



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO GENERIC LETTER 96-05,

"PERIODIC VERIFICATION OF DESIGN-BASIS

CAPABILITY OF SAFETY-RELATED MOTOR-OPERATED VALVES"

COMMONWEALTH EDISON COMPANY

BRAIDWOOD STATION, UNITS 1 AND 2

DOCKET NOS. STN 50-456 AND STN 50-457

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 Commonwealth Edison Company (ComEd, the licensee) to verify periodically the design-basis capability of safety-related MOVs at Braidwood Station, Units 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

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important to safety related 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 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 (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, 1993, 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 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 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 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, 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 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 BRAIDWOOD GL 96-05 PROGRAM

On November 13, 1996, ComEd submitted a 60-day response to GL 96-05 notifying NRC that it would implement the requested MOV periodic verification program. On March 15, 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 Braidwood. In a letter dated August 24, 1998, the licensee updated its commitment to GL 96-05. On April 12, 1999, the licensee provided a response to a request for additional information regarding GL 96-05 forwarded by the NRC staff on February 4, 1999.

In its submittal dated March 15, 1997, the licensee described its MOV periodic verification program, including scope, existing and planned testing, capability margin, and implementation of the JOG program at Braidwood. For example, the licensee will use the methodology described in ASME Code Case OMN-1 for periodic verification of MOV design-basis capability. The licensee also stated that dynamic testing of selected MOVs would be performed under its MOV periodic verification program. During a telephone call conducted on June 30, 1999, the licensee clarified a commitment regarding its applicable owners' group made in its submittal dated August 24, 1998. In particular, the licensee stated that it will continue to participate in the

JOG program on MOV Periodic Verification as a member of WOG, and implement the program elements in the Topical Report MPR-1807 (Revision 2) describing the JOG program. The August 24, 1998, submittal also stated that the licensee would evaluate degradation for any safety-related MOVs not covered by the JOG program within the same time frame as the JOG program.

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 Braidwood in response to GL 96-05. NRC Inspection Report 50-456 & 457/96009 (IR 96009) provided the results of an inspection 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 in IR 96009 based on verification of the design-basis capability of safety-related MOVs at Braidwood. 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 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 non-safety position.

In IR 96009, the NRC staff reviewed the scope of the licensee's MOV program in response to GL 89-10 at Braidwood and found that the licensee removed a number of essential service water MOVs from GL 89-10 program scope because they were not required to change position during a design basis accident. The scope change was consistent with GL 89-10 and its supplements.

In its letter dated November 13, 1996, the licensee committed to implement the requested MOV periodic verification program at Braidwood in response to GL 96-05 and did not take exception to the scope of the generic letter. The staff considers the licensee to have made adequate commitments regarding the scope of its MOV program. The licensee will be responsible for justifying any deviations from the recommended scope of GL 96-05 at Braidwood.

5.2 MOV Assumptions and Methodologies

The NRC staff expects licensees to maintain the assumptions and methodologies used in the development of its 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 will need to be maintained up-to-date, including consideration of any plant modifications or power uprate conditions.

In IR 96009, the NRC staff reviewed the licensee's justification for the assumptions and methodologies used in the MOV program in response to GL 89-10. 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.

In its letter dated August 24, 1998, the licensee described activities to support the basis for several MOV program assumptions. The licensee stated that, in some instances, MOV stems are lubricated between periodic verification tests which prevents the gathering of as-found test data for evaluating stem factor degradation. However, the licensee uses results from other as-left and as-found periodic verification tests to determine stem factor degradation for valves where as-found conditions were not obtained. Further, the licensee stated that, if the valve factor for a newly installed or overhauled MOV exceeds the grouping valve factor, a differential pressure test for the applicable MOV will be accomplished within three refueling outages of the baseline differential pressure test regardless of apparent margin. The licensee's letter dated April 12, 1999, discussed ongoing activities, such as review of motor actuator output, to update 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 Braidwood, the NRC staff discussed in IR 96009 several items of the licensee's MOV program to be addressed over the long term. In its letter dated April 12, 1999, the licensee reported on the status of those long-term GL 89-10 items. For example, the licensee (1) revised test procedures to properly account for variation in torque switch repeatability, (2) completed planned diagnostic tests of butterfly MOVs, and (3) reviewed the thrust requirements for MOVs considered to have outlier performance. The licensee also stated that it is updating its probability risk assessment (PRA) evaluations and plans to review all MOV safety rankings once the new PRA evaluations are completed. During a telephone call conducted on June 30, 1999, the licensee clarified to the NRC staff its plan to revise procedures to include reasonably bounding valve factors for non-dynamically tested MOVs in rising-stem valve margin calculations.

The NRC staff is reviewing licensee's actions in response to GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," and will issue an SE at the completion of the review.

In IR 96009, the NRC staff summarized its review of the qualitative and quantitative aspects of the licensee's program for trending MOV performance at Braidwood. For example, the licensee maintains various databases that contain MOV failures, diagnostic test results, and MOV problems. The licensee periodically evaluates available information to prevent repetition of MOV failures. In its letter dated April 12, 1999, the licensee described a six-element program that was established to trend MOV motor actuator output. Rate of loading variation, springpack relaxation, and motor current are examples of MOV parameters that are monitored.

In IR 96009, the NRC staff concluded that the licensee had demonstrated the design-basis capability of its safety-related MOVs at Braidwood. With the licensee's ongoing MOV activities and trending program, no outstanding issues regarding the licensee's GL 89-10 program remain at Braidwood.

5.4 JOG Program on MOV Periodic Verification

In its letter dated August 24, 1998, the licensee updated its commitment to implement the JOG program on MOV periodic verification. The licensee's commitment to implement 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 NRC staff considers the licensee's commitment to include all three phases of the JOG program and that the licensee is responsible for reviewing and implementing the limitations and conditions discussed in the NRC's SE dated October 30, 1997, in applying the JOG program. This includes coordinating and feeding back test information obtained from the JOG dynamic testing program. The staff considers the commitments by the licensee to implement the JOG program at Braidwood to be an acceptable response to GL 96-05 for valve age-related degradation. If the licensee proposes to implement an approach at Braidwood different from the JOG program, the licensee will be expected to notify the NRC and to provide justification for the proposed alternative approach.

In its letter dated March 15, 1997, the licensee noted that interim MOV static diagnostic testing under the JOG program would be performed on a test frequency based on the safety significance and available margin of each GL 96-05 MOV. In its letter dated August 24, 1998, the licensee indicated that margin requirements and static diagnostic test frequencies were consistent with the JOG recommendations. As noted above, the licensee indicated in its letter dated April 12, 1999, that the Braidwood PRA evaluation is being updated. The licensee plans to review the MOV risk rankings based on the methods presented in the WOG Engineering Report V-EC-1658 when the update is complete. The licensee is expected to address the conditions and limitations in the NRC SE dated April 14, 1998, which accepted Engineering Report V-EC-1658, when implementing the WOG MOV risk-ranking methodology.

The licensee's program at Braidwood to verify periodically the design-basis capability of safety-related MOVs will implement the provisions of ASME Code Case OMN-1 with certain clarifications described in the licensee's March 15, 1997, letter in response to GL 96-05. The licensee will use the OMN-1 methodology to satisfy GL 96-05, with clarifications such as (1) testing is scheduled according to the intervals specified in the JOG MOV program, (2) motor actuator torque capability of ac-powered MOVs is based on the Commonwealth Edison method previously accepted by the NRC staff, (3) the margin between MOV capability and operating requirements is based on stem thrust, (4) stem factor may be determined from stem thrust and measured torque or tested spring pack displacement, and (5) stem lubrication may be performed in some instances between verification tests. In addition to OMN-1, the licensee will continue to perform stroke-time tests of MOVs in accordance with its IST program. As discussed in GL 96-05, the NRC staff considers it acceptable to apply ASME Code Case OMN-1 in verifying periodically the design-basis capability of safety-related MOVs. The licensee's MOV program satisfies the limitations regarding the use of ASME Code Case OMN-1 in meeting the intent of GL 96-05, such as evaluating data over the first 5 years to support long

test intervals. Based on the review of the licensee's GL 96-05 submittals, the staff considers the identified clarifications to OMN-1 to be justified.

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. JOG indicates that each licensee is responsible for addressing any MOVs outside the scope of applicability of the JOG program. 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 of those MOVs. The NRC staff recognizes that JOG has selected a broad range of MOVs and conditions for the dynamic testing program. Consequently, the NRC staff expects significant information to 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, 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. In its submittal dated August 24, 1998, the licensee stated that it would evaluate valve degradation for any safety-related MOVs at Braidwood not covered by the JOG program within the same time frame as the JOG program. 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. Upon completion of the JOG dynamic test program and development of the JOG long-term MOV periodic verification criteria, the licensee will be expected to establish a long-term MOV periodic verification program for those MOVs outside the scope of the JOG program by applying information from the JOG program or additional dynamic tests, as necessary.

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 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.

In its letter dated April 12, 1999, the licensee indicated that it uses a combination of periodic static testing, preventative maintenance, and data analysis in accordance with established site procedures and programs to assure adequate actuator output capability for safety-related MOVs at Braidwood to perform their design-basis functions. For example, the licensee performs preventative maintenance and inspections to minimize the degradation of MOV actuator output. The licensee's MOV periodic verification program includes evaluation of as-found and as-left static baseline test results to monitor stem lubricant degradation. The

licensee's setup method include margins for variations in stem factor, load sensitive behavior, and gearbox efficiency. The NRC staff notes that 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 Technical Update 98-01 and its Supplement 1, Limitorque Corporation provided updated guidance for predicting the torque output of its ac-powered motor actuators. As discussed in its letter dated April 12, 1999, the licensee uses its own method for determining motor gearing capability for ac-powered motor actuators that is based on a comprehensive motor and actuator test program. As noted in NRC inspection reports, the NRC staff has accepted the use of the ComEd methodology for estimating MOV motor-actuator output capability, based on test data obtained by the licensee. ComEd will be expected to assess any changes in its methodology that might be necessary as a result of the Limitorque updated guidance.

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 April 12, 1999, the licensee notes that the future Limitorque technical update on dc-powered MOVs would not be applicable because there are no safety-related dc-powered MOVs at Braidwood.

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

6.0 CONCLUSION

On the basis of this evaluation, the staff finds that the licensee has established an acceptable program to verify periodically the design-basis capability of the safety-related MOVs at Braidwood. 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 SE dated October 30, 1997, on the JOG program on MOV periodic verification; and the NRC SE dated April 14, 1998, on WOG methodology for ranking MOVs by their safety significance.

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