September 25, 2006

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SUBJECT: FINAL SAFETY EVALUATION ON JOINT OWNERS' GROUP PROGRAM ON MOTOR-OPERATED VALVE PERIODIC VERIFICATION (TAC NOS. MC2346, MC2347, AND MC2348)

Gentlemen:

In response to Generic Letter (GL) 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," dated September 18, 1996, nuclear power plant licensees developed an industry-wide Joint Owners' Group (JOG) Program on Motor-Operated Valve (MOV) Periodic Verification. The Nuclear Regulatory Commission (NRC) staff accepted the JOG Program Description Topical Report (TR) MPR-1807, Revision 2, "Motor-Operated Valve Periodic Verification," dated July 1997, in a safety evaluation (SE) dated October 30, 1997, with certain conditions. The NRC staff relied on licensee commitments to the JOG program in closing its review of GL 96-05 programs at the participating nuclear power plants. On February 27, 2004, the JOG submitted the final TR MPR-2524, "Joint Owners' Group Motor Operated Valve Periodic Verification Program Summary," for NRC review and approval.

The NRC staff has completed its review of MPR-2524, and as discussed in the enclosed SE, concludes that the JOG Program on MOV Periodic Verification provides an acceptable industry-wide response to GL 96-05 for valve age-related degradation if implemented in accordance with the enclosed SE. Nuclear power plant licensees that have committed to implement the JOG program in response to GL 96-05 are responsible for implementing the applicable conditions in the SE dated October 30, 1997, on the JOG Program Description TR MPR-1807, and the findings of the enclosed SE on the JOG final TR MPR-2524. Where a licensee that has committed to implement the JOG program as part of its response to GL 96-05 identifies safety-related MOVs or their application that are outside the scope of the JOG program, the licensee is expected to notify the NRC staff of its plans for periodically verifying the design-basis capability of those MOVs in accordance with its commitments to GL 96-05.

If you have any questions, please contact the JOG Program Project Manager, Sean Peters, at (301) 415-1842.

Sincerely,

/RA/

Ho K. Nieh, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project Nos. 691, 693, and 694

Enclosure: Safety Evaluation

cc w/encl: See next page

If you have any questions, please contact the JOG Program Project Manager, Sean Peters, at (301) 415-1842.

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FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

JOINT OWNERS' GROUP PROGRAM ON PERIODIC VERIFICATION OF

DESIGN-BASIS CAPABILITY OF SAFETY-RELATED MOTOR-OPERATED VALVES

PROJECT NOS. 691, 693, AND 694

1.0 INTRODUCTION

In response to Generic Letter (GL) 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," nuclear power plant licensees developed an industry-wide Joint Owners' Group (JOG) Program on Motor-Operated Valve (MOV) Periodic Verification. The JOG prepared an initial topical report (TR) describing the program, MPR-1807, Revision 2, "Motor-Operated Valve Periodic Verification," dated July 1997, which the NRC staff accepted in a safety evaluation (SE) dated October 30, 1997, with certain conditions. The NRC staff relied on licensee commitments to the JOG program in closing its review of GL 96-05 programs at the participating nuclear power plants. On February 27, 2004, the JOG submitted the final TR MPR-2524, "Joint Owners' Group Motor Operated Valve Periodic Verification Program Summary," for NRC review and approval. The enclosed final SE describes the NRC staff review of the JOG Program on MOV Periodic Verification, as described in the final JOG TR MPR-2524, and defines the basis for our approval.

2.0 BACKGROUND

On June 28, 1989, the NRC issued GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," in response to performance concerns with MOVs in nuclear power plants. In GL 89-10, the NRC requested nuclear power plant licensees to verify the design-basis capability of their safety-related MOVs by dynamic testing where practicable. The licensees of 103 operational nuclear power plant units implemented their GL 89-10 programs through the performance of extensive testing and analyses. Based on a series of inspections, the NRC staff closed its review of the GL 89-10 program at each nuclear power plant.

On September 18, 1996, the NRC issued GL 96-05 to provide recommendations to nuclear power plant licensees for assuring the long-term capability of safety-related MOVs to perform their design-basis functions. In GL 96-05, the NRC staff requested that licensees establish a program, or ensure the effectiveness of their current program, 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 provisions in GL 96-05 superceded the long-term aspects of GL 89-10. The NRC staff reviewed the GL 96-05 programs established at nuclear power plants through a combination of inspections and documentation review. The NRC staff prepared a plant-specific SE describing its review of the GL 96-05 program for each nuclear power plant.

In response to GL 96-05, the Boiling Water Reactor Owners' Group (BWROG), B&W Owners' Group (B&WOG), Westinghouse Owners' Group (WOG), and Combustion Engineering Owners' Group (CEOG) developed the JOG Program on MOV Periodic Verification to obtain benefits from sharing information between licensees on MOV performance. The JOG program included the following three elements: (1) an "interim" MOV periodic verification program for licensees to use in response to GL 96-05 during development of a long-term program; (2) a 5-year MOV dynamic diagnostic test program; and (3) a long-term MOV periodic diagnostic test program to be based on information from the dynamic testing program. Licensees of 98 nuclear power reactor units committed to implement the JOG program as part of their response to GL 96-05. On July 30, August 6, and August 12, 1997, respectively, the BWROG, B&WOG, CEOG, and WOG submitted the JOG Program Description TR MPR-1807, "Motor-Operated Valve Periodic Verification," to the NRC for review and approval.

The NRC staff reviewed the JOG Program Description TR MPR-1807 and issued an SE describing its review on October 30, 1997. With several conditions specified in the SE, the NRC staff concluded that the JOG Program on MOV Periodic Verification could achieve an acceptable industry-wide response to GL 96-05 for valve age-related degradation. The NRC staff relied on the commitments of nuclear power plant licensees participating in the JOG program to implement all three phases of the JOG program in preparing SEs that closed its review of GL 96-05 for each participating plant. The NRC staff reviewed separately the GL 96-05 programs for the five nuclear power plant units whose licensees did not commit to implement the JOG program.

3.0 JOG PROGRAM ON MOV PERIODIC VERIFICATION

In a letter dated February 27, 2004, the JOG submitted for NRC review its TR MPR-2524, "Joint Owners' Group Motor Operated Valve Periodic Verification Program Summary," describing the long-term MOV periodic verification recommendations for use by licensees that committed to implement the JOG program as part of their response to GL 96-05. The JOG program addresses the potential degradation in required thrust or torque for safety-related gate, butterfly, balanced disk globe, and unbalanced disk globe valves. In that the JOG program does not cover potential degradation in actuator output thrust or torque, the JOG indicated that potential degradation of actuator capability is the responsibility of each individual licensee. The JOG program is summarized below:

3.1 JOG Interim MOV Test Program

The JOG established an interim MOV test program to be followed by participating licensees during the MOV dynamic test program and the evaluation of the program results. The interim MOV periodic test program consisted of (1) continuation of the Inservice Testing (IST) provisions in the American Society of Mechanical Engineers (ASME) *Boiler & Pressure Vessel Code* (Code), and (2) performance of static diagnostic testing on a frequency based on functional capability and risk significance. **Under the JOG interim program, each participating licensee would establish a static diagnostic test interval for MOVs within the JOG program based on their individual classification as High, Medium, or Low Risk; and High, Medium, or Low Margin. In the interim test matrix, the JOG specified intervals between static diagnostic**

tests for MOVs within the JOG program ranging from one to six refueling operating cycles, but not exceeding 10 years.

3.2 MOV Dynamic Test Program

The MOV dynamic test program implemented by the JOG included 176 valves tested over a 5-year period at the participating nuclear power plants. Under the MOV dynamic test program, each participating nuclear power plant licensee planned to test two MOVs three times each, with repeat tests separated by at least a year. From this process, the JOG developed an initial test scope of 197 valves but, as expected, some attrition of the test valves occurred during the performance of the MOV dynamic test program. When testing MOVs as part of the JOG program, the participating licensees followed the JOG Differential Pressure Test Specification provided in the JOG Program Description TR.

The JOG Differential Pressure Test Specification included provisions for (1) valve maintenance and material condition, (2) system conditions, (3) instrumentation, (4) sequence, (5) data evaluation, and (6) documentation. The test specification required that time-history data for stem thrust (or stem torque for butterfly valves) and differential pressure be obtained, and that subsequent data analyses be performed in a prescribed manner. In accordance with the test specification, the participating licensees prepared a data package for each tested valve. The JOG evaluated the test data following standardized procedures and approved 513 data packages for the 176 valves tested as part of the MOV dynamic test program.

The MOV dynamic test program and its results for specific valve types are described below:

3.2.1 <u>Gate Valves</u>

In the MOV dynamic test program for gate valves, the final gate valve test matrix included 134 valves. These valves were selected to include a range of design attributes and fluid conditions to determine if there were observable changes in required differential pressure thrust related to degradation. The JOG considered the potential mechanisms for degradation of gate valves to be: (a) an increase in disk-to-seat friction due to differential pressure stroking or effects of the fluid environment, and (b) an increase in guide friction due to differential pressure stroking or effects of the fluid environment on Stellite guides, corrosion of carbon steel guides, and wear or galling of non-hardfaced guides caused by differential pressure stroking. The JOG considered the key factors that can potentially influence the friction behavior for gate valves to be: (a) disk and seat material pair, (b) disk and body guide material pair, (c) fluid environment and temperature, (d) cumulative differential pressure strokes, and (e) current valve factor.

For the majority of the tested gate valves, the JOG determined that disk-to-seat friction controls the required differential pressure thrust, and is the key mechanism affecting potential degradation. The JOG found that disk-to-guide friction occasionally controls the required differential pressure thrust in the opening direction, but is of negligible influence in the closing direction. The JOG determined that the tested gate valves showed no evidence of age-related degradation (i.e., increases in required thrust due only to the passage of time).

With regard to gate valve disk-to-seat friction, the JOG found the gate valves to show a stable friction coefficient, and no evidence of service-related degradation (i.e., increases in required thrust due to differential pressure stroking), except under particular conditions. Specifically, the

JOG found disassembly and reassembly of a gate valve to reduce the valve factor in most cases. This temporarily reduced valve factor tended to increase as a result of differential pressure stroking, and to return to a valve factor typical of non-disassembled valves. Some non-disassembled gate valves, particularly those that are not differential pressure stroked in service, also showed initially low disk-to-seat valve factors. These valve factors increased during the course of differential pressure testing in the JOG program.

The JOG observed the disk-to-guide friction in gate valves to be stable, with the exception of disassembled valves with self-mated carbon steel guides, self-mated 300 series stainless steel guides, and 300 series vs. 17-4PH stainless steel guides. For these materials, disassembled valves showed a slight decrease in guide friction, which tended to increase with differential pressure stroking to friction values typical of non-disassembled valves. Guide valve factors for valves with carbon steel guides at elevated temperatures were higher than those observed in cold water, but the values remained stable.

When the as-tested matrix was compared to the planned matrix, the JOG identified two categories where the program scope envisioned by the JOG Program Description TR could not be achieved: (a) Aloyco Split Wedge Gate Valves above 120 °F, and (b) Gate Valves with Stainless Steel Guides above 120 °F. For Aloyco split wedge gate valves that are differential pressure stroked in service above 120 °F, the JOG program covers the potential degradation in thrust for flow isolation (closing direction) and for opening. However, the potential degradation in thrust at hard-seating (closing direction) is covered only for these valves that do not have inservice differential pressure stroking above 120 °F. Aloyco split wedge gate valves required to stroke against differential pressure above 120 °F as a design-basis condition, but not stroked in service against differential pressure above 120 °F, are covered by the JOG program. The JOG program did not cover gate valves with 300 series stainless steel versus 400 series stainless steel guides, or with self-mated 300 series stainless steel guides, that are stroked in service against differential pressure at a temperature above 120 °F. The gate valves with these stainless steel guides that are required to stroke against differential pressure above 120 °F as a design-basis condition, but are not stroked in service against differential pressure above 120 °F, are covered by the JOG program.

3.2.2 Butterfly Valves

In its Program Description TR, the JOG determined that only the bearing torque component of the required differential pressure torque for butterfly valves needed to be evaluated for degradation under dynamic conditions. In its dynamic testing program for butterfly valves, the JOG evaluated the bearing torque coefficient for degradation. The JOG final TR identified two mechanisms for degradation in the bearing friction coefficient: (a) wear of the bearing material from cumulative stroking, and (b) accumulation of particulates in the bearing from the fluid.

A total of 23 butterfly valves were tested in the MOV dynamic test program covering a variety of bearing materials, including bronze, stainless steel, and non-metallic materials. Of which, 13 valves were tested in untreated water systems and 10 valves were tested in treated water systems. 16 butterfly valves had stems mounted vertically, 6 valves had a horizontal stem orientation, and 1 valve had the stem mounted at 45 ° from the vertical axis. The butterfly valve test matrix included valve stem materials of 17-4PH stainless steel, 300 series stainless steel, 400 series stainless steel, and Monel K-500. No butterfly valves were tested under compressible flow conditions, such as with steam or air flow. The JOG final TR referred to data from previous testing performed by the Idaho National Engineering Laboratory (INEL) under NRC sponsorship, where the bearing friction coefficient for butterfly valves in air was observed to behave similarly to the coefficient in treated water. As such, the JOG determined that the results from water flow tests in its butterfly valve dynamic test program could be applied to butterfly valves in air or nitrogen service.

The 23 tested butterfly valves were separated into four groups for analysis: (a) bronze bearings in treated water systems, (b) bronze bearings in untreated water systems, (c) 300 series stainless steel bearings in untreated water systems, and (d) non-metallic bearings in treated and untreated water systems. The results provided by the JOG are summarized below:

> For butterfly valves with bronze bearings in treated water systems, the bearing friction coefficient did not degrade and was relatively stable.
>
> For butterfly valves with bronze bearings with hub seals in untreated water systems, the bearing friction coefficient was stable, and demonstrated behavior similar to valves with bronze bearings in treated water systems. For butterfly valves with bronze bearings without hub seals in untreated water systems, there was significant variation (increases and decreases) in the bearing friction coefficient. However, there was no overall increasing or decreasing trend.
>
> For the butterfly valve with 300 series stainless steel bearings and a 17-4PH stainless steel shaft without a hub seal tested in an untreated water system, there was significant variation (increases and decreases) in the bearing friction coefficient. However, there was no overall increasing or decreasing trend.
>
> For butterfly valves with non-metallic bearings, the JOG found that the coefficient of friction for bearings made of Teflon in a fiberglass carrier, Teflon on a stainless steel substrate, or Tefzel, was stable in treated water. In untreated water, there were slight variations in the friction coefficient for these bearings. For butterfly valves with bearings made of Nomex, Polyethylene, or Nylatron, the bearing friction was observed to be generally stable, with small variations in untreated water.
>
> The JOG determined from its evaluation of the butterfly valve test results that there was no age-related or service-related degradation in required bearing torque. That is, the JOG found that there was no increase in the required bearing torque due only to the passage of time (without differential pressure stroking), and no increase in the required bearing torque due to differential pressure stroking for the butterfly valves tested. The JOG also determined that valve stem material, the amount of differential pressure stroking, stem orientation, and normal position did not affect bearing friction performance (i.e., coefficient of friction variation and magnitude).

3.2.3 <u>Balanced Disk Globe Valves</u>

For balanced disk globe valves, the JOG considered the friction between the disk and its guiding surface to be the principal contributor to the required differential pressure thrust. The JOG assumed that the friction coefficient between the disk and its guiding surface depends primarily on the materials of the two surfaces and their temperature, but may also be affected by contact geometry (e.g., flat-on-flat), contact stress and fluid medium. The JOG believed that the friction coefficient at the disk-to-body guide interface could potentially increase due to cumulative differential pressure stroking, or exposure to certain fluids and temperatures.

Seven balanced disk globe valves in treated or untreated water systems were tested as part of the JOG program. These balanced disk globe valves covered the following guide surface materials: Stellite, hardened steels (400 series stainless steel and 17-4PH stainless steel), mild steels (carbon steel and 300 series stainless steel), and bronze. In four valves, hardened steel was paired with mild steel. In two valves, hardened steel was paired with hardened steel or Stellite. In one valve, mild steel was paired with bronze. Two valves were tested with flow over the seat and five valves were tested with flow under the seat.

No balanced disk globe valves were tested under compressible flow conditions, such as with steam or air flow. Based on its industry survey, the JOG found that most safety-related applications for balanced disk globe valves in nuclear power plants are in water systems. Because the gate valve test results indicated that air versus water service does not have a major influence on metal friction, the JOG concluded that the application of the balanced disk globe valve test results for water service was reasonable for balanced disk globe valves in air service. Based on its review of the gate valve test results in steam applications, the JOG determined that potential changes in the friction coefficient at the guide interface in balanced disk globe valves would not be affected by the elevated temperatures in steam applications.

The JOG reported that the balanced disk globe valve tests revealed that the differential pressure thrusts were relatively small with low valve factors. Five of the seven valves had maximum differential pressure thrusts less than 1000 lbs. In the cases of the two valves with maximum differential pressure thrusts equal to or greater than 1000 lbs, the majority of the load was attributable to the pressure imbalance load component. Closing stroke valve factors were low and relatively constant throughout the three-test series. Opening stroke valve factors were also low for most of the tested valves without indication of increasing trends. The JOG found that, for two of the valves, the majority of the increased thrust demand was associated with the significant self-closing thrust due to disk imbalance loads.

Three balanced disk globe valves were tested in untreated water. All three valves showed unexpected thrust variations during testing. However, none of these variations significantly affected the differential pressure thrust. The JOG did not observe a degradation trend.

The JOG concluded that there was no age-related or service-related degradation in required thrust for the balanced disk globe valves. The JOG reported that the seven balanced disk globe valves tested in the JOG program showed relatively constant differential pressure thrust across the three-test series, and that there did not appear to be degradation associated with the required differential pressure thrust. The JOG noted that balanced disk globe valves in untreated water systems might be subject to variations in required thrust unrelated to differential pressure thrust. The JOG considered these variations to be attributable to the buildup of foreign material in the valve and not indicative of degradation.

3.2.4 Unbalanced Disk Globe Valves

In that the JOG Program Description TR identified no mechanism for degradation of required thrust in unbalanced disk globe valves, the JOG indicated that the intent of its program for these valves was to dynamically test several unbalanced disk globe valves to confirm the absence of degradation. Twelve unbalanced disk globe valves were selected for differential pressure testing. The unbalanced disk globe valve test matrix covered the following guide materials: Stellite, Inconel, hardened steels (400 series stainless steel, 17-4PH stainless steel)and mild steels (carbon steel and 300 series stainless steel). In five valves, the guides were self-mated Stellite or Stellite paired with mild steel. In four valves, mild steel was paired with mild steel. In three valves, mild steel was paired with either hardened steel or Inconel.

Eight valves were tested in treated water systems with one valve tested in untreated water. One of the tested valves had overseat flow while the remaining eight valves had underseat flow. The tests revealed the valve factors for four of the valves to be relatively constant across the test series, and found no degradation in required thrust for these valves. For the other five valves, the valve factors showed small variations between tests that were within measurement uncertainty.

Three valves were tested in steam systems with flow under the seat. The JOG determined that the results for the three unbalanced disk globe valves in steam systems showed steady behavior between tests. As a result, the JOG found no degradation of the required differential pressure thrust for unbalanced disk globe valves tested in steam systems.

The JOG determined that there was no age-related or service-related degradation in the required thrust for unbalanced disk globe valves.

3.3 JOG Long-Term MOV Periodic Verification Recommendations

To periodically verify MOV design-basis capability with regard to valve operating requirements, the JOG final TR specifies that the MOVs within the scope of the JOG program be statically or dynamically tested at assigned intervals according to their JOG classification. The static diagnostic test intervals are based on the risk ranking and functional margin for each individual MOV. Under the JOG program, the licensee ranks each MOV as Low, Medium, or High Risk using an owners' group method or utility-specific criteria. The licensee determines the functional margin of each MOV after accounting for applicable uncertainties in the analysis. MOVs with functional margin less than 5 percent, equal to or greater than 5 percent but less than 10 percent, or equal to or greater than 10 percent are categorized as Low, Medium, or High Margin, respectively.

The JOG final TR established static diagnostic test intervals (in years) for MOVs within the scope of the JOG program as follows:

Static Diagnostic Test Intervals (years)	Low Margin	Medium Margin	High Margin
High Risk	2	4	6
Medium Risk	4	8	10
Low Risk	6	10	10

Under the JOG program, the licensee classifies each MOV within the scope of GL 96-05 into one of four classes (A through D) according to: (1) unique MOV physical characteristics,

(2) particular system characteristics, and (3) the method used in determining the valve's required thrust or torque. The four classifications of MOVs are described below:

Class A valves are those valves within the scope of the JOG program that have been determined to not be susceptible to degradation in their operating requirements based directly on testing performed in the JOG program or by other suitable basis, such as the Electric Power Research Institute (EPRI) MOV Performance Prediction Methodology (PPM). For these valves, the JOG program specifies only periodic static diagnostic testing to verify that the MOV is properly set and to quantify the margin, as well as to provide any needed plant-unique information on actuator performance or potential actuator degradation. For Class A valves that have positive functional capability margin, the JOG program assumes that these valves have High Margin in the static diagnostic test matrix with a test interval of 6 years for High Risk valves and 10 years for the Medium and Low Risk valves.

Class B valves are those valves within the scope of the JOG program that have been determined to not be susceptible to degradation in their operating requirements based on test results in the JOG program extended by analysis and engineering judgment to configurations and conditions beyond those tested. For these valves, the JOG program specifies only periodic static diagnostic testing to verify that the MOV is properly set and to quantify the margin, as well as to provide any needed plant-unique information on actuator performance or potential actuator degradation. For Class B valves, the JOG program specifies that the static diagnostic test matrix be followed based on functional margin and risk categorization of the specific MOV.

Class C valves are those valves within the scope of the JOG program that have been determined to be susceptible to changes in the required thrust or torque, based on the test results from the JOG program. For gate valves in Class C, the JOG program establishes an allowance when computing the functional margin. If the margin is positive, the JOG program specifies that periodic testing of those gate valves be performed in accordance with the static diagnostic test matrix based on risk categorization and functional margin. For all Class C butterfly valves and for Class C gate valves where the margin is less than zero, the JOG program specifies that the MOV must be either: (1) differential pressure tested at a 2-year interval, with the first differential pressure test to occur at the next available opportunity, not to exceed 2 years, or (2) modified or set such that potential increases or variations in required thrust or torque are accommodated. According to the JOG final TR, globe valves cannot be assigned to Class C.

Class D valves are those valves that are determined to be outside the scope of the JOG program, but within the scope of GL 96-05. The JOG states that individual licensees are responsible for justifying the periodic verification approach for these MOVs.

The JOG specifies that the participating licensees will implement the long-term MOV periodic verification recommendations within 6 years following issuance of the SE by the NRC on the final TR. The JOG's recommendations for long-term periodic verification of MOV design-basis capability based on individual valve type are summarized as follows:

3.3.1 Gate Valves

In determining the JOG classification for an individual gate valve, the licensee considers the following parameters related to the performance of the valve:

- Type of valve,
- Nature of typical differential pressure stroking of the valve,
- Disk-to-seat materials,
- Disk-to-body guide materials,
- Type of fluid in the system in which the valve is located, and
- Valve factor or apparent disk-to-seat coefficient of friction for the valve

Using this information, the JOG long-term periodic verification approach applies a five-step method to classify the gate valve as follows:

> In Step 1, the licensee determines whether the required thrust was calculated using the EPRI MOV PPM or the EPRI Thrust Uncertainty Method (TUM). If the MOV meets the setup criteria specified for Step 1 in the JOG final TR, the gate valve is classified as Class A or B according to the guidance in the report based on the level of confidence in the required thrust determination. If the setup criteria in Step 1 are not met, the licensee moves to Step 2.
>
> In Step 2, the licensee determines whether the valve needs to be placed in Class D (outside the JOG program scope) based on specific applications of Aloyco split wedge gate valves, or solid or flexible wedge gate valves with 300 series stainless steel versus 400 series stainless steel guides or with self-mated 300 series stainless steel guides. If not, the licensee moves to Step 3.
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> In Step 3, the licensee evaluates the valve according to its design configuration and inservice application based on criteria for valve type, disk-to-seat materials, fluid conditions, amount of differential pressure stroking, design-basis function, and disk-to-guide materials. Depending on the results of Step 3, the gate valve is classified as Class A or D, or the licensee moves to Step 4.
>
> In Step 4, the licensee evaluates the basis for the required thrust being used to determine the valve's functional margin. A gate valve that meets the criteria in Step 4 for the required thrust based on differential pressure tests of that specific valve or similar grouped valves is considered to not be susceptible to degradation and can be classified as Class A or B depending on the results of Step 3. If the gate valve does not meet the Step 4 criteria, the licensee moves to Step 5.
>
> In Step 5, the licensee compares the valve coefficient of friction used to set the MOV to a threshold coefficient of friction above which the coefficient is not considered to increase as determined by the JOG testing program. If the MOV was set using a coefficient of friction equal to or greater than the threshold, the valve can be classified as Class A or B depending on the results of Step 3. If the MOV was set using a coefficient of friction less than the threshold, the valve is placed in Class C where an allowance must be included in the coefficient of friction used in setting the MOV.

For Class C gate valves, the JOG specifies that the coefficient of friction used in setting the MOV must be increased each 2-year period up to the threshold coefficient of friction. If the margin (with the applicable friction coefficient allowance included in the calculation) is less than zero, the MOV must be either: (a) differential pressure tested at a 2-year interval, with the first differential pressure test to occur at the next available opportunity, not to exceed 2 years, or (b) modified or set such that potential increases or variations in required thrust are accommodated. The allowance factor does not need to be considered for Class C gate valves if the coefficient of friction is set to the threshold value, or a valid qualifying basis for required thrust is determined for the valve as described in Step 4.

3.3.2 Butterfly Valves

In determining the JOG classification for an individual butterfly valve, the licensee considers the following parameters related to the performance of the valve:

- Shaft material,
- Bearing material,
- Design-basis function,
- Disk-to-body guide materials,
- Type of fluid in the system in which the valve is located,
- Presence or absence of a hub seal, and
- Current bearing friction used to determine margin for the valve.

Using this information, the JOG long-term periodic verification approach applies a four-step method to classify the butterfly valve as follows:

In Step 1, the licensee determines whether the required torque was calculated using the EPRI MOV PPM, directly or beyond its normal applicability limits. If the MOV meets the setup criteria specified for Step 1 in the JOG final TR, the butterfly valve is classified as Class A or B according to the guidance in the report based on the level of confidence in the required torque determination. If the setup criteria in Step 1 are not met, the licensee moves to Step 2.

In Step 2, the licensee evaluates the valve according to its design configuration and inservice application based on criteria for design-basis function, bearing material, shaft material, fluid conditions, and the presence of a hub seal. Depending on the results of Step 2, the butterfly valve is classified as Class A or D, or the licensee moves to Step 3.

In Step 3, the licensee evaluates the basis for the bearing friction component of the required torque being used to determine the butterfly valve’s functional margin. Where a butterfly valve meets the criteria in Step 3 for bearing friction based on differential pressure tests of that specific valve or similar grouped valves, the butterfly valve is considered to not be susceptible to variation above the qualifying basis degradation and can be classified as Class A or B depending on the results of Step 2. If the butterfly valve does not meet the Step 3 criteria, the licensee moves to Step 4.

In Step 4, the licensee compares the bearing friction coefficient used to set the MOV to a threshold coefficient of friction above which the coefficient is not considered to increase as determined by the JOG testing program. If the MOV was set using a coefficient of friction equal to or greater than the threshold, the valve can be classified as Class A or B depending on the results of Step 2. If the MOV was set using a coefficient of friction less than the threshold, the valve is placed in Class C.

The JOG final TR specifies that a Class C butterfly valve undergo a process to satisfy the qualifying basis in Step 3 or the threshold coefficient of friction in Step 4. The JOG final TR includes two options for Class C butterfly valves. Option 1 specifies differential pressure testing of the valve at a 2-year interval until the qualifying basis for the bearing friction coefficient in Step 3 is satisfied. Option 2 specifies re-evaluating the valve, and modifying it if necessary, so that the MOV has positive margin with a bearing friction coefficient equal to the threshold value indicated in the JOG final TR.

3.3.3 Balanced Disk Globe Valves

In determining the JOG classification for an individual balanced disk globe valve, the licensee considers the following parameters related to the performance of the valve:

- Disk-body guide materials,
- Extent of differential pressure stroking, and
- Fluid conditions.

Using this information, the JOG long-term periodic verification approach applies a three-step method to classify the balanced disk globe valve as follows:

In Step 1, the licensee determines whether the required thrust was calculated using the EPRI MOV PPM, directly or beyond its normal applicability limits. If the MOV meets the setup criteria specified for Step 1 in the JOG final TR, the balanced disk globe valve is classified as Class A or B according to the guidance in the report based on the level of confidence in the required thrust determination. If the setup criteria in Step 1 are not met, the licensee moves to Step 2.

In Step 2, the licensee evaluates the valve according to its design configuration and inservice application based on criteria for disk-to-body guide material, extent of differential pressure stroking, and fluid conditions. Based on the results of Step 2, the valve is classified as Class D (outside the scope of the JOG program), or is further evaluated under Step 3.

In Step 3, the licensee determines if the valve is in a treated or untreated (raw) water application. If the valve is located in a treated water system, the valve is classified as Class A or B based on the results of Step 2. If the valve is located in an untreated water system, it is assigned to Class B* where the static diagnostic test intervals are applied, but a warning is provided regarding a potentially unusual mechanism that results in increased thrust requirements apparently from the build-up and release of particulate material inside the valve.

For Class B balanced disk globe valves, the JOG recommends that the licensee review the results of static tests for evidence of thrust increases related to intermittent build-up of solid material in the valve. If such increased thrust is observed, the JOG recommends that the licensee exercise the valve to remove the material or apply an increased thrust requirement when setting the MOV to compensate for this effect. The JOG also recommends that the licensee exercise Class B* valves periodically to reduce the susceptibility to such thrust increases.

3.3.4 Unbalanced Disk Globe Valves

In determining the JOG classification for an individual unbalanced disk globe valve, the licensee considers the following parameters related to the performance of the valve:

- Extent of differential pressure stroking and
- Fluid conditions.

Using this information, the JOG long-term periodic verification approach applies a four-step method to classify the unbalanced disk globe valve as follows:

> In Step 1, the licensee determines whether the required thrust was calculated using the EPRI MOV PPM, directly or beyond its normal applicability limits. If the MOV meets the setup criteria specified for Step 1 in the JOG final TR, the unbalanced disk globe valve is placed in Class A or B according to the guidance in the report based on the level of confidence in the required thrust determination. If the setup criteria in Step 1 are not met, the licensee moves to Step 2.
>
> In Step 2, the licensee determines if the valve is stroked only against zero differential pressure conditions in service, or if the design-basis function of the valve is to operate only under static conditions. If either statement is true, the valve is placed in Class A. If not, the licensee moves to Step 3.
>
> In Step 3, the licensee determines whether the valve has a rising/rotating stem and strokes against differential pressure in the open direction with flow over the seat. If so, the valve is placed in Class D. If not, the licensee moves to Step 4.
>
> In Step 4, the licensee evaluates the valve for specific fluid conditions including type, temperature, flow rate, and flashing. Based on that evaluation using the criteria in the JOG final TR, the valve is placed in Class A, B, or D.

3.4 JOG Guidance for Class D Valves

In its final TR, the JOG states that individual licensees are responsible for justifying the periodic verification approach for MOVs within the scope of GL 96-05 that are placed in Class D (i.e., determined to be outside the scope of the JOG program). Nevertheless, the JOG provides guidance for the periodic verification of the design-basis capability of Class D valves for the consideration of nuclear power plant licensees. In particular, the JOG states that the following evaluations may be performed for Class D valves:

> Perform *in situ* differential pressure tests of the excluded valves or similar valves under the conditions that were not covered by the JOG program and evaluate the results for degradation.

Perform laboratory-type testing of the valves or sub-components to specifically address the degradation mechanism that was not covered by the JOG program (e.g., potential galling of self-mated 300 series stainless steel surfaces at temperatures above 120 °F).

Obtain information from other industry sources that provide insight on the conditions that were not covered by the JOG program.

The JOG states that any information learned as part of these evaluations should be incorporated into the plant-specific MOV Periodic Verification Program.

4.0 EVALUATION OF THE JOG MOV PROGRAM

4.1 Regulatory Evaluation

The NRC regulations require that components that are important to the safe operation of a nuclear power plant be treated in a manner that provides adequate assurance that they will satisfactorily perform their safety functions. Appendix A, "General Design Criteria for Nuclear Power Plants," and Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR) contain broadly based requirements for these nuclear power plant components. In Section 55a of 10 CFR Part 50, the NRC has required nuclear power plant licensees to implement provisions of the ASME Code for testing of MOVs as part of their IST programs. In 1999, the NRC revised 10 CFR 50.55a to incorporate by reference the ASME *Code for Operation and Maintenance of Nuclear Power Plants* (OM Code). The NRC also supplemented the quarterly MOV stroke-time testing specified in the ASME OM Code by requiring licensees that have the ASME OM Code as their Code of record to verify the design-basis capability of MOVs within the scope of the Code on a periodic basis. In the statement of considerations for the rule, the NRC referenced GL 89-10 and GL 96-05 when discussing the implementation of the requirement for periodic verification of MOV design-basis capability.

In 1989, NRC issued GL 89-10 in response to performance concerns with MOVs in nuclear power plants. All 103 operational nuclear power plants have implemented their GL 89-10 programs. The NRC staff closed its review of the GL 89-10 programs as indicated in applicable inspection reports and letters to licensees. The NRC issued GL 89-10 as a compliance backfit in response to the identification of operational experience revealing inadequacies in the design, qualification, testing, and maintenance of safety-related MOVs.

In 1996, the NRC issued GL 96-05 to provide detailed guidance for the periodic verification of MOV design-basis capability. In GL 96-05, the NRC staff asked licensees to establish a program, or ensure the effectiveness of the current program, 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. Accordingly, GL 96-05 programs at nuclear power plants are expected to provide assurance that the changes in required performance from degradation resulting in: (1) an increase in MOV operating thrust or torque requirements, and (2) a decrease in the motor actuator output capability, can be properly identified and addressed. The NRC issued GL 96-05 as a compliance backfit in light of the weaknesses in the ASME Code to assess the operational readiness of MOVs to perform their safety functions under design-basis conditions.

4.2 Technical Evaluation

Following issuance of the SE in October 1997 on the JOG Program Description TR, the NRC staff conducted public meetings with the JOG about every 6 months to discuss the status of the MOV dynamic test program. At a public meeting on October 1 and 2, 2003, the JOG presented the final results of the MOV dynamic test program. Upon receipt of the JOG final TR in February 2004, the NRC staff initiated the review of the long-term MOV periodic verification program developed by the JOG. Pacific Northwest National Laboratory (PNNL) provided technical assistance to the NRC staff as part of the documentation review and audits in evaluating the long-term MOV periodic verification program described in the JOG final TR.

On September 13 to 16, 2004, the NRC staff conducted a technical audit of the JOG program at the office of the JOG contractor MPR Associates in Alexandria, VA. During the audit, the NRC staff reviewed information used in the development of the long-term MOV periodic verification recommendations. The NRC staff also reviewed specific data packages from the MOV dynamic tests conducted by licensees as part of the JOG program. In addition, the NRC staff and JOG discussed the long-term MOV periodic verification recommendations as specified in the JOG final TR.

On October 20, 2004, the NRC staff provided an extensive request for additional information (RAI) to the JOG on the long-term MOV periodic verification recommendations and their bases. On February 8, 2005, the JOG submitted a detailed response to the NRC request. On June 14, 2005, the NRC staff conducted a technical audit of the RAI response at the office of the JOG contractor and discussed the supporting documentation for the responses. On September 27, 2005, the JOG provided a supplement to its RAI response to address open items from the June 2005 audit.

Specific aspects of the NRC staff review of the JOG program are summarized below.

4.2.1 Scope of the JOG Program

The NRC staff reviewed the scope of the MOV dynamic test program conducted by the JOG to determine whether sufficient information was available regarding the valve types, material combinations, and service conditions of the valves to establish the JOG's long-term MOV periodic verification recommendations. As discussed in its final TR, the JOG restricted the applicability of the program where only limited data on valve types, material combinations, and service conditions were available. The NRC staff finds the justification provided for the scope of the JOG Program on MOV Periodic Verification to be reasonable.

As part of its program, the JOG extended the results of valve testing in water and steam to valves in air and nitrogen systems based on separate effects testing performed for the EPRI MOV PPM and by the INEL. The NRC staff requested the JOG to provide additional bases for the justification of this extension. In its February 2005 RAI response, the JOG discussed its consideration of the available valve test data for both air and water conditions to determine if the test results were applicable. The JOG noted that, based on the available test data, the friction for valves in water service was slightly higher than the friction for valves in air service. The JOG also determined that, as the valves were stroked, the friction change was similar for the two fluids. Based on these test results and the absence of identified degradation mechanisms in air or nitrogen that would not be present in water, the JOG determined that the aging friction results from testing valves in water could be extended to valves in air or nitrogen service. Because the application of engineering judgment could potentially increase the uncertainty in the program, the JOG specified that valves in air or nitrogen service cannot be placed in Class A. Rather, the JOG stated that those valves can only be placed in Class B or lower classes with the more restrictive MOV periodic verification actions. With this provision in the JOG program, the NRC finds the extension of the test results for valves in water service to valves in air or nitrogen service to be a reasonable interpretation of the test data.

4.2.2 Test Methods and Data Analysis

In its review, the NRC staff evaluated the test methods and data analysis for gate, butterfly, and globe valves as described in the JOG final TR. The JOG program included repetitive dynamic testing of 176 MOVs in nuclear power plants under a variety of applications. The NRC staff finds that the wide range of tested valves and system conditions in the JOG program supports the generic application of the program results with the specific comments discussed in this SE.

The JOG final TR included information on age-related degradation mechanisms and the manner in which the test results were evaluated. The NRC staff requested the JOG to address the potential for age-related degradation mechanisms in gate valves based on the test data. In its February 2005 RAI response, the JOG discussed additional analyses and revisions to the TR in support of its determination that gate valves did not show age-related degradation (i.e., increases in required thrust due only to the passage of time). Based on its review, the NRC staff considers some of the actual test results to be higher than the coefficient of friction thresholds established by the JOG. Therefore, operating experience might reveal the need to adjust the coefficient of friction thresholds through long-term trends. Further, the NRC staff notes the importance of a strong “qualifying basis” of applicable differential pressure test data where the JOG program allows the coefficient of friction threshold for an individual valve to be bypassed.

From its review, the NRC staff noted large swings in the applicable bearing and disk-to-seat coefficients of friction in some butterfly and globe valves when tested in untreated water. The NRC staff requested the JOG to address these untreated water effects in more detail. In its February 2005 RAI response, the JOG discussed the test data supporting the determination that the observed untreated water effects are independent of differential pressure and are not a potential degradation mechanism. The JOG stated that, prior to implementing the JOG MOV periodic verification method, users are responsible for justifying their valve operating requirements and that, independent of the JOG method, users have a responsibility to consider their own operating experience and test results within the context of their plant-unique MOV programs. In its September 2005 supplemental RAI response, the JOG provided additional discussion of its evaluation of the test results for gate, globe, and butterfly valves in various fluid applications. The NRC staff considers the JOG to have adequately supported the analysis of the test data from various fluid applications. Nevertheless, in light of the limited aspects of some of the test data, the NRC staff expects licensees implementing the JOG program to account for untreated water effects in the event that unanticipated increases are identified in operating requirements and, if necessary, to adjust periodic verification testing intervals or coefficient of friction thresholds accordingly.

In its final TR, the JOG noted that the thrust required to achieve hard seating of the valve could be affected by the direction of flow for some gate valves. In particular, the thrust requirements to operate Anchor/Darling double-disk gate valves and Aloyco split wedge gate valves were shown to be sensitive to the flow direction when hard seating. The NRC staff requested the JOG to address the sensitivity of the thrust required to operate these valves to flow direction. In its February 2005 RAI response, the JOG presented additional guidance to be included in the TR to clarify the hard seating requirements for these two valve types. The JOG stated that the TR would be revised: (a) to identify limitations related to the disk orientation in the pipe in the qualifying basis criteria for certain gate valves; and (b) to provide additional guidance for users when applying the coefficient of friction thresholds to evaluate hard seating for double disk and split wedge gate valves in the coefficient of friction threshold screening for gate valves. The NRC staff finds this additional guidance to appropriately emphasize the importance of thrust sensitivity to flow direction for specific valve types.

4.2.3 JOG Long-Term MOV Periodic Verification Recommendations

In its review, the NRC staff evaluated the recommendations for long-term MOV periodic verification developed by the JOG. In response to NRC staff questions, the JOG clarified or amplified the bases for the long-term MOV periodic verification recommendations in its RAI responses. Based on its review, the NRC staff considers the justification provided by the JOG for the long-term MOV periodic verification recommendations to be reasonable as discussed in this SE.

In its final TR, the JOG defines Class A valves as those valves not susceptible to degradation, as supported directly by testing performed in the JOG program or by other suitable basis (e.g., EPRI MOV PPM). The NRC staff requested the JOG to clarify the use of the term "other suitable basis" under the JOG program. In its February 2005 RAI response, the JOG stated that the use of “other suitable basis” in the final TR refers to only those bases that are defined within the report for the purposes of JOG classification. The NRC staff notes that licensees are responsible for implementing acceptable methods as allowed by the JOG program. For example, the NRC staff has reviewed the EPRI MOV PPM and several of its addenda (including the EPRI Thrust Uncertainty Method) and issued an SE and supplements describing the results of those reviews. In addition, EPRI has issued periodic updates and error notices that specify modifications or limitations to its MOV PPM in light of additional testing or operational experience. Licensees are responsible for addressing such updates and operational experience when implementing the JOG program.

In reviewing the JOG final TR, the NRC staff noted that the JOG allows licensees to use engineering judgement in implementing the JOG program. For example, the JOG program allows the use of engineering judgement with regard to extension of the EPRI MOV PPM; evaluation of gate valve data to determine whether required thrust is controlled by disk-to-seat friction; applicability of differential pressure data in determining valve friction coefficients; determination of valve strokes to achieve a reliable friction plateau; justification of test results under plant-specific conditions; justification for valve grouping; and evaluation of balanced disk globe valves in untreated water systems. During its review, the NRC staff requested the JOG to clarify the reliance on engineering judgement in the program. In its February 2005 RAI response, the JOG provided additional information regarding the bases for allowing engineering judgement in specific instances within the program. The NRC staff reviewed the bases for the use of engineering judgement and discussed them with the JOG during the June 2005 audit. In response to those discussions, the JOG provided additional guidance in its September 2005 supplemental RAI response to justify the use of the EPRI MOV PPM beyond its normal applicability limits, and in determining whether repeat differential pressure strokes have achieved a reliable plateau for the valve coefficient of friction. As discussed in this SE, the NRC staff considers the bases and additional guidance provided by the JOG for the use of engineering judgement to be reasonable. Nevertheless, the NRC staff emphasizes that licensees are responsible for applying engineering judgement consistent with their commitments to GL 96-05 to provide a sound basis for the continued design-basis capability of their safety-related MOVs.

In its review, the NRC staff noted that the JOG final TR allows the application of the JOG program recommendations to unbalanced disk globe valves operating with incompressible (non-flashing) water above 150 °F by extension. The JOG determined that, for incompressible water above 150 °F, the flow field around the disk is the same as for cold water. Because there was no degradation in cold water for unbalanced globe valves, the JOG extended the program to hot water applications. The JOG program allows unbalanced disk globe valves that stroke against water at temperatures up to 150 °F to be classified as Class A valves provided the other Class A criteria are satisfied. The JOG program specifies that unbalanced disk globe valves that stroke against water at temperatures above 150 °F be considered Class B valves (if the other Class B criteria are satisfied) with the more restrictive static diagnostic test intervals. The NRC staff finds this extension to be reasonable provided the fluid within the valve does not flash. In its September 2005 supplemental RAI response, the JOG reaffirmed the licensee's responsibility to confirm that the fluid does not flash for the conditions that exist in the system when the valve is stroked. Without confirmation of non-flashing conditions, the JOG stated that unbalanced disk globe valves that stroke in water service above 150 °F are classified as Class D valves (outside the scope of the JOG program). The NRC staff considers this clarification of the need to confirm that the water flowing through unbalanced disk globe valves remains incompressible to be appropriate for considering those valves to be within the scope of the JOG program.

The JOG stated that valves that have a design-basis function to operate under differential pressure conditions, but do not stroke against differential pressure in service, can have a rating that may lead to Class A categorization. Appendix B to the JOG final TR provides differential pressure levels for gate and globe valves below which the differential pressure loading is considered to be negligible. Appendix B to the JOG final TR also allows infrequent valve strokes under differential pressure conditions that are not expected to be repeated to be omitted when determining whether a valve strokes against differential pressure during plant operations or transients. Based on its review, the NRC staff requested the JOG to provide additional support for the guidance in Appendix B to the JOG final TR. In its February 2005 RAI response, the JOG discussed the potential for increased thrust or torque requirements for gate, globe, or butterfly valves, as applicable, as a result of inadvertent differential pressure strokes. In its September 2005 supplemental RAI response, the JOG discussed input from vendors, tests, and other sources to develop the JOG criteria for negligible differential pressure strokes. The NRC staff finds the JOG's justification for the assessment of differential pressure stroking to be reasonable.

The JOG final TR presents a static diagnostic test matrix with testing intervals for MOVs within the scope of the JOG program ranging from 2 to 10 years based on MOV risk ranking and functional margin. The NRC staff requested the JOG to discuss its basis for the recommended 8-year test frequency for Medium Risk and Medium Margin MOVs rather than the 6-year test frequency recommended for MOVs categorized as Low Risk and Low Margin, or High Risk and

High Margin. In its February 2005 RAI response, the JOG stated that the static test interval of 8 years for Medium Risk and Medium Margin MOVs is based on the interim program guidance in the JOG Program Description TR. The JOG noted that the determination of these intervals was principally based on engineering judgment rather than specific calculations. From the MOV dynamic test program, the JOG reported that it had not identified information that challenged these initial assumptions. In its September 2005 supplemental RAI response, the JOG discussed the special consideration given to the extremes in the test frequency table for risk and margin combinations. For example, the JOG noted that the Low Risk/High Margin MOV test interval was capped at 10 years in recognition of NRC staff concerns with exceeding 10-year test intervals until further MOV operating experience is obtained. The JOG established the Low Margin/Low Risk MOV and High Margin/High Risk MOV test intervals as 6 years (instead of 8 years) to provide additional attention to those valves. The NRC staff considers the static diagnostic test intervals established by the JOG to be reasonable with the recognition that operating experience might reveal a need for their reassessment.

In the final TR, the JOG discussed disk-to-body guide materials for gate valves whose maximum opening thrust is controlled by the valve guides. The NRC staff requested the JOG to provide additional explanation of the consideration of this thrust controlling mechanism for individual valves. In its February 2005 RAI response, the JOG noted that the final TR describes the valve classification based on the disk-to-body guide material pair. For a few combinations of guide materials and fluid conditions, the JOG rating for some gate valves can be improved if diagnostic differential pressure test results show that the required thrust is controlled by disk-to-seat friction. Otherwise, valves are treated and evaluated by assuming that the thrust is potentially controlled by disk-to-guide friction. In that a differential pressure test of a valve at less than design-basis conditions might not reveal whether the thrust is controlled by disk-to-guide friction at design-basis conditions, the JOG stated that the final TR would be revised to: (a) specify a minimum flow rate of 90 percent of the valve's design basis value for application of the provision that allows use of diagnostic test data to evaluate whether the opening stroke required thrust is controlled by disk-to-seat friction; and (b) explain the importance of flow rate in determining whether disk-to-seat friction or disk-to-guide friction controls the required thrust, and the basis for the 90 percent flow rate requirement. The NRC staff finds this clarification of the controlling mechanism for the opening thrust for gate valves to be reasonable.

In the final TR, the JOG described the determination of the differential pressure operating requirements for a valve based on testing a sample of valves in a group and applying the results to all valves in that group. As part of its review, the NRC staff requested the JOG to discuss its grouping approach in more detail. In its February 2005 RAI response, the JOG noted that all of the JOG grouping methods require that two or more valves be tested. In addition, the JOG determined that these tests ensure that the required thrust has reached a stable plateau. In its September 2005 supplemental RAI response, the JOG provided additional discussion of the grouping criteria. The NRC staff finds the JOG supporting basis for valve grouping to be reasonable.

Based on its review, the NRC staff requested the JOG to provide additional support for the establishment of the disk-to-seat coefficient of friction allowances for gate valves in the JOG program. In its February 2005 RAI response, the JOG stated that the coefficient of friction allowances are designed to place Class C gate valves on a path to become Class A or B valves. Accordingly, the JOG program specifies that licensees "notch-up" their setup coefficient of friction for Class C valves every two years, until the coefficient of friction reaches the threshold value. MOVs set with a friction coefficient that includes the applicable allowance will typically only have one or two refueling cycles (2 to 4 years) before the applied coefficient of friction reaches the threshold value. In its September 2005 supplemental RAI response, the JOG stated that the gate valve disk-to-seat coefficient of friction allowances were selected based on engineering judgement to provide an aggressive correction path by increasing the coefficient of friction over time. The NRC staff finds this provision for increasing the coefficient of friction in Class C gate valves to be reasonable.

In its final TR, the JOG stated that the bearing friction coefficient threshold of 0.39 for bronze bearing butterfly valves bounds 95 percent of the measured test data for the bronze bearing butterfly valves. The NRC staff requested the JOG to discuss the justification for the proposed threshold value for the bearing friction coefficient for butterfly valves with bronze bearings without hub seals. In its February 2005 RAI response, the JOG stated that the threshold value for butterfly valves with bronze bearings without hub seals in untreated water of 0.39 is based on the evaluation of 61 bearing friction data points obtained from 11 valves. In its September 2005 supplemental response, the JOG provided further clarification of its basis for the consideration of the bearing coefficient of friction for butterfly valves without hub seals. In particular, the JOG determined that butterfly valves without hub seals behave very differently in treated and untreated water. The NRC staff considers the JOG's evaluation to be reasonable with the understanding that licensees need to be aware of the potential for an increase in operating requirements (particularly for butterfly valves without hub seals).

The JOG proposed an implementation schedule of 6 years for its long-term MOV periodic verification program following issuance of this SE. The NRC staff considers this proposed implementation schedule to be reasonable provided the licensee continues to address any identified issues related to MOV operability in accordance with NRC regulatory requirements. Licensees will be expected to notify the NRC of deviations from the JOG program (including the implementation schedule) in accordance with their commitments to GL 96-05.

4.2.4 <u>Conditions and Limitations in NRC Safety Evaluation dated October 30, 1997</u>

The NRC staff reviewed the status of the conditions and limitations in the SE dated October 30, 1997, on the JOG Program Description TR in light of the JOG final TR. The results of that review are as follows:

> Condition A specified that the JOG must submit for NRC review and approval a revision to (or replacement report for) the JOG Program Description TR following the JOG dynamic test program. The submittal of the JOG final TR satisfies this condition.
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> Condition B noted that the NRC staff had accepted a BWROG TR on MOV risk categorization and specified that licensees that did not participate in the development of that TR must justify their MOV risk categorization methodology as part of their implementation of the JOG program. [Subsequently, the NRC staff accepted a WOG TR on MOV risk ranking methodology in an SE dated April 14, 1998.] Licensees continue to be responsible for applying a justified MOV risk categorization methodology.
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> Condition C specified that licensees implementing the JOG program must address the NRC evaluation and conclusions in the SE on the JOG Program Description TR and the

follow-up SE after the results of the JOG dynamic test program are evaluated. The condition also specified that participating licensees must justify any deviations from the JOG program. Licensees continue to be responsible for implementing the JOG program in accordance with their commitments to GL 96-05.

Condition D specified that licensees implementing the JOG program must determine any valves that are outside the scope of applicability of the JOG overall program or the JOG dynamic test program (or deleted from the JOG program scope), such as in terms of valve manufacturer, size, type, materials, or service conditions; and must justify a separate program for MOV periodic verification for those valves, materials, and service conditions not encompassed by the JOG program. In its final TR, the JOG states that individual licensees are responsible for justifying the periodic verification approach for MOVs within the scope of GL 96-05 that are placed in Class D (i.e., determined to be outside the scope of the JOG program). For the consideration of nuclear power plant licensees, the JOG provides guidance for the periodic verification of the design-basis capability of Class D valves in its final TR. Where a licensee that has committed to implement the JOG program as part of its response to GL 96-05 identifies safety-related MOVs or their application that are outside the scope of the JOG program, the NRC staff expects the licensee to notify the NRC staff of its plans for periodically verifying the design-basis capability of those MOVs in accordance with its commitments to GL 96-05. The NRC staff considers the guidance provided in the JOG final TR to represent a good starting point for establishing an approach to periodically verify the design-basis capability of GL 96-05 MOVs that are not covered by the JOG program. The NRC staff considers the 6-year schedule proposed by the JOG for MOVs within the scope of the JOG program also to be reasonable for the plant-specific methods to periodically verify the design-basis capability of GL 96-05 MOVs outside the scope of the JOG program, provided other considerations such as MOV operability continue to be satisfied.

Condition E specified that licensees implementing the JOG program must address the information provided as a result of the JOG program during and following the JOG dynamic test program. This responsibility includes notification of the NRC under 10 CFR Part 21, evaluation of operational experience for applicability, and consideration of effects on component operability, as appropriate. Licensees continue to be responsible for these actions.

Condition F specified that licensees must ensure that each MOV in the JOG program will have adequate margin (including consideration for aging-related degradation) to remain operable until the next scheduled test, regardless of its risk categorization or safety significance. Licensees continue to be responsible this action.

Condition G specified that licensees may retain their approach for MOV setup where it is justified that MOVs are properly evaluated for operability. When establishing test frequencies under the JOG program, licensees were said to need to apply uncertainties as appropriate in calculating actuator output or valve required thrust (or torque). Licensees continue to have flexibility in their MOV setup approach provided applicable uncertainties are addressed.

Condition H specified that, with the focus of the JOG program on the potential age-related increase in the thrust and torque required to operate the valves, licensees must address apart from the JOG program the thrust and torque delivered by the motor actuator. The condition stated that licensees must address the effects of aging on rate-of-loading and stem friction coefficient under dynamic conditions, and other potential age-related effects such as spring-pack relaxation, and actuator and switch lubrication degradation. In its February 2005 RAI response, the JOG emphasized that actuator degradation is outside the scope of the JOG program. Licensees continue to be responsible for addressing MOV actuator output and potential degradation in accordance with their GL 96-05 commitments.

Condition I noted that the MOV dynamic test sequence in the JOG program specified the performance of an instrumented static test within 30 days prior to the dynamic test. The condition indicated that the JOG would evaluate available test information, to the extent possible, to determine whether the performance of a static test preceding the MOV dynamic test would affect the conclusions of the JOG program. The JOG final TR presented evaluations used to quantify the effect that a prior static test might have on the valve factor of a differential pressure test for gate valves. To evaluate the effect of time between the static and dynamic tests, the JOG studied the test data for valves with static tests more than 29 days prior to the first differential pressure test. From this information, the JOG determined that the results did not indicate a trend in the valve factor data based on the length of time prior to the dynamic test. To evaluate the impact of a static test within 30 days of the MOV dynamic test, the JOG studied gate valve tests with two consecutive differential pressure strokes based on the view that the differential pressure stroke would have a more significant impact than the static test. For gate valves tested in cold water, the JOG reported that the effect of the first differential pressure stroke was to slightly increase the valve factor during the second stroke. For gate valves tested in hot water and steam, the JOG determined that the trend was reversed and observed a slight decrease in valve factor from the first stroke to the second stroke. As a result, the JOG considered that the effect of the performance of a static stroke prior to a differential pressure test was negligible, and did not need to be incorporated into the final MOV periodic verification recommendations for gate valves. The NRC staff evaluated the JOG data and NRC research results, and found the JOG's resolution of this issue to be reasonable.

Condition J specified that MOVs with scheduled test frequencies beyond 5 years will need to be grouped with other MOVs that will be tested on frequencies less than 5 years in order to validate assumptions for the longer test intervals. This condition is superceded by the test intervals established by the long-term JOG program.

5.0 CONCLUSION

The NRC staff has reviewed the JOG Program on MOV Periodic Verification in response to GL 96-05 as described in the JOG TR MPR-2524. The NRC staff considers the RAI responses provided by the JOG on February 8 and September 27, 2005, to also constitute part of the JOG program. Based on review of the TR and RAI responses, and audits conducted of the supporting documentation for the development of the long-term MOV testing recommendations, the NRC staff concludes that JOG Program on MOV Periodic Verification provides an acceptable industry-wide response to GL 96-05 for valve age-related degradation where implemented in accordance with this SE. Nuclear power plant licensees that have committed to implement the JOG program in response to GL 96-05 are responsible for implementing the applicable conditions in the SE dated October 30, 1997, on the JOG Program Description TR MPR-1807, and the findings of this SE on the JOG final TR MPR-2524. Where a licensee that has committed to implement the JOG program as part of its response to GL 96-05 identifies safety-related MOVs or their application that are outside the scope of the JOG program, the NRC staff expects the licensee to notify the NRC staff of its plans for periodically verifying the design-basis capability of those MOVs in accordance with its commitments to GL 96-05.

6.0 REFERENCES

BWR Owners' Group, Combustion Engineering Owners' Group, and Westinghouse Owners' Group letters forwarding Topical Report MPR-1807 (Rev. 2, July 1997), "Motor-Operated Valve Periodic Verification," July 30, August 6, and August 12, 1997.

JOG letter forwarding JOG Topical Report MPR-2524 (Rev. 0, February 2004), "Joint Owners' Group Motor Operated Valve Periodic Verification Program Summary," February 27, 2004.

JOG letter forwarding response to NRC staff request for additional information on the JOG Program on MOV Periodic Verification, February 8, 2005.

JOG letter forwarding a supplemental response to NRC staff request for additional information on the JOG Program on MOV Periodic Verification, September 27, 2005.

NRC Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," June 28, 1989.

NRC Generic Letter 96-05, "Periodic Verification of the Design-Basis Capability of Safety-Related Motor-Operated Valves," September 18, 1996.

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Date: September 22, 2006

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