UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

LICENSEE RESPONSE TO GENERIC LETTER 96-05, "PERIODIC VERIFICATION OF DESIGN-BASIS CAPABILITY OF SAFETY-RELATED MOTOR-OPERATED VALVES,"

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NUMBERS 50-317 AND 50-318

1.0 INTRODUCTION

Many fluid systems at nuclear power plants depend on the successful operation of motor-operated valves (MOVs) in performing their safety functions. Several years ago, MOV operating experience and testing, and research programs sponsored by the nuclear industry and the U. S. Nuclear Regulatory Commission (NRC), revealed weaknesses in a wide range of activities (including design, qualification, testing, and maintenance) associated with the performance of MOVs in nuclear power plants. For example, some engineering analyses used in sizing and setting MOVs did not adequately predict the thrust and torque required to operate valves under their design-basis conditions. In addition, inservice tests of valve stroke time under zero differential-pressure and flow conditions did not ensure that MOVs could perform their safety functions under design-basis conditions.

Upon identification of the weaknesses in MOV performance, significant industry and regulatory activities were initiated to verify the design-basis capability of safety-related MOVs in nuclear power plants. After completion of these activities, nuclear power plant licensees began establishing long-term programs to maintain the design-basis capability of their safety-related MOVs. This safety evaluation (SE) addresses the program developed by Baltimore Gas and Electric Company (licensee) to verify periodically the design-basis capability of safety-related MOVs at the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2.

2.0 REGULATORY REQUIREMENTS

The NRC regulations require that MOVs important to safety be treated in a manner that provides assurance of their intended performance. Criterion 1 to Appendix A, "General Design Criteria for Nuclear Power Plants," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 50) states, in part, that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. The quality assurance program to be applied to safety-related components is described in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. In Section 50.55a of 10 CFR Part 50, the NRC requires licensees to establish inservice testing (IST) programs in accordance with Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

In response to concerns regarding MOV performance, NRC staff issued Generic Letter (GL) 89-10 (June 28, 1989), "Safety-Related Motor-Operated Valve Testing and Surveillance," which requested that nuclear power plant licensees and construction permit holders ensure the capability of MOVs in safety-related systems to perform their intended functions by reviewing MOV design bases, verifying MOV switch settings initially and periodically, testing MOVs under design-basis conditions where practicable, improving evaluations of MOV failures and necessary corrective action, and trending MOV problems. The staff requested that licensees complete the GL 89-10 program within approximately three refueling outages or 5 years from the issuance of the generic letter. Permit holders were requested to complete the GL 89-10 program before plant startup or in accordance with the above schedule, whichever was later.

The NRC staff issued seven supplements to GL 89-10 that provided additional guidance and information on MOV program scope, design-basis reviews, switch settings, testing, periodic verification, trending, and schedule extensions. GL 89-10 and its supplements provided only limited guidance regarding MOV periodic verification and the measures appropriate to assure preservation of design-basis capability. Consequently, the staff determined that additional guidance on the periodic verification of MOV design-basis capability should be prepared. On September 18, 1996, the NRC staff issued GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," requesting each licensee establish a program, or ensure the effectiveness of its 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 bases of the facility. In GL 96-05, the NRC staff summarized several industry and regulatory activities and programs related to maintaining long-term capability of safety-related MOVs. For example, GL 96-05 discussed non-mandatory ASME Code Case OMN-1, "Alternative Rules for Preservice and Inservice Testing of Certain Electric Motor Operated Valve Assemblies in LWR Power Plants, OM Code 1995 Edition; Subsection ISTC," which allows the replacement of ASME Code requirements for MOV quarterly stroke-time testing with exercising of safety-related MOVs at least once per operating cycle and periodic MOV diagnostic testing on a frequency to be determined on the basis of margin and degradation rate. In GL 96-05, the NRC staff stated that the method in OMN-1 meets the intent of the generic letter with certain limitations. The NRC staff also noted in GL 96-05 that licensees remain bound by the requirements in their code of record regarding MOV stroke-time testing, as supplemented by relief requests approved by the NRC staff.

In GL 96-05, licensees were requested to submit the following information to the NRC:

a. within 60 days from the date of GL 96-05, a written response indicating whether or not the licensee would implement the requested actions; and

b. within 180 days from the date of GL 96-05, or upon notification to the NRC of completion of GL 89-10 (whichever is later), a written summary description of the licensee's MOV periodic verification program.

The NRC staff is preparing an SE on the response of each licensee to GL 96-05. The NRC staff intends to rely to a significant extent on an industry initiative to identify valve age-related degradation which could adversely affect the design-basis capability of safety-related MOVs (described in Section 3.0) where a licensee commits to implement that industry program. The NRC staff will conduct inspections to verify the implementation of GL 96-05 programs at nuclear power plants as necessary.

3.0 JOINT OWNERS GROUP PROGRAM ON MOV PERIODIC VERIFICATION

In response to GL 96-05, the Boiling Water Reactor Owners Group (BWROG), Westinghouse Owners Group (WOG), and Combustion Engineering Owners Group (CEOG) jointly developed an MOV periodic verification program to obtain benefits from the sharing of information between licensees. The Joint Owners Group (JOG) Program on MOV Periodic Verification is described by the BWROG in its Licensing Topical Report NEDC-32719, "BWR Owners' Group Program on Motor-Operated Valve (MOV) Periodic Verification," and described by the WOG and the CEOG in their separately submitted Topical Report MPR-1807, "Joint BWR, Westinghouse and Combustion Engineering Owners' Group Program on Motor-Operated Valve (MOV) Periodic Verification." The stated objectives of the JOG program on MOV Periodic Verification are (1) to provide an approach for 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. The specific elements of the JOG program are (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 or 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.

The JOG interim MOV periodic verification program includes (1) continuation of MOV stroke-time testing required by the ASME Code IST program; and (2) performance of MOV 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. In implementing the interim MOV static diagnostic test program, licensees will rank MOVs within the scope of the JOG program according to their safety significance. The JOG program specifies that licensees need to justify their approach for risk ranking MOVs. In Topical Report NEDC 32264, "Application of Probabilistic Safety Assessment to Generic Letter 89-10 Implementation," the BWROG described a methodology to rank MOVs in GL 89-10 programs with respect to their relative importance to core-damage frequency and other considerations to be added by an expert panel. In an SE dated February 27, 1996, the NRC staff accepted the BWROG methodology for risk ranking MOVs in boiling water reactor nuclear plants with certain conditions and limitations. In the NRC SE (dated October 30, 1997) on the JOG Program on MOV Periodic Verification, the NRC staff indicated its view that the BWROG methodology for MOV risk ranking is appropriate for use in response to GL 96-05. With respect to Westinghouse-designed pressurized water reactor nuclear plants, the WOG prepared Engineering Report V-EC-1658, "Risk Ranking Approach for Motor-Operated Valves in Response to Generic Letter 96-05." On April 14, 1998, the NRC staff issued an SE accepting with certain conditions and limitations the WOG approach for ranking MOVs based on their risk significance. Licensees not applicable to the BWROG or WOG methodologies need to justify their MOV risk-ranking approach individually.

The objectives of the JOG dynamic test program are to determine degradation trends in dynamic thrust and torque, and to use dynamic test results to adjust the test frequency and method specified in the interim program if warranted. The JOG dynamic testing program includes (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 over a 5-year interval with at least a 1-year interval between valve-specific tests according

to a standard test specification; (4) evaluation of results of each test; and (5) evaluation of collective test results.

In the last phase of its program, the JOG 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 licensees. A feedback mechanism will be established to ensure timely sharing of MOV test results among licensees and to prompt individual licensees to adjust their own MOV periodic verification program, as appropriate.

Following consideration of NRC staff comments, the BWROG submitted Licensing Topical Report NEDC-32719 (Revision 2) describing the JOG program on July 30, 1997. Similarly, the CEOG and the WOG submitted Topical Report MPR-1807 (Revision 2) describing the JOG program on August 6 and 12, 1997, respectively. On October 30, 1997, the NRC staff issued an SE accepting the JOG program with certain conditions and limitations as an acceptable industry-wide response to GL 96-05 for valve age-related degradation.

4.0 CALVERT CLIFFS GL 96-05 PROGRAM

On November 15, 1996, Baltimore Gas and Electric Company submitted a 60-day response to GL 96-05 notifying the NRC that it would implement the requested MOV periodic verification program at Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2. On March 13, 1997, the licensee submitted a 180-day response to GL 96-05 providing a summary description of the MOV periodic verification program planned to be implemented at Calvert Cliffs. In a letter dated June 30, 1998, the licensee updated its commitment to GL 96-05. On April 2, 1999, the licensee provided a response to a request for additional information regarding GL 96-05 forwarded by the NRC staff on January 29, 1999.

In its letter dated March 13, 1997, the licensee described its MOV periodic verification program, including scope, existing and planned testing, MOV risk ranking, and implementation of the JOG program at Calvert Cliffs. The licensee planned to transition to the JOG methodology and commence dynamic testing JOG-selected MOVs by the end of the 1998 refueling outage. In its letter dated June 30, 1998, the licensee updated its GL 96-05 commitment to implement Topical Report MPR-1807 (Revision 2) and clarified that dynamic testing of two of its four JOG-selected MOVs would not be complete until the refueling outage in 2003. In its letter dated April 2, 1999, the licensee provided additional details regarding its MOV periodic verification program. For example, the licensee described the MOV risk-ranking approach at Calvert Cliffs and its planned implementation of the MOV risk-ranking methodology described in WOG Engineering Report V-EC-1658 (Revision 2) by the end of 2000.

5.0 NRC STAFF EVALUATION

The NRC staff has reviewed the information provided in the licensee's submittals describing the program to verify periodically the design-basis capability of safety-related MOVs at Calvert Cliffs in response to GL 96-05. NRC Inspection Reports 50-317&318/97-02 (IR 97-02) and 50-317&318/98-09 (IR 98-09) provided the results of inspections to evaluate the licensee's program to verify the design-basis capability of safety-related MOVs in response to GL 89-10. The staff closed the review of the GL 89-10 program at Calvert Cliffs in IR 98-09 based on verification of the design-basis capability of safety-related MOVs at Calvert Cliffs. The staff's evaluation of the licensee's response to GL 96-05 is described below.

5.1 MOV Program Scope

In GL 96-05, the NRC staff indicated that all safety-related MOVs covered by the GL 89-10 program should be considered in the development of the MOV periodic verification program. The staff noted that the program should consider safety-related MOVs that are assumed to be capable of returning to their safety position when placed in a position that prevents their safety system (or train) from performing its safety function; and the system (or train) is not declared inoperable when the MOVs are in their nonsafety position.

In a letter dated November 15, 1996, the licensee committed to implement the requested MOV periodic verification program at Calvert Cliffs in response to GL 96-05 and did not take exception to the scope of the generic letter. In its letter dated March 13, 1997, the licensee indicated that the scope of its MOV periodic verification program is consistent with the scope of its GL 89-10 program. In IRs 97-02 and 98-09, the NRC staff reviewed the licensee's MOV program scope in response to GL 89-10 and verified that the removal of several MOVs from the GL 89-10 program at Calvert Cliffs met the intent of GL 89-10 and its supplements.

The staff considers the licensee to have made adequate commitments regarding the scope of its MOV program.

5.2 MOV Assumptions and Methodologies

Licensees maintain their assumptions and methodologies used in the development of MOV programs consistent with the plant configuration throughout the life of the plant (a concept commonly described as a "living program"). For example, the design basis of safety-related MOVs is maintained up to date, including consideration of any plant modifications or power uprate conditions.

In IRs 97-02 and 98-09, the NRC staff reviewed the licensee's justification for the assumptions and methodologies used in the MOV program in response to GL 89-10 at Calvert Cliffs. With certain long-term items discussed in the following section, the staff determined that the licensee had adequately justified the assumptions and methodologies used in its MOV program. The licensee's letter dated April 2, 1999, described several ongoing activities to update its MOV program which are discussed below. The NRC staff considers the licensee to have adequate processes in place to maintain the assumptions and methodologies used in its MOV program, including the design basis of its safety-related MOVs.

5.3 GL 89-10 Long-Term Items

When evaluating the GL 89-10 program at Calvert Cliffs, the NRC staff discussed in IRs 97-02 and 98-09 several items of the licensee's MOV program to be addressed over the long term. In its letter dated April 2, 1999, the licensee reported on the status of those long-term GL 89-10 items. For example, the licensee has modified a controlling procedure to correct globe valve thrust equation inconsistencies. Regarding the use of the EPRI MOV Performance Prediction Methodology (PPM) for gate valves larger than 18 inches in diameter, the licensee plans to continue its efforts to monitor information from other plants and the industry with respect to gate valve size, and to evaluate the information for impact on MOV calculations as part of its periodic verification program. The licensee is evaluating various options to improve the capability of the feedwater isolation valves and will perform an internal inspection on the next feedwater isolation

valve that requires internal valve work. Also in GL 89-10, the NRC staff identified pressure locking and thermal binding as potential performance concerns for safety-related MOVs. The NRC staff completed its review of the licensee's actions in response to GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," in an SE dated January 8, 1999.

In IRs 97-02 and 98-09, the NRC staff discussed qualitative and quantitative aspects of the licensee's program for trending MOV performance at Calvert Cliffs. For example, the licensee monitors test data such as actuator thrust/torque output and stem friction coefficient. In IR 97-02, the NRC staff reported that licensee's MOV trending program met the intent of GL 89-10 and its supplements. In its letter dated April 2, 1999, the licensee stated that it will continue to obtain and trend static test data for GL 96-05 MOV including the acquisition of as-found test data when practical.

With the licensee's ongoing MOV activities and trending program, no outstanding issues regarding the licensee's GL 89-10 program remain at Calvert Cliffs.

5.4 JOG Program on MOV Periodic Verification

In its letter dated June 30, 1998, the licensee updated its commitment to implement the JOG Program on MOV Periodic Verification as described in Topical Report MPR-1807 (Revision 2). In an SE dated October 30, 1997, the NRC staff accepted the JOG program as an industry-wide response to GL 96-05 with certain conditions and limitations. The JOG program consists of the following three phases: (1) the JOG interim static diagnostic test program; (2) the JOG 5-year dynamic test program; and (3) the JOG long-term periodic test program. The staff considers the licensee's commitment in response to GL 96-05 to include implementation of all three phases of the JOG program at Calvert Cliffs. The conditions and limitations discussed in the NRC SE dated October 30, 1997, apply to the JOG program at Calvert Cliffs. The staff considers the commitments by the licensee to implement all three phases of the JOG program at Calvert Cliffs to be an acceptable response to GL 96-05 for valve age-related degradation.

In its letter dated April 2, 1999, the licensee described its current MOV risk-ranking approach which applies both qualitative and quantitative considerations. The licensee plans to revise its current MOV risk ranking through application of the methodology presented in WOG Engineering Report V-EC-1658 (Revision 2) following upgrading of the Probabilistic Risk Assessment (PRA) at Calvert Cliffs in 2000. The licensee is working with the CEOG to obtain a sample matrix of high-risk MOVs from other Combustion Engineering plants and plans to compare its MOV risk ranking to the CEOG sample matrix. In the interim, an expert panel reviewed the current MOV risk ranking at Calvert Cliffs to achieve a near-term upgrade. Until the PRA update is complete, the licensee has established the maximum test interval in its interim MOV static diagnostic test program as three refueling outages. As the licensee is implementing the WOG methodology for MOV risk ranking, the conditions and limitations discussed in the NRC SE dated April 14, 1998, on the WOG MOV risk-ranking methodology apply to the JOG program at Calvert Cliffs with consideration of differences in plant design. The NRC staff considers the licensee's approach to risk ranking MOVs at Calvert Cliffs to be acceptable.

In its letter dated June 30, 1998, the licensee noted that it took exception to one aspect of the JOG periodic verification program as described by Topical Report MPR-1807 (Revision 2). The licensee reported that the third and final dynamic tests on two MOVs will not be completed until the refueling outage in 2003. In its letter dated April 2, 1999, the licensee indicated that sharing of JOG dynamic test results would reveal any degradation mechanisms associated with the type of valves installed at Calvet Cliffs and that completion of testing in 2003 is not expected to adversely affect the long-term MOV program at Calvert Cliffs. The NRC staff considers this clarification of the licensee's commitment to the JOG periodic verification program to be acceptable.

In its letters dated March 13, 1997, and April 2, 1999, the licensee stated that it is evaluating the use of data obtained from the motor control center (MCC) rather than at the valve for selected GL 96-05 MOVs. As part of its consideration of the use of MCC data, the licensee intends to address: (1) the correlation between new MCC test data and existing direct MOV data measurements; (2) the relationship between changes in MCC test data and MOV thrust and torque performance; (3) system accuracies and sensitivities to MOV degradation for both outputs and operating performance requirements; and (4) validation of MOV operability using MCC testing. The licensee indicated that the MOV Users Group is in the process of developing a document that will provide guidance on the requirements of an MCC-based periodic test program.

The JOG program is intended to address most gate, globe and butterfly valves used in safety-related applications in the nuclear power plants of participating licensees. The JOG indicates that each licensee is responsible for addressing any MOVs outside the scope of applicability of the JOG program. The NRC staff recognizes that the JOG has selected a broad range of MOVs and conditions for the dynamic testing program, and that significant information will be obtained on the performance and potential degradation of safety-related MOVs during the interim static diagnostic test program and the JOG dynamic test program. As the test results are evaluated, the JOG might include or exclude additional MOVs with respect to the scope of its program. Although the test information from the MOVs in the JOG dynamic test program might not be adequate to establish a long-term periodic verification program for each MOV outside the scope of the JOG program, sufficient information should be obtained from the JOG dynamic test program to identify any immediate safety concern for potential valve age-related degradation during the interim period of the JOG program. Therefore, the NRC staff considers it acceptable for the licensee to apply its interim static diagnostic test program to GL 96-05 MOVs that currently might be outside the scope of the JOG program with the feedback of information from the JOG dynamic test program to those MOVs. In the NRC SE dated October 30, 1997, the NRC staff specifies that licensees implementing the JOG program must determine any MOVs outside the scope of the JOG program (including service conditions) and justify a separate program for periodic verification of the design-basis capability (including static and dynamic operating requirements) of those MOVs.

5.5 Motor Actuator Output

The JOG program focuses on the potential age-related increase in the thrust or torque required to operate valves under their design-basis conditions. In the NRC SE dated October 30, 1997, on the JOG program, the NRC staff specifies that licensees are responsible for addressing the thrust or torque delivered by the MOV motor actuator and its potential degradation. Although the JOG does not plan to evaluate degradation of motor actuator output, significant information

on the output of motor actuators will be obtained through the interim MOV static diagnostic test program and the JOG dynamic test program. Several parameters obtained during MOV static and dynamic diagnostic testing help identify motor actuator output degradation when opening and closing the valve including, as applicable, capability margin, thrust and torque at control switch trip, stem friction coefficient, load sensitive behavior, and motor current.

In IRs 97-02 and 98-09, the NRC staff reported that the licensee's MOV trending program appeared to be capable of adequately tracking and evaluating data to maintain MOV design-basis capability. In its letter dated April 2, 1999, the licensee indicated that it will continue to trend static test data to detect decreases in actuator output to ensure adequate actuator output capability for safety-related MOVs at Calvert Cliffs. The licensee plans to obtain as-found data when practical. The licensee will also trend dynamic test results obtained through its JOG program. The licensee plans to evaluate any indication of degradation as part of its trending program to address actuator and motor-related degradation.

In Technical Update 98-01 and its Supplement 1, Limitorque Corporation provided updated guidance for predicting the torque output of its ac-powered motor actuators. In IR 98-09, the NRC staff reported that licensee adequately addressed the new industry guidance on Limitorque motor actuator output capability, using pullout efficiency in its MOV sizing and switch setting calculations and a 0.9 application factor in design calculations. In its letter dated April 2, 1999, the licensee confirmed this review was complete. Any MOV operability concerns that might be identified in the future will be processed in accordance with established regulatory requirements and plant-specific commitments. On November 30, 1999, the licensee clarified to the NRC staff that there are not any dc-powered MOVs in the GL 96-05 program at Calvert Cliffs.

The NRC staff considers the licensee to be establishing sufficient means to monitor MOV motor actuator output and its potential degradation.

6.0 CONCLUSION

The NRC staff finds that the licensee has established an acceptable program to verify periodically the design-basis capability of the safety-related MOVs at Calvert Cliffs through its commitment to all three phases of the JOG Program on MOV Periodic Verification and the additional actions described in its submittals. Therefore, the staff concludes that the licensee is adequately addressing the actions requested in GL 96-05. The staff may conduct inspections at Calvert Cliffs to verify the implementation of the MOV periodic verification program is in accordance with the licensee's commitments; this NRC SE; the NRC SE dated October 30, 1997, on the JOG Program on MOV Periodic Verification; and (as applied by the licensee for this Combustion Engineering-design plant) the NRC SE dated April 14, 1998, on the WOG methodology for ranking MOVs by their safety significance.

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