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"

PILGRIM NUCLEAR POWER STATION

DOCKET NO. 50-293

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 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 Boston Edison Company (BECo) to periodically verify the design-basis capability of safety-related MOVs at the Pilgrim Nuclear Power Station (Pilgrim). Entergy Nuclear Generation Company (Entergy) completed its purchase of Pilgrim on July 13, 1999. By letter dated August 2, 1999, Entergy, the new licensee for Pilgrim, stated that they have adopted all outstanding commitments previously made by BECo for Pilgrim.

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 Part 50. In 10 CFR 50.55a, 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 on June 28, 1989, the NRC staff issued Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." This GL requested that nuclear power plant licensees and construction permit holders ensure the capability of MOVs in safety-related systems to perform their intended functions. This could be achieved 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 its issuance. 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 ensure 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." This GL requested each licensee to 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 GL 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 was later), a written summary description of the licensee's MOV periodic verification program.

The NRC staff is preparing an SE for each licensee's response 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 that are not applying 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 test 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, on July 30, 1997, the BWROG submitted Licensing Topical Report NEDC-32719 (Revision 2) describing the JOG program. 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 a 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 PILGRIM GL 96-05 PROGRAM

On November 15, 1996, the licensee submitted a 60-day response to GL 96-05 notifying the NRC that, as requested in the GL, it would establish a program at Pilgrim to periodically verify that safety-related MOVs continue to be capable of performing their safety functions within the current licensing bases of the facility. On June 18, 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 Pilgrim. In a submittal dated December 23, 1997, the licensee provided supplementary information regarding the schedule for implementing its GL 96-05 program. In a submittal dated June 26, 1998, the licensee updated its commitment to GL 96-05 with respect to the JOG Program on MOV Periodic Verification. On November 25, 1998, the licensee provided a response to a request for additional information regarding GL 96-05 forwarded by the NRC staff on September 14, 1998.

In its letter dated June 26, 1998, the licensee stated that it plans to continue participating in the JOG Program on MOV Periodic Verification as a member of the BWROG and plans to implement the program described in Topical Report NEDC-32719 (Revision 2). In its submittal dated June 18, 1997, the licensee described the implementation of the JOG program at Pilgrim, including GL 96-05 program scope, MOV risk ranking and margin, static and dynamic periodic testing, and evaluation of test results. By letter dated November 25, 1998, the licensee described its risk ranking of MOVs based on probabilistic and deterministic considerations. In a telephone conference on February 25, 1999, with the NRC staff, the licensee provided the current status of its GL 96-05 program and indicated that the program is currently being implemented at Pilgrim.

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 Pilgrim in response to GL 96-05. The staff also reviewed NRC Inspection Report (IR) 50-293/97-13 which provided the results of an inspection to evaluate the completion of the licensee's program to verify the design-basis capability of safety-related MOVs in response to GL 89-10. Based on IR 97-13 and a letter from the licensee dated December 11, 1997, the NRC staff closed the review of the GL 89-10 program to verify the design-basis capability of safety-related MOVs at Pilgrim. The NRC 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 NRC staff noted that the program should also 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 97-13, the NRC staff closed its review of the GL 89-10 program at Pilgrim and did not identify concerns with the scope of the licensee's MOV program. In its letter dated June 18, 1997, the licensee stated that the scope of its MOV periodic verification program was based on its GL 89-10 scope and that its GL 96-05 program included 85 safety-related MOVs. The licensee also noted that safety-related MOVs without an active safety-related opening or closing function were not included in its periodic verification program. The licensee did not take exception to the provision in GL 96-05 regarding assurance that MOVs are capable of returning to their safety position, or declaring the system (or train) inoperable if the safety system (or train) is prevented from performing its safety function when those MOVs are placed in a nonsafety position.

The NRC staff concludes that the licensee has made adequate commitments regarding the scope of its MOV program under GL 96-05.

5.2 MOV Assumptions and Methodologies

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

In IR 97-13, 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 Pilgrim. 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. In its letter dated November 25, 1998, the licensee discussed ongoing activities, such as revising MOV design calculations, monitoring stem friction coefficient, and reviewing motor actuator output, to update its MOV program assumptions and methodologies. The NRC staff concludes

that the licensee has 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 closing the review of the GL 89-10 program at Pilgrim, the NRC staff discussed in IR 97-13 several aspects of the licensee's MOV program to be addressed over the long term. By letters dated December 11, 1997, and June 26, 1998, the licensee provided additional information on its use of the Electric Power Research Institute (EPRI) MOV Performance Prediction Methodology (PPM). By letter dated November 25, 1998, the licensee described its actions to address the GL 89-10 long-term items. For example, the licensee had (1) performed evaluations of the operating requirements for many MOVs using the EPRI MOV PPM, (2) evaluated the predictability of the performance of specific MOVs under high flow conditions, (3) verified its assumptions for stem friction coefficient and rate of loading, (4) reevaluated the capability of two butterfly valves not dynamically tested, and (5) continued its updating of MOV design calculations. During the telephone conference on February 25, 1999, the licensee provided the current status of these activities, including completion of the EPRI MOV PPM calculations and the review of torque requirements for Pratt butterfly valves. Also in GL 89-10, the NRC staff identified pressure locking and thermal binding as potential performance concerns for safety-related MOVs.

As noted in IR 97-13, the NRC staff is addressing the licensee's actions in response to GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," separately.

In IR 97-13, the NRC staff reviewed the licensee's program for tracking and trending MOV performance to maintain MOV design-basis capability. The staff noted that MOV items tracked at Pilgrim were consistent with the list provided in GL 89-10. Further, in its letter dated November 25, 1998, the licensee stated that it was trending stem friction coefficient and rate of loading effects. As noted in IR 97-13, the licensee prepares status reports every 2 years for qualitative and quantitative trending of such MOV performance information as maintenance, diagnostic test results, and corrective actions.

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

5.4 JOG Program on MOV Periodic Verification

By letter dated June 26, 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 Pilgrim. The conditions and limitations discussed in the NRC's SE dated October 30, 1997, apply to the JOG program at Pilgrim. The staff considers the commitments by the licensee to implement all three phases of the JOG program at Pilgrim to be an acceptable response to GL 96-05 for valve age-related degradation.

In its submittal dated June 18, 1997, the licensee stated that its interim MOV static diagnostic test program would be consistent with the interim program criteria in the JOG MOV periodic verification program. Guidance for the calculation of MOV margin is provided in the JOG Topical Report NEDC-32719 and the NRC's SE dated October 30, 1997. By letter dated June 18, 1997, the licensee indicated that it had ranked each MOV in its GL 96-05 program into a high-, medium-, or low-safety significance category. By letter dated November 25, 1998, the licensee reported that MOVs had been ranked by an expert panel. The topics considered when establishing the MOV risk category included probabilistic versus deterministic risk assessment, probability, functional redundancy, safety function, and MOV program guidance. The specific items considered by the expert panel included relative value of each safety function, system analytical margins, knowledge of Emergency Operating Procedures and operator training, feasibility of operator action, and MOV environment (internal and external). The NRC staff considers the licensee's risk ranking of MOVs at Pilgrim to be acceptable because the licensee's risk ranking approach is reasonable in comparison to the generic BWROG MOV risk ranking methodology described in Topical Report NEDC-32264 and the NRC's SE dated February 27, 1996.

During the telephone conference on February 25, 1999, the licensee discussed the current status of its MOV risk ranking process that identified 23 high-risk MOVs, 33 medium-risk MOVs, and 29 low-risk MOVs. The high risk MOVs were said to include, for example, high pressure coolant injection (HPCI) isolation valves, reactor core isolation cooling (RCIC) isolation valves, low pressure coolant injection (LPCI) valves, and service water system valves.

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 might be found to be outside the scope of the JOG program with the feedback of information during the JOG dynamic test program. In the NRC's 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 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. Further, plant-specific and JOG test information can provide support for the licensee's plan for monitoring MOV motor actuator output and its potential degradation.

In its submittal dated November 25, 1998, the licensee stated that, in addressing the potential degradation of MOV actuator delivered thrust or torque, it would continue to: (1) perform periodic static diagnostic testing to confirm MOV capability and proper control switch settings consistent with previous commitments; (2) perform appropriate preventative maintenance activities, such as stem lubrication, actuator gearcase grease inspection, and actuator refurbishment, to provide reasonable confidence of proper actuator performance; and (3) apply appropriate margins to account for actuator degradations such as stem lubricant degradation, spring pack relaxation, and rate of loading effects. The licensee is also trending stem coefficient of friction and rate of loading effects to help monitor MOV motor actuator output degradation. The licensee is working with various industry organizations to maintain awareness of the latest information concerning MOV performance.

In IR 97-13, the NRC staff reported that the licensee was responding to issues identified in NRC Information Notice (IN) 96-48, "Motor-Operated Valve Performance Issues," including the output of ac-powered Limitorque motor actuators. In its submittal dated November 25, 1998, the licensee stated that its ac-powered MOV output calculation method included the use of actuator pullout efficiencies in both stroke directions, a 0.9 application factor, and an exponent of 2.2 to calculate degraded voltage factors. The licensee's MOV output calculation method encompasses the guidance in Limitorque Technical Update 98-01 and its Supplement 1. The licensee noted that it had applied an alternative method described in Limitorque Technical Update 98-01 for one MOV at Pilgrim. Any MOV operability concerns that might be identified in the future will be processed in accordance with established regulatory requirements and plant-specific commitments.

By 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. During the telephone conference on February 25, 1999, the licensee indicated that it is aware of the dc-powered MOV issue and that it is participating in a BWROG activity to address the new industry information on dc-powered motor actuator output. The licensee discussed the status of its evaluation of dc-powered MOV output including the use of actuator pullout efficiency, a 0.9 application factor, and rated motor torque.

The NRC staff concludes that the licensee is 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 periodically verify the design-basis capability of the safety-related MOVs at Pilgrim 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 NRC staff may conduct inspections at Pilgrim to verify that implementation of the MOV periodic verification program is in accordance with the licensee's commitments, this NRC SE, and the NRC's SE dated October 30, 1997, on the JOG Program on MOV Periodic Verification.

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