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

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" BROWNS FERRY NUCLEAR PLANT, UNITS 2 AND 3 DOCKET NUMBERS 50-260 AND 50-296

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 Tennessee Valley Authority (licensee) to verify, periodically, the design-basis capability of safety-related MOVs at the Browns Ferry Nuclear Plant, Units 2 and 3.

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 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 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 the 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 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 BROWNS FERRY GL 96-05 PROGRAM

On November 18, 1996, Tennessee Valley Authority submitted a 60-day response to GL 96-05 notifying the NRC that it would implement the requested MOV periodic verification program. On March 17, 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 Browns Ferry, Units 2 and 3. In a letter dated April 28, 1998, the licensee updated its commitment to GL 96-05. On March 30, 1999, the licensee provided a response to a request for additional information regarding GL 96-05 issued by the NRC staff on January 12, 1999.

In its letters dated March 17, 1997, and April 28, 1998, the licensee committed to participate in the JOG MOV Periodic Verification Program as a member of BWROG and to implement the program elements described in the Topical Report NEDC 32719 (Revision 2) describing the JOG program. The licensee also addressed the specific conditions and limitations identified in the NRC SE dated October 30, 1997, accepting the JOG program and described its MOV periodic verification program, including scope, existing and planned testing, and implementation of the JOG program at Browns Ferry. The licensee stated that (1) the interim MOV static diagnostic test program at Browns Ferry would apply the same MOV risk and margin categories as recommended in the JOG topical report; (2) dynamic testing of selected MOVs would be performed under its MOV periodic verification program; (3) adjustments would be made to its GL 96-05 program based on the test results and recommendations from the JOG testing program; and (4) the JOG program would begin implementation at Browns Ferry by late 1997 in Unit 2 and late 1998 in Unit 3. As part of its commitment, the licensee stated in its letter dated April 28, 1998, that deviations identified during the implementation of the JOG program would be justified (discussed below).

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 Browns Ferry in response to GL 96-05. NRC Inspection Reports (IRs) 50-260, 296/97-11, 98-03, and 98-05 (IRs 97-11, 98-03, and 98-05) 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 Browns Ferry as discussed in IR 98-05 based on verification of the design-basis capability of safety-related MOVs at Browns Ferry and the licensee's actions to resolve outstanding MOV issues as described in its letter dated July 16, 1998. 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 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 non-safety position.

In IR 97-11, the NRC staff reported the results of the licensee's re-evaluation of a number of MOVs that were removed from the Browns Ferry's GL 89-10 MOV program scope. In a letter dated January 6, 1997, the licensee stated that the MOVs would be added back into the GL 89-10 program scope except in the instances when the system/train is declared inoperable when the MOV is taken out of its normal safety position. The licensee stated that plant procedures would be revised to require that the applicable system or train be declared inoperable if the valve is taken out of its normal safety position for testing. In IRs 97-11 and 98-03, the NRC staff verified that the MOVs were added back into the licensee's GL 89-10 program or that the revisions to declare the system/train inoperable when an MOV is taken out of its normal safety position had been incorporated into surveillance procedures.

In its letter dated November 18, 1996, the licensee committed to implement the requested MOV periodic verification program at Browns Ferry in response to GL 96-05 and did not take exception to the scope of the generic letter. In its letter dated April 28, 1998, the licensee indicated that the criteria for determining the scope of MOVs for GL 96-05 are consistent with the NRC's acceptance of the scope of MOVs associated with 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 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 is maintained up-to-date, including consideration of any plant modifications or power uprate conditions.

In IRs 98-03 and 98-05, 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 Browns Ferry. The staff determined that the licensee had adequately justified the assumptions and methodologies used in its MOV program. The licensee's letter dated March 30, 1999, indicated ongoing activities, such as review of motor actuator output, to update its MOV program assumptions and methodologies. The staff finds 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 evaluating the GL 89-10 program at Browns Ferry, the NRC staff discussed in IRs 98-03 and 98-05 items from the licensee's MOV program to be addressed over the long term. In IR 98-08, the staff found that the licensee had resolved long-term issues regarding completion of the Unit 2 thrust calculations and the use of industry test data to justify the load sensitive behavior assumptions for MOVs with roller screw stem nuts. The licensee's plans to show that dc-powered MOVs will perform their design-basis functions within specified stroke time requirements is discussed in Section 5.5 of this SE. 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 June 23, 1999.

In IR 97-11, the NRC staff discussed qualitative and quantitative aspects of the licensee's program for trending MOV performance at Browns Ferry. For example, the licensee reviews MOV maintenance histories to evaluate both corrective and preventive actions performed on MOVs. The licensee also reviews MOV test signatures for trends. The licensee periodically evaluates this information on a refueling outage frequency to identify problems. In IR 98-03, the NRC staff found that the licensee had resolved a violation regarding the failure to prepare trend reports and the NRC staff determined that licensee's trend reports met the recommendations of GL 89-10.

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

5.4 JOG Program on MOV Periodic Verification

In its letter dated April 28, 1998, the licensee updated its commitment to implement the JOG Program on MOV Periodic Verification as described in Topical Report MPR-32179 (Revision 2) and responded to the conditions and limitations on use of the topical report identified in the NRC SE dated October 30, 1997, accepting the JOG program as an industry-wide response to GL 96-05. 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 licensee stated that deviations identified during the implementation of the JOG program will be justified. The NRC staff is not approving this exception because the licensee has not provided the criteria to be used as the bases for justifying any deviations. 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 Browns Ferry. The staff considers the commitments by the licensee to implement all three phases of the JOG program at Browns Ferry to be an acceptable response to GL 96-05 for valve age-related degradation.

In its letters dated March 17, 1997, and April 28, 1998, the licensee indicated that (1) the interim MOV static diagnostic testing under the JOG program would be performed on a test frequency based on the safety significance and functional capability of each GL 96-05 MOV; and (2) MOV ranking at Browns Ferry was assigned based on the MOV risk-ranking approach and results presented in the Topical Report NEDC 32264. An expert panel consisting of representatives of appropriate site organizations at Browns Ferry reviewed the results of the analysis and provided additional input for the final determination in risk ranking the MOVs. The conditions and limitations discussed in the NRC SE of Topical Report NEDC-32264, dated February 27, 1996, apply to Browns Ferry. Based on the licensee's summary, the staff considers the licensee's methodology for risk ranking MOVs at Browns Ferry 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. JOG indicates that each licensee is responsible for addressing any MOVs outside the scope of applicability of the JOG program. The licensee's submittal dated April 28, 1998, described valves that are outside the scope of applicability of the JOG dynamic test program, and its plans to monitor the performance of these valves. In particular, the GL 96-05 program at Browns Ferry includes globe valves manufactured by Kerotest that are currently outside the scope of the JOG program. The licensee has determined that these MOVs have high capability margins. The licensee is statically monitoring these MOVs and will evaluate a periodic verification program consistent with similar valves. The licensee will review the program scope if JOG revises its test matrices.

The NRC staff recognizes that 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, 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 stated 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 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 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 its letter dated March 30, 1999, the licensee indicated that it uses a combination of periodic testing and data trending of actuator parameters to monitor actuator performance to assure adequate actuator output capability for safety-related MOVs at Browns Ferry to perform their design-basis functions. For example, the licensee stated that it is monitoring thrust and torque at control switch trip; total thrust and torque; average running thrust, current, and torque; peak inrush current; spring pack displacement and stem factor at control switch trip; stroke time; and rate of loading, as applicable. In IR 98-03, the NRC staff reported that the licensee is monitoring stem friction coefficient, comparing data from dynamic MOV tests with existing assumptions, and making adjustments as necessary. The licensee also intends to incorporate degradation-related information obtained from industry initiatives into the Browns Ferry MOV program.

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 March 30, 1999, the licensee reported that it has reviewed and implemented the technical recommendations of the update and its supplement. The licensee has incorporated the results of these reviews into the MOV sizing calculations at Browns Ferry including actuator pullout efficiency and a 0.9 application factor. For those MOV motors sized at 60 foot-pounds torque, 1800 rpm, and 56 frame size, the licensee also revised these MOV calculations to include an additional output capability reduction based on a review by Limitorque. 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 IR 98-08, the NRC staff provided the status of an open Inspector Followup Item regarding dc-powered MOV stroke time and aspects of the licensee's output calculations that needed to be addressed. In its letter dated March 30,1999, the licensee stated that it is participating in the BWROG effort to provide updated guidance for dc-powered MOVs. The licensee subsequently clarified in a telephone conference on November 8, 1999, that it uses current Limitorque guidance (pullout efficiency, 0.9 application factor, and a linear voltage reduction against rated starting torque) to determine dc-powered actuator capability. The licensee is monitoring this issue and will evaluate any new dc-powered MOV output information as it becomes available.

The NRC staff considers the licensee has established 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 verify, periodically, the design-basis capability of the safety-related MOVs at Browns Ferry, Units 2 and 3, 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. In closing out GL 96-05, the staff is not approving the licensee's proposed exception to implement possible deviations to the JOG program because the licensee has not provided the criteria to be used as the bases for justifying any deviations. 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 February 27, 1996, on the BWROG methodology for ranking MOVs by their safety significance.

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