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"

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

HOPE CREEK GENERATING STATION

DOCKET NO. 50-354

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 Public Service Electric and Gas Company (the licensee) to periodically verify the design-basis capability of safety-related MOVs at the Hope Creek Generating Station (HCGS).

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 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

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for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR 50. In Section 50.55a of 10 CFR 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, the NRC staff issued Generic Letter (GL) 89-10 dated 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 to establish a program, or to 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 BWROG in its Licensing Topical Report NEDC-32719, "BWR Owners' Group Program on Motor-Operated Valve (MOV) Periodic Verification," and described by WOG and 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," 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's 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, 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 who do not apply 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, 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, BWROG submitted Licensing Topical Report NEDC-32719 (Revision 2) describing the JOG program on July 30, 1997. Similarly, CEOG and 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 HCGS GL 96-05 PROGRAM

On November 18, 1996, the licensee submitted a 60-day response to GL 96-05 notifying the NRC that it would implement the requested MOV periodic verification program at HCGS. 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 HCGS. In a letter dated June 4, 1998, the licensee updated its commitment to GL 96-05. On May 27, 1999, the licensee provided a response to a request for additional information regarding GL 96-05 forwarded by the NRC staff on March 1, 1999. In a telephone conference with the NRC staff on July 29, 1999, the licensee clarified several aspects of its GL 96-05 program.

In its letter dated March 13, 1997, the licensee described its MOV periodic verification program, including scope, testing, trending, and implementation of the JOG program at HCGS. The licensee indicated that: (1) the scheduling of static diagnostic tests would be based upon MOV risk significance and margin in accordance with the criteria described in the JOG topical report, operating history, and environment; (2) dynamic diagnostic testing of selected MOVs would be performed under its MOV periodic verification program; and (3) adjustments would be made to its GL 96-05 program based on the test results and recommendations from the JOG testing program. In its letter dated June 4, 1998, the licensee committed to implement the JOG Program on MOV Periodic Verification as described in the Topical Report NEDC-32719 (Revision 2). During the telephone conference on July 29, 1999, with the NRC staff, the

licensee clarified that it had initiated the dynamic diagnostic test portion of the JOG program at HCGS during the fall 1997 refueling outage.

5.0 NRC STAFF EVALUATION

The NRC staff has reviewed the information provided in the licensee's submittals describing the program to periodically verify the design-basis capability of safety-related MOVs at HCGS in response to GL 96-05. NRC Inspection Report 50-354/96-04 (IR 96-04) 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 HCGS in IR 96-04 based on verification of the design-basis capability of safety-related MOVs at HCGS. 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 IR 96-04, the NRC staff reviewed the scope of the licensee's MOV program in response to GL 89-10 at HCGS and found that the scope was consistent with GL 89-10 and its supplements. In its letter dated November 18, 1996, the licensee committed to implement the requested MOV periodic verification program at HCGS 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 stated that the interim MOV Periodic Verification Program would be applied to each valve within the scope of GL 89-10. 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 IR 96-04, 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 HCGS. The staff determined that the licensee had adequately justified the assumptions and methodologies used in its MOV program with certain long-term aspects discussed in the following section. The licensee's letter dated May 27, 1999, indicated ongoing activities, such as review of motor actuator output, to update its MOV program assumptions and methodologies. The 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 HCGS, the NRC staff discussed in IR 96-04 several items of the licensee's MOV program to be addressed over the long term. In its letter dated May 27, 1999, the licensee reported on the status of those long-term GL 89-10 aspects. For example, the licensee modified the output capability of MOVs 1FDHV-F002, 1FDHV-F003, and 1ABHV-F016 to increase their available margins. Operating conditions for MOVs 1BCHV-F004A/B and 1BEHV-F005A/B were re-evaluated and it was determined that the margins were acceptable based on revised design-basis pressures. MOV 1FDHV-F001 was dynamically tested to verify valve performance and its ability to meet design-basis assumptions. The licensee planned to revise its butterfly valve program by July 31, 1999, to require the use of the Electric Power Research Institute MOV Performance Prediction Methodology in those cases where torque requirements are not clear or verified.

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 the 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 May 14, 1999.

In IR 96-04, the NRC staff discussed qualitative and quantitative aspects of the licensee's program for trending MOV performance at HCGS. For example, the licensee was reviewing MOV maintenance work histories and diagnostic test results to evaluate MOV performance. In its letter dated March 13, 1997, the licensee stated that static and dynamic diagnostic test results would be monitored and trended. In its submittal dated May 27, 1999, the licensee provided information on its trending of performance parameters to evaluate motor actuator capabilities. Motor current, actuator torque, and valve thrust are examples of MOV parameters that are currently trended. The licensee stated that it planned to revise its MOV tracking and trending program to include the evaluation of stem coefficient of friction and MOV failures or corrective action.

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

5.4 JOG Program on MOV Periodic Verification

In its letter dated June 4, 1998, the licensee updated its commitment to implement the JOG Program on MOV Periodic Verification as described in Topical Report NEDC-32719 (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 includes: (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 HCGS. The conditions and limitations discussed in the NRC's SE dated October 30, 1997, apply to the JOG Program at HCGS. The staff considers the commitments by the licensee to implement all three phases of the JOG program at HCGS to be an acceptable response to GL 96-05 for valve age-related degradation.

In its letter dated March 13, 1997, the licensee noted that the interim MOV static diagnostic testing under the JOG program would be performed on a test frequency based on the risk significance and capability margin of each GL 96-05 MOV, and testing will be scheduled in accordance with the JOG program criteria. In its letter dated May 27, 1999, the licensee indicated that the program to establish MOV risk-ranking at HCGS would be revised by July 31, 1999, to implement the risk-ranking approach presented in the BWROG Topical Report NEDC-32264 (Revision 2), and to address the concerns identified in the NRC's SE dated February 27, 1996. In its report, the BWROG also provided an example list of risk-significant MOVs for consideration by each licensee in applying the owners group methodology. Based on the licensee's summary, the staff considers the licensee's plans for risk ranking MOVs at HCGS to be acceptable.

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 feedback of information from the JOG dynamic test program to those MOVs. In the NRC's SE dated October 30, 1997, the NRC staff specified 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 these 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's 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 can be obtained during MOV static and dynamic testing to 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 its letter dated May 27, 1999, the licensee stated that as an ongoing effort to maintain adequate actuation capability, it is implementing a static MOV test program and trending valve performance. In particular, the licensee indicated that it is trending actuator torque, motor current, and valve thrust to monitor actuator degradation. The licensee also plans to revise its procedures to specify that the stem coefficient of friction be monitored. 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 its letter dated May 27, 1999, the licensee reported that it had evaluated its ac-powered MOVs using the updated guidance, and that no immediate MOV operability concerns were identified. During the telephone conversation on July 29, 1999, the licensee clarified that the number of low margin MOVs increased as a result of the review and that long-term plans were being developed to increase margins and provide additional testing as necessary. Any MOV operability concerns that might be identified in the future will be processed in accordance with established regulatory requirements and plant-specific commitments.

In its letter dated July 17, 1998, forwarding Technical Update 98-01, Limitorque indicates that a future technical update will be issued to address the application of dc-powered MOVs. In its letter dated May 27, 1999, the licensee notes that BWROG has initiated an effort to evaluate dc-powered motor capability and that HCGS will review the BWROG dc-powered MOV methodology when completed and take the appropriate actions. During the July 29, 1999, telephone conversation, the licensee indicated that, as preliminary action, MOV output had been recalculated using pullout efficiency and a 0.9 application factor for the 24 dc-powered MOVs in its GL 96-05 program.

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 staff finds that the licensee has established an acceptable program to periodically verify the design-basis capability of the safety-related MOVs at HCGS 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 has adequately addressed the actions requested in GL 96-05. The staff may conduct inspections to verify the implementation of the MOV periodic verification program is in accordance with the licensee's commitments; this NRC SE; the NRC's SE dated October 30, 1997, on the JOG Program on MOV Periodic Verification; and the NRC's SE dated February 27, 1996, on the BWROG methodology for ranking MOVs by their safety significance.

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Date: December 7, 1999

This completes the NRC staff's efforts on TAC No. M97056. If you have any questions regarding this matter, please contact me at (301) 415-1420.

Sincerely,

ORIGINAL SIGNED BY:

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Docket No. 50-354

Enclosure: Safety Evaluation

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