



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"  
VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2  
DOCKET NOS. 50-424 AND 50-425

## 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 Southern Nuclear Operating Company, Inc., (licensee) to verify periodically the design-basis capability of safety-related MOVs at Vogtle Electric Generating Plant, 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 important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. The quality assurance program to be applied to safety-related components is described in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. In Section 50.55a of 10 CFR Part 50, the NRC requires licensees to establish inservice testing (IST) programs in accordance with Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

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

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

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

- a. within 60 days from the date of GL 96-05, a written response indicating whether or not the licensee would implement the requested actions; and
- b. within 180 days from the date of GL 96-05, or upon notification to the NRC of completion of GL 89-10 (whichever is later), a written summary description of the licensee's MOV periodic verification program.

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

NRC staff will conduct inspections to verify the implementation of GL 96-05 programs at nuclear power plants as necessary.

### 3.0 JOINT OWNERS GROUP PROGRAM ON MOV PERIODIC VERIFICATION

In response to GL 96-05, the Boiling Water Reactor Owners Group (BWROG), Westinghouse Owners Group (WOG), and Combustion Engineering Owners Group (CEOG) jointly developed an MOV periodic verification program to obtain benefits from the sharing of information between licensees. The Joint Owners Group (JOG) Program on MOV Periodic Verification is described by 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 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 VOGTLE GL 96-05 PROGRAM

On November 14, 1996, Southern Nuclear Operating Company, Inc., submitted a 60-day response to GL 96-05 notifying the NRC that it would implement the requested MOV periodic verification program at Vogtle Electric Generating Plant, Units 1 and 2. On March 12, 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 Vogtle. In a letter dated June 3, 1998, the licensee updated its commitment to GL 96-05. On April 28 and October 1, 1999, the licensee provided a response to NRC staff requests for additional information regarding the GL 96-05 program.

In its letter dated March 12, 1997, the licensee described its MOV periodic verification program, including scope, testing, application of the Electric Power Research Institute (EPRI) MOV Performance Prediction Methodology (PPM), ranking MOVs by their safety significance, MOV degradation mechanisms, and implementation of the JOG program at Vogtle. At that time, the licensee indicated that its MOV interim static diagnostic test program differed from the JOG program in that the test frequency was 5 years or 3 cycles and that risk ranking had not been considered at Vogtle. In its letter dated June 3, 1998, the licensee committed to continue its participation in the JOG MOV Periodic Verification Program and to implement the program elements described in the Topical Report MPR-1807 (Revision 2). The licensee stated that the initial dynamic diagnostic tests for the four MOVs were complete and that the MOVs were scheduled to be retested during the refueling outages scheduled for Spring 1999 and Fall 2000. In its letter dated April 28, 1999, the licensee stated that it planned to implement the JOG interim static test program (including MOV risk ranking method and test frequency) in 1999. In its letter dated October 1, 1999, the licensee stated that the review of individual MOV risk significance was performed using methods to quantify the risk significance that are consistent with WOG Engineering Report V-EC-1658-A.

## 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 Vogtle in response to GL 96-05. NRC Inspection Report 50-424 & 425/97-04 (IR 97-04) 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 Vogtle in IR 97-04 based on verification of the design-basis capability of safety-related MOVs at Vogtle and commitments made by the licensee to confirm certain program assumptions in a letter dated May 5, 1997. 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 non-safety position.

IR 97-04 reported that the licensee removed 26 MOVs from the scope of its GL 89-10 program. The NRC staff reviewed the change in scope and concluded that the licensee's MOV program scope in response to GL 89-10 at Vogtle was consistent with GL 89-10 and its supplements. In its letter dated March 12, 1997, the licensee stated that the scope of valves covered by GL 96-05 is the same as 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 should maintain the assumptions and methodologies used in the development of 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 IR 97-04, 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 Vogtle. The staff determined that the licensee had adequately justified the assumptions and methodologies used in its MOV program. 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 Vogtle, the NRC staff discussed in IR 97-04 several items of the licensee's MOV program to be addressed over the long term. NRC Inspection Report 50-424 & 425/98-06 (IR 98-06) and the licensee's letter dated April 28, 1999, reported that the GL 89-10 long-term items were complete. In IR 98-06, the NRC staff reported that the

licensee (1) revised the calculation used to predict the torque required to operate 8-inch butterfly MOVs to bound the test results obtained in differential pressure tests; (2) tested two 18-inch butterfly valves and verified that the required torque calculation bounded the test results; (3) reviewed the conditions and limitations in the NRC SE that approved the use of the EPRI MOV PPM for the prediction of valve operating requirements; (4) reevaluated minimum required thrusts for gate valves in group AD-3 using a 0.7 valve factor and modified the MOVs to increase their thrust capabilities; (5) reduced the packing loads (by replacement of packing) for valves 1/2-HV3548 to increase closing thrust capability margins; (6) revised procedures to include an additional 5% bias uncertainty in the target thrust setting of all torque switch controlled rising stem valves; (7) reviewed dynamic test results for valve groups W-2A, W-2B, and W-8, and revised required thrust calculations to bound test data; (8) revised calculations to apply the EPRI MOV PPM to valves in valve groups W-9, W-11, and W-12; and (9) revised calculations for Fisher, Velan, and Westinghouse rising stem MOVs operating under limit switch control to use a 0.18 stem coefficient of friction to be more consistent with plant data. In its letter dated April 28, 1999, the licensee stated that the actuators for MOVs 1HV-9380A/B were modified to provide additional margin and the torque switches for MOVs 1HV-8716A, 1HV-8804A, and 2HV-8716A were adjusted to provide additional margin.

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 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 97-04, the NRC staff discussed qualitative and quantitative aspects of the licensee's program for trending MOV performance at Vogtle. For example, the licensee's MOV program provides guidance on the investigation of failures, corrective actions, trending of failures, review of test data for trends, and preparation of an annual trend report. The NRC staff concluded that the licensee's MOV corrective actions and trending program was acceptable based on the review of corrective maintenance work orders, the annual trend report, and the guidance contained in the licensee's MOV program. In its letter dated April 28, 1999, the licensee also stated that its MOV periodic verification program includes review of motor actuator output and stem factor.

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

#### 5.4 JOG Program on MOV Periodic Verification

In its letter dated June 3, 1998, the licensee committed to implement the JOG Program on MOV Periodic Verification described in Topical Report MPR-1807 (Revision 2) and the NRC SE dated October 30, 1997, accepting the JOG program as an industry-wide response to GL 96-05 with certain conditions and limitations. In its letter dated April 28, 1999, the licensee revised its interim static test program to commit to implement the JOG interim static test program. 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 Vogtle. The conditions and limitations discussed in the NRC SE dated October 30, 1997, apply to the JOG program at Vogtle. The staff considers the

commitments by the licensee to implement all three phases of the JOG program at Vogtle to be an acceptable response to GL 96-05 for valve age-related degradation.

In its April 28, 1999, letter, the licensee stated that it planned to transition into the JOG interim static test program risk-ranking method and test frequency in 1999. The licensee stated that it intends to implement a two-step transition into the JOG MOV program. Step 1 is a transition program which incorporates MOV risk significance assessments and available margins to set static test frequencies. For example, the licensee compared its MOV risk ranking with the WOG list of typical high/medium risk MOVs and justified the differences between Vogtle and the WOG list. The licensee established an expert panel with representatives from maintenance, operations, engineering and probabilistic safety analysis (PSA) to assess MOV safety significance with consideration of system safety significance, valve importance measures, WOG example list of important MOVs, and plant safety during shutdown operations. Step 2 of the transition will complete the final conversion to the JOG program as described in Topical Report MPR-1807 and will include the revised PSA model and necessary program revisions to make the static test program consistent with the JOG program. As part of the implementation, the licensee stated that the MOV periodic verification program at Vogtle will include consideration of the conditions and limitations provided in NRC SEs of Topical Report MPR-1807 accepting the JOG program (dated October 30, 1997) and WOG Engineering Report V-EC-1658 implementing the WOG MOV risk-ranking methodology (dated April 14, 1998). In its letter dated October 1, 1999, the licensee stated that the PSA review of individual MOV risk significance was performed using methods to quantify the risk significance that are consistent with WOG Engineering Report V-EC-1658-A.

In its letter dated April 28, 1999, the licensee stated that diagnostic methods that acquire data from the motor control center (MCC) may be used in the future based on each individual valve's relative risk significance and available margin. The licensee noted that no specific plans for application of this diagnostic system have been developed for the MOV periodic verification program. The licensee stated that additional information would be provided to the NRC staff prior to the application of this methodology at Vogtle. The NRC staff considers examples of issues to be evaluated using MCC test data to include: (1) the correlation between new MCC test data and existing direct MOV data measurements; (2) the relationship between changes in MCC test data and MOV thrust and torque performance; (3) system accuracies and sensitivities to MOV degradation for both outputs and operating performance requirements; and (4) validation of MOV operability using MCC testing.

The 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 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, 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 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 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 specified 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 April 28, 1999, the licensee indicated that, to assure adequate actuator output capability for safety-related MOVs at Vogtle to perform their design-basis functions, it uses a comprehensive review of test results to confirm acceptable results of MOV output, to confirm continued MOV operability, and to assess trends of valve and actuator performance. For example, the licensee reported that it is monitoring stem factor and actuator output to ensure that actuator output exceeds requirements. The licensee also stated that participation in the JOG dynamic test program is part of its monitoring for valve degradation.

In Technical Update 98-01 and its Supplement 1, Limatorque Corporation provided updated guidance for predicting the torque output of its ac-powered motor actuators. In its letter dated April 28, 1999, the licensee reported that it applied motor test information developed by Commonwealth Edison Company (ComEd) to confirm adequate actuator output capability when incorporating the guidance contained in Technical Update 98-01 into its MOV program. The licensee stated that several MOVs had lower than recommended margins and that all necessary modifications to improve margins have been completed. The NRC staff notes that the licensee is responsible for addressing any changes to the ComEd methodology resulting from the Limatorque update. Any MOV operability concerns that might be identified in the future will be processed in accordance with regulatory requirements and plant-specific commitments.

In its letter dated July 17, 1998, forwarding Technical Update 98-01, Limatorque indicated that a future technical update will be issued to address the application of dc-powered MOVs. In its letter dated October 1, 1999, the licensee stated that it is participating in WOG's effort to work with BWROG to provide updated guidance for dc-powered MOVs. The licensee also noted that it uses current Limatorque guidance (pullout efficiency and 0.9 application factor) 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 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 verify periodically the design-basis capability of the safety-related MOVs at Vogtle 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 SE dated October 30, 1997, on the JOG Program on MOV Periodic Verification; and the NRC SE dated April 14, 1998, on the WOG methodology for ranking MOVs by their safety significance.

Principal Contributors: T. Scarbrough, NRR  
S. Tingen, NRR

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