Current (one phase)	□ _____
□ SSR	□ Switch actuations	□ _____
□ TTC	□ Motor power	□ _____
□ Current (one phase)	□ Stem strain gages	□ _____
□ Switch actuations	□ _____	
□ Motor power	□ _____	
□ _____		

2. Of those MOVs in your GL 89-10 Program or those valves outside your GL 89-10 Program which are routinely tested with diagnostic test equipment, how many have been DP tested in the past and are DP-testable in the future? Note: do *not* include *unbalanced* disk globe valves.

Gate _____
Balanced Disk Globe _____
Butterfly _____

3. For each valve (or group of identical valves) identified in Item 2, fill out the information on Sheet PV-1. Make copies of the blank sheet as needed. If the information is available on existing printouts or files, it is acceptable to send a copy of the existing information rather than filling out the sheet.

Sheet PV-1
Information on Valves Which Will be or Could be Periodically DP Tested
Page of 1 of 2

Instructions: Fill this sheet out for each valve (or group of identical valves). Fax completed sheets to Paul Damerell, MPR (703) 519-0224.

Plant: _____ Completed by: _____

Units: _____ Phone: _____

Valve No(s). _____ **Valve Type** ☐ Gate ☐ Balanced Disk Globe ☐ Butterfly

General Information

System _____
Valve Description _____
_____

Normal Position ☐ Open ☐ Closed ☐ Throttled

Stem Orientation ☐ Vertical ☐ Horizontal ☐ _____° from Vertical

Pipe Orientation ☐ Vertical ☐ Horizontal ☐ _____° from Vertical

Ease of Repeat DP Testing
- ☐ Already plan to do or have done
- ☐ Could do readily
- ☐ Moderately difficult
- ☐ Extremely difficult

Valve Design

Manufacturer _____
Size _____ inches
Pressure Class _____
Body Material ☐ Carbon Steel ☐ Stainless Steel

If Gate Valve:

Disk Type ☐ Flex W ☐ Solid W ☐ Split W ☐ Double Disk ☐ _____

Seat Ring Face ☐ Stellite ☐ _____
Disk Face ☐ Stellite ☐ _____
Body Guide Type ☐ Cast or Welded ☐ Horseshoe ☐ None ☐ _____
Disk Guide Face ☐ CS ☐ 300 Series SS ☐ Stellite ☐ _____
Body Guide Face ☐ CS ☐ 300 Series SS ☐ Stellite ☐ 400 Series SS ☐ 17-4 PH ☐ _____

If Butterfly Valve

Shaft ☐ 300 Series SS ☐ 400 Series SS ☐ _____
Bearing ☐ Bronze ☐ Fiberglass/Teflon ☐ SS/Teflon ☐ _____

If Balanced Disk Globe

Disk *Guiding* Surface ☐ Stellite ☐ _____
Body *Guiding* Surface ☐ CS ☐ 300 SS ☐ _____

Sheet PV-1
Information on Valves Which Will be or Could be Periodically DP Tested

Valve No (s). _____

Fluid Conditions

Fluid Type ☐ Water ☐ Steam
☐ Air ☐ _____

Cleanliness/Chemistry

☐ Reactor Coolant
☐ Feedwater, mainsteam or condensate
☐ Treated tank or closed loop (e.g., CCW, torus)
☐ Untreated (e.g., service water)
☐ _____

Normal Fluid temp. _____ °F

If normally open, fluid flow rate _____
☐ gpm ☐ _____

Stroking Conditions

Approximate total valve strokes/yr. _____

Approximate total valve strokes/yr. with flow and DP _____ DP Value _____ psig

Does valve modulate for a control function?
☐ Yes ☐ No

Approximate manual strokes (full or partial) per year _____

Miscellaneous

If gate valve, current as-tested valve factor (as-measured without uncertainty corrections)

Close _____ ☐ flow isolation
_____ ☐ hard-seated
Open _____

Test DP value _____ psid
Test temp. _____ °F

Other comments about valves(s) related to potential degradation _____
_____
_____
_____
_____
_____
_____
_____
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_____
_____
_____

Title: Specification for Joint Owners Group Periodic Verification Testing	**Prepared by:**
	Reviewed by:
Date: January 13, 1997	**Approved by:**

TABLE OF CONTENTS

BACKGROUND

The BWR Owners Group and the Westinghouse Owners Group have formed the Joint Owners Group (JOG) Periodic Verification (PV) Program to support members' responses to NRC Generic Letter (GL) 96-05. As part of this program, member plants will conduct periodic in-plant DP tests on selected gate and butterfly valves to provide the necessary data for the program.

PURPOSE

The purpose of this document is to provide guidance for controlling valves for the JOG PV test program, performing valve tests and documenting test results. This specification includes both requirements and recommendations. Guidance which uses the word "shall" are requirements. Valve tests which do not meet all of these requirements will be reviewed on a case-by-case basis to determine if the deviations affect the test results. Guidance which uses the word "should" are recommendations -- it is desirable to meet this guidance; however, it is not a requirement. Deviations from these recommendations should be noted in the test report package.

CONTROL OF VALVES FOR PERIODIC VERIFICATION TESTING

Material Condition

Valves selected for PV testing shall be determined to be in reasonable working order. Based on the most recent diagnostic tests, the valves shall stroke smoothly with no apparent binding or sticking. Recent MOV leak tests (if conducted) shall not indicate excessive or abnormal leakage. Externally, the valves shall not show signs of damage or deterioration.

Maintenance

A PV test program for a valve includes three test sequences, each consisting of static and DP tests, performed at 1 year (minimum) intervals. During this PV test period, maintenance of the test valve shall be limited to ensure that no unwanted changes occur between valve tests which could affect use of the data. Specifically,

- No internal maintenance of the valve shall be performed. The valve shall not be removed from the pipe. Other than remote visual inspection equipment, no foreign objects shall be deliberately introduced into the volume which is contained by the valve body, the bonnet and the valve pipe ends. For gate valves, the bonnet-to-body joint shall not be disassembled.

- No maintenance to the test valve which could affect required thrust or torque, or the measurement of these parameters, shall be made. Maintenance which can be performed include packing replacement, gland bolt torque adjustments, stem re-lubrication and torque or limit switch adjustments.

If any of the above requirements are not met during the PV test period, then the valve is eliminated from the program. Therefore, if it appears likely that the above requirements cannot be met for the full PV test period, then inclusion of the valve in the PV test program should be re-considered.

Testability

Valves for PV testing shall be installed in systems which can be effectively controlled to establish "repeatable" flow and pressure conditions at the valve during testing and which can support installation of the required test equipment. A review of installed valve configurations and system capabilities shall be conducted to ensure that the valves can fully support the testing requirements. If not, then inclusion of the valve in the PV test program should be re-considered.

REQUIREMENTS FOR TESTING

Test Procedure

Testing shall be performed in accordance with written procedures which meet the requirements in this document, and which are developed in accordance with plant administrative, system operating, maintenance, surveillance testing, or other applicable requirements. Test conduct shall 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 shall be reviewed according to standard plant practices.

The procedural steps shall be sufficiently detailed to ensure methodical, repeatable, and consistent valve performance testing.

The same test procedure shall be used for all PV tests (i.e., all strokes of all sequences) performed on a specific valve.

System Lineup

The system lineup should be the same for all test sequences performed for a particular valve. A description of the system lineup shall be included on the JOG PV Test Valve Summary sheet in Attachment A. PV tests shall be performed under flow conditions using installed system or auxiliary subsystem process pumps. System alignment and valve, pump, or equipment sequencing shall be controlled by plant or system procedures or a special (engineering type) test procedure. The test procedure shall 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).

Test Conditions

Valves shall be tested at as high a DP as is practical; however, there is no requirement to exceed the design basis DP of the valve. The test conditions (pressures, flow and temperature) shall be essentially the same for all test sequences of a given valve. The maximum test pressures shall be within 10% of the average pressure for the three tests. The flow shall be within 20% of the average flow for the three tests. The temperatures shall be within 20°F of the average temperature for the three tests. A description of the test conditions shall be included on the JOG PV Test Valve Summary sheet in Attachment A. For gate valves, the measured DP load (measured thrust at initial wedging or just after cracking, corrected for packing and stem rejection loads) should be at least twice the packing load, at least 2000 pounds and at least 25% of the measured thrust at control switch trip. For butterfly valves, the measured bearing torque (see Equation 3) should be at least half the measured unseating torque and at least twice the measured packing torque.

Instrumentation

Equivalent instrumentation and sensors shall be used for all test sequences of a specific valve. A description of the instrumentation shall be included on the JOG PV Test Valve Summary sheet in Attachment A. Parameters which are required to be measured during valve testing, as well as additional parameters which are recommended for measurement (optional), are listed in Table 1. Requirements for accuracy and response time of the instrumentation are included in Table 1.

Table 1 also lists whether a time history or single point measurement is required for each parameter. If a time history measurement is required, the data acquisition equipment shall measure and record the parameter throughout the entire valve stroke. Output (either analog or digital) from the measurement instruments shall be input to multi-channel data recording devices which are capable of referencing all input signals to a common point in time. Data recording shall begin sufficiently before initiation of each valve stroke and end sufficiently after termination of each valve stroke such that transients occurring at the beginning and end of the valve stroke are measured.

If a single point measurement is allowed, a single value for the parameter may be determined at the time of the valve test (e.g., by direct visual indication of the parameter).

The following additional requirements and recommendations related to instrumentation are also applicable.

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

- The data recording devices shall be compatible for interface with the measuring instruments. In particular, the recorders shall 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. The individual channel sampling rates shall be sufficient to capture any transient effects, such as gate valve wedging and unwedging

- Instruments used in measuring and recording test data shall be covered by a formal calibration program meeting the Quality Assurance requirements of 10CFR50 Appendix B. All instruments shall be checked for calibration prior to testing. Calibration records shall be available which document that the equipment accuracy is within the limits stated in Table 1. All calibrations shall be traceable to NIST Standards. Thrust and torque measurements shall be calibrated in both the opening and closing directions.

- Thrust and torque instruments should be appropriately zeroed before testing, and the data shall be corrected for any "zero shifts" prior to data evaluation or plotting.

Test Sequences

Tables 2a and 2b list the valve strokes which make up a recommended PV test sequence. Strokes marked with as asterisk represent the minimum acceptable test sequence. Three test sequences are required to be performed for each PV test valve, as follows.

- A *baseline test sequence* is performed first to establish the operating characteristics of the valve (i.e., required thrust or torque).
- An *interim test sequence* is performed at least one year after the baseline test sequence.
- A *final test sequence* is performed at least one year after the interim test sequence.

Data Evaluation

All test data for a given valve shall be evaluated in a consistent manner. All measurements shall be reported without adjustment for errors or uncertainties.

A JOG PV Gate Valve Test Analysis Data Sheet, as shown in Attachment A, shall be completed for each gate valve open/close stroke pair. This sheet should be completed as follows.

1. Fill in the plant name, the valve identification number and the date and time of the tests.
2. Identify the sequence (baseline, interim or final) and the stroke number (from Table 2).
3. Provide a description of the test (e.g., 100% DP test), if desired.
4. List the valve mean seat diameter, the stem diameter, the flow rate through the valve in the fully open position (or the maximum open position during the test), the fluid temperature at the time of testing and the method of actuator control for the closing stroke.
5. For the closing stroke, identify the time, stem thrust, upstream pressure and DP at each of the following points.
    - Running Load: a location near the fully open position where the DP is essentially zero. An average value over a range of disk motion can be used.
    - Maximum Thrust: the maximum measured stem thrust for the stroke up to and including the point of initial wedging.
    - At Flow Isolation: the point at which the DP stops increasing and levels off to its maximum value (applicable to DP strokes only). The pressure behavior in some

systems makes this point difficult to identify. If flow isolation cannot be identified by pressure or other data, do not include this point in the evaluation.

- At Initial Wedging: the point at which the disk wedges between the seat rings and the stem thrust increases rapidly (i.e., hard-seat contact).
- At Control Switch Trip: the point at which the torque or limit switch trips.
- Final Thrust: the maximum thrust measured at the end of the stroke.

For the opening stroke, identify the time, stem thrust, upstream pressure and DP at each of the following points.

- At Cracking: the thrust peak at the beginning of the stroke before the disk begins to move.
- Just After Cracking: the location just after the cracking peak, typically followed by a region of relatively constant thrust.
- At Flow Initiation: the point at which the DP begins to decrease from its maximum value (applicable to DP strokes only).
- Maximum After Cracking: the maximum measured stem thrust for the stroke after the cracking peak.
- Running Load: a location near the fully open position where the DP is essentially zero. An average value over a range of disk motion can be used.

6. Where requested on the test analysis data sheet, calculate the apparent valve factor (VF) using the equations below. Note that thrust, DP and P_{UP} are the values at the point being evaluated.

Closing:
$$VF = \frac{\text{Thrust} - \text{Thrust}_{running} - (P_{UP} - P_{UP-RUNNING}) * \left(\frac{\pi * d^2_{stem}}{4}\right)}{DP * \left(\frac{\pi * d^2_{mean\ seat}}{4}\right)} \qquad \text{(Equation 1)}$$

Opening:
$$VF = \frac{\text{Thrust} - \text{Thrust}_{running} + (P_{UP} - P_{UP-RUNNING}) * \left(\frac{\pi * d^2_{stem}}{4}\right)}{DP * \left(\frac{\pi * d^2_{mean\ seat}}{4}\right)} \qquad \text{(Equation 2)}$$

A JOG PV Butterfly Valve Test Analysis Data Sheet, as shown in Attachment A, shall be completed for each butterfly valve open/close stroke pair. This sheet should be completed as follows.

1. Fill in the plant name, the valve identification number and the date and time of the tests.

2. Identify the sequence (baseline, interim or final) and the stroke number (from Table 2).

3. Provide a description of the test (e.g., 100% DP test), if desired.

4. List the bearing and shaft materials, the disk and stem diameters, the static unseating torque (the average unseating torque for the static opening strokes, strokes 2 and 8) the flow rate through the valve in the fully open position (or the maximum open position during the test), the temperature at the time of testing and the method of actuator control for the closing stroke.

5. For the closing stroke, identify the time, stem torque, upstream pressure and DP at each of the following points.

   - Running Load: a location near the fully open position where the DP is essentially zero. An average value over a range of disk motion can be used.
   - Maximum Torque: the maximum measured stem torque for the stroke.
   - At Seating: the point at which the disk seats against the valve body.
   - At Control Switch Trip: the point at which the torque or limit switch trips.

   For the opening stroke, identify the time, stem torque, upstream pressure and DP at each of the following points.

   - At Unseating: the torque peak at the beginning of the stroke as the disk moves out of the seat.
   - Maximum Torque: the maximum measured stem torque for the stroke.
   - Running Load: a location near the fully open position where the DP is essentially zero. An average value over a range of disk motion can be used.

6. For DP opening strokes, calculate the apparent bearing coefficient of friction (mu) using the equation below.

$$\mu_b = \frac{24 * (\tau_{DPO} - \tau_{STO})}{DP * A_{DISK} * d_{STEM}} \qquad \text{(Equation 3)}$$

τ_{DPO}: Unseating torque for DP test, ft-lbs
τ_{STO}: Unseating torque for static test, ft-lbs
DP: DP at unseating during DP stroke, psi
A_{DISK}: Area of disk, in^2
d_{STEM}: Stem diameter at bearing, in

Documentation

A test report package shall be prepared to summarize the results for a particular valve. The following information shall be included in the package.

- A completed JOG PV Test Valve Summary Sheet for each valve tested.
- Completed JOG PV Valve Test Analysis Data Sheets for all strokes performed for each valve. Note that plots are required to be attached to these data sheets for each stroke.
- Plots showing measured stem thrust or torque versus time for all DP tests performed on the valve to date. Data should be "overlayed" such that all opening stroke data is shown on one plot and all closing stroke data is shown on one plot. Data should be "synchronized" to initial wedging, for closing strokes, or cracking, for opening strokes. For example, one closing stroke should be selected as the reference stroke, and the time values for the other strokes should be offset such that the time associated with initial wedging is the same for all closing strokes.
- A description of any maintenance performed on the valve between test sequences, including actuator switch adjustments and stem lubrication.

A test package shall be issued after the first test sequence is performed for a valve and revised as additional test sequences are performed.

Quality Assurance

Results from MOV PV testing will be used by JOG Program members to address NRC GL 96-05. Results of the program will ultimately be used to evaluate equipment important to plant safety. All activities associated with MOV PV testing shall be performed in accordance with the applicable portions of the participating plant Quality Assurance program.

Table 1. Instrumentation List for PV Testing (Page 1 of 2)

Parameter	Measurement Type	Accuracy	Response Time	Comments
Stem Thrust (gate valves only), and Stem Torque (optional for gate valves, required for butterfly valves)	Time history	[later]	[later]	Direct thrust measurement is required. Equipment shall be calibrated for both opening and closing. The effects of hysteresis, repeatability, instrument error, installation methods, and other common sources of error shall be included in the accuracy determination. Documentation shall be available to validate the accuracy of the thrust or torque measurement instrument. The documentation produced by the Test Equipment and Claims Validation Committee of the MOV Users Group may be suitable. Calibration of thrust or torque measurement equipment shall be in a manner that can be directly related to the as-installed configuration of the equipment on the valve. Careful attention shall be given to installation and removal of the instrumentation so as to ensure consistent accuracy. For example, changes in the structural stiffness or the stem factor affect the data accuracy.
Upstream Line Pressure, and MOV Differential Pressure	[to be decided later]	[later]	[later]	Pressure/DP transducers shall be connected to existing system penetrations (e.g., instrumentation taps, vent lines, drain lines). If possible, pressure sensors should be located such that the pressure drop between the sensor and the valve is less than 5% of the maximum test DP. Attachment J of Reference (1) includes a worksheet for estimating whether a specific instrument location meets this criteria for valve testing in water flow systems.
Fluid Temperature	Single point	[later]	[later]	Appropriate instruments include installed thermocouples or RTDs in thermowells, indicating thermometers, or strap-on thermocouples or RTDS. Temperature measurements of either the pipe or the fluid may be obtained at any point in the test flow path unless a source of cooling or heating exists between the temperature measurement point and the MOV. An operating heat exchanger is an example of one such device. Temperature measurement equipment shall then be located between the MOV and the cooling or heating source. If instrumentation is temporarily installed to measure flow temperature, it shall be installed as close to the MOV under test as possible. If permanently installed instruments are used, the instrument closest to the MOV should be used.
Flow Rate	Single point	[later]	[later]	Fluid flow rate through the valve with the valve fully open (or open to its maximum position in the test) shall be measured. Appropriate instruments include installed orifice or venturi tube flow instruments, or clamp-on ultrasonic meters. For installed flow measuring instrumentation, accuracy shall be within +5% of full range. If clamp-on ultrasonic flow measuring equipment is used, the following accuracy requirements shall be met. At fluid velocities greater than 4 ft/sec, flow rate measuring equipment shall 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 shall be accurate to within +0.2 ft/sec of the actual flow velocity. Flow measurement shall be obtained at a location which is as close as possible to 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.

Table 1. Instrumentation List for PV Testing (Page 2 of 2)

Parameter	Measurement Type	Accuracy	Response Time	Comments
Motor Operator Control Switch Contact Actuation	Time history	[later]	[later]	Time history measurements of control switch contact actuation shall 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) shall be monitored. Appropriate instruments include external circuits for measuring voltage changes in the switch circuits (or spare contacts) during MOV operation.
Motor Current	Time history	[later]	[later]	If desired, the motor current (rms) at the valve motor controller shall be measured. Appropriate instruments include current transducers or clamp-on ammeters.
Valve Stem Position (optional)	Time history	[later]	[later]	
Spring Pack Force (optional)	Time history	[later]	[later]	
Motor Operator Spring Pack Displacement (optional)	Time history	[later]	[later]	If desired, movement of the spring pack shall be measured relative to the spring pack preload position. An appropriate instrument would be an LVDT installed on the motor operator spring pack assembly.
Three Phase Motor Power (optional)	Time history	[later]	[later]	

Table 2. Recommended Valve PV Test Sequence

Stroke No.	Description	Direction	
1*	static	O → C	
2*	static	C → O	
3*	dynamic	O → C**	
4*	dynamic	C → O**	
5	dynamic	O → C	
6	dynamic	C → O	
7	static	O → C	
8	static	C → O	

* These strokes represent the minimum acceptable test sequence.

** If needed, the dynamic opening stroke may be performed prior to the dynamic closing stroke. In this case, the closing stroke just prior to the dynamic opening stroke shall be identical to stroke 1 (static closing stroke), or data shall be recorded for the stroke.

ATTACHMENT A

Data Sheets for JOG PV Testing Program

Title: Specification for Joint Owners Group Periodic Verification Testing	Date: January 13, 1997

JOG PV TEST VALVE SUMMARY SHEET

DESCRIPTION OF VALVE

Manufacturer: _____ Size: _____ Pressure Class: _____

Valve Identification: _____ (e.g., plant name-MOV Tag Number)

Valve Description: _____

Valve Function: _____

TEST CONFIGURATION

Briefly describe the system configuration for testing. Describe the fluid medium, the upstream pressure source, the downstream pressure sink, the location of the valve in the system and the flowpath.

INSTRUMENTATION

Complete the table below.

Parameter	Description of Sensor	Accuracy
Stem Thrust		
Stem Torque		
DP		
Upstream Pressure		
Temperature		
Flow Rate		
Actuator Switch Actuation		
Motor Current		
[illegible]		
Other:		
Other:		

Title: Specification for Joint Owners Group Periodic Verification Testing	Date: January 13, 1997

JOG PV Gate Valve Test Analysis Data Sheet

Plant: _____ Valve _____

Sequence: baseline / interim / final Stroke(s): _____

Test Date/Time: open: _____ close: _____

Test Description: _____

Mean Seat Diameter (in): _____ Flow Rate* (gpm): _____

Stem Diameter (in): _____ Temperature (F): _____

Closing Control Switch: torque / limit

Closing Stroke					
Point	Time (sec)	DP (psi)	P_{UP} (psi)	Thrust (lbs)	Apparent Valve Factor*
Running					---
Maximum Thrust					
At Flow Isolation*					
At Initial Wedging					
At Control Switch Trip		---	---		---
Final Thrust		---	---		---

Opening Stroke					
Point	Time (sec)	DP (psi)	P_{UP} (psi)	Thrust (lbs)	Apparent Valve Factor*
At Cracking					---
Just After Cracking					
At Flow Initiation*					
Maximum After Cracking					
Running					---

* Required for DP strokes only.

NOTE: Attach copies of the following plots for the strokes above.
Static strokes -- thrust versus time
DP strokes -- thrust, DP and upstream pressure versus time

Title: Specification for Joint Owners Group Periodic Verification Testing	Date: January 13, 1997

JOG PV Butterfly Valve Test Analysis Data Sheet

Plant: _____ Valve: _____

Sequence: baseline / interim / final Stroke(s): _____

Test Date/Time: open: _____ close: _____

Test Description: _____

Bearing Material: _____ Disk Diameter (in): _____

Shaft Material: _____ Stem Diameter (in): _____

Static Unseating Torque*: _____ Flow Rate* (gpm): _____

Closing Control Switch: torque / limit Temperature (F): _____

Closing Stroke				
Point	Time (sec)	DP (psi)	P_{UP} (psi)	Torque (ft-lbs)
Running				
Maximum Torque				
At Seating				
At Control Switch Trip				

Opening Stroke					
Point	Time (sec)	DP (psi)	P_{UP} (psi)	Torque (ft-lbs)	Apparent Bearing mu*
At Unseating					
Maximum Torque					---
Running					---

* Required for DP strokes only.

NOTE: Attach copies of the following plots for the strokes above.
Static strokes -- torque versus time
DP strokes -- torque, DP and upstream pressure versus time

PRELIMINARY COMMENTS ON
JOINT OWNERS' GROUP MOV PERIODIC VERIFICATION PROGRAM

1. The description of the Joint Owners' Group (JOG) MOV Periodic Verification Program should more clearly describe the "interim" MOV periodic verification program to be implemented by individual licensees during the JOG dynamic testing program.

2. The description of the JOG MOV Periodic Verification Program should clearly specify that the licensee must ensure that each GL 96-05 MOV will have adequate margin to remain operable until the next scheduled test, regardless of its risk categorization or safety significance.

3. In establishing the schedule for static diagnostic testing of GL 96-05 MOVs, the JOG interim MOV periodic verification program establishes a testing frequency of 1 to 6 cycles (with a maximum of 10 years) based on aging-related margin and safety significance for the specific MOV. The interim program should indicate that the licensee must also consider the operating history of the specific valve, and its application and environment, when determining the appropriate static diagnostic test frequency.

4. The Owners' Groups intend to evaluate data from the JOG five-year dynamic testing program to verify the adequacy of the minimum age-related margin requirements established in the interim program. The JOG program should provide a prompt feedback mechanism to ensure that the dynamic test information continues to support the established testing frequency in the interim program and that a mechanism exists to facilitate licensee actions in response to JOG test data. This is particularly important because of the small margins that might be available to account for age-related degradation for some GL 96-05 MOVs.

5. The Owners' Groups forwarded a survey to their licensees to identify the population of GL 96-05 MOVs that require information on potential age-related degradation. Based on the survey, the Owners' Groups will select a sample of MOVs to be dynamically tested three times over the next 5 years with the participating licensees conducting specified testing to support the selected sample. The Owners' Groups intend to allow use of GL 89-10 dynamic test data (if available) for the first of the three tests. The Owners' Groups did not have information on the number of MOVs to be tested, or the specific systems or operating conditions for these MOVs. The staff will provide comments on the specific testing plan when available.

6. The JOG MOV Periodic Verification Program description stated that unbalanced disk globe valves will be addressed only by static diagnostic testing because the Owners' Groups had not identified any dynamic degradation mechanisms for these types of valves. The staff stated that the decision to eliminate unbalanced disk globe valves from the dynamic testing program and to rely on the assumed minimal margin for degradation must be based on dynamic test information. The staff stated

that the Owners' Groups should obtain this information from available test data or include a sample of these valves in the JOG dynamic test program. The JOG program description should address this issue.

7. The Owners Groups intend to update the JOG MOV Periodic Verification Program as new information from the dynamic testing program is obtained. Licensees committing to the Topical Report on the JOG MOV Periodic Verification Program will be expected to address program updates.

8. The JOG MOV Periodic Verification Program focuses on the potential age-related increase in the thrust and torque required to operate the valves. Licensees will be expected to address the thrust and torque delivered by the motor actuator, including consideration of NRC Information Notice 96-48, "Motor-Operated Valve Performance Issues." Further, licensees will be expected to address the effects of aging on rate-of-loading and stem friction coefficient under dynamic conditions.

9. The JOG MOV Periodic Verification Program description did not discuss resolution and closure of the JOG program. Although the NRC staff would expect to agree with the JOG approach, the staff will not be able to approve the validation of the interim MOV Periodic Verification Program (including the minimum age-related margin, or testing frequency and type) until completion of the five-year dynamic testing program and evaluation of the results. The Owners' Groups should include a commitment in their program to submit an update to the Topical Report upon completion of the dynamic testing program to demonstrate confirmation of the interim program process.

10. The JOG MOV Periodic Verification Program description does not include consideration of ASME Code Case OMN-1, and leaves this to the individual licensees. The Owners' Groups stated their intent to evaluate the application of the JOG MOV Periodic Verification Program to ASME Code Case OMN-1 over the next few months. For example, the Owners' Groups plan inquiries to ASME regarding certain aspects of this Code Case. The staff encouraged the Owners' Groups to make efforts to take advantage of the benefits of OMN-1 to improve testing methods while minimizing repetitive stroke-time testing of the valves.

11. The JOG program criteria for the frequency of static diagnostic testing require amplification. See JOG Viewgraph 12. For example, the risk criteria for Westinghouse licensees have not been established. The relationship of the JOG program to BWR Owners' Group Topical Report NEDC 32264, "Application of Probabilistic Safety Assessment to Generic Letter 89-10 Implementation," and the NRC staff Safety Evaluation (dated February 27, 1996) is not clear. Along this line, the establishment of expert panels is needed to provide confidence in ranking the safety significance of the MOVs. The conduct of "other" testing such as IST should also be put in context. Criteria for extending or changing test intervals should be provided.

12. The JOG MOV Periodic Verification Program description references the program developed by Monticello for MOV periodic verification. The Owners' Groups should review the NRC inspection report discussing the staff evaluation of the Monticello program and the staff's acceptance of the licensee's overall program.

13. The JOG MOV Periodic Verification Program description refers to specific language in GL 96-05 regarding the scope of the program as covering the GL 89-10 MOVs. However, the JOG program description does not address the discussion in GL 96-05 on consideration of safety-related MOVs assumed to be operable in their non-safety position. The staff noted that licensees have various approaches in addressing these specific MOVs and that the JOG MOV Periodic Verification Program description should indicate that licensees are responsible for their plant-specific approach.

14. The Owners' Groups presented a standard specification for the JOG dynamic testing program. The NRC staff noted that maintenance performed on MOVs in the testing program should be evaluated on a case-by-case basis for its potential effect on identification of age-related degradation. The staff stated that, in addition to differential pressure measurements, the thrust trace should be evaluated when attempting to identify the point of flow isolation during MOV testing. The staff stated that use of an average running load could introduce uncertainties in the determination of the apparent valve factor as a result of differences in the selection of the data points from the diagnostic traces. The test specification needs to include diagnostic equipment characteristics, such as accuracy and response time.