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"

CATAWBA NUCLEAR STATION, UNITS 1 AND 2

DOCKET NUMBERS 50-413 AND 414

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, 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 such 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 Duke Energy Corporation (the licensee) to verify periodically the design-basis capability of safety-related MOVs at the Catawba Nuclear Station, Units 1 and 2.

2.0 REGULATORY REQUIREMENTS

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

Enclosure

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, the 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. Construction 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 SEs 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 among 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 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 for plants for which the BWROG or WOG methodologies are not applicable 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 to BWROG, CEOG and WOG 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 CATAWBA'S GL 96-05 PROGRAM

On November 14, 1996, the licensee submitted a 60-day response to GL 96-05 notifying the NRC that it would implement the requested MOV periodic verification program at Catawba. 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 for implementation at Catawba. In a submittal dated March 31, 1998, the licensee updated its commitment to GL 96-05. On March 19, 1999, the licensee provided a response to a request for additional information regarding GL 96-05 forwarded by the NRC staff on January 27, 1999.

In its letter dated March 31, 1998, the licensee committed to continue its participation in the JOG MOV Periodic Verification Program as a member of WOG and to implement the program elements described in the Topical Report MPR-1807, Revision 2, describing the JOG program. The licensee also addressed the specific conditions identified in the NRC SE dated October 30, 1997, accepting the JOG program. In its letter dated March 17, 1997, the licensee described its MOV periodic verification program, including scope, existing and planned testing, and

implementation of the JOG program at Catawba. For example, the licensee described the interim MOV static diagnostic test program at Catawba as applying the same MOV risk and margin threshold values as identified in the JOG topical report. The licensee also stated that dynamic testing of selected MOVs would be performed to support the JOG dynamic test program. The licensee stated that adjustments would be made to its GL 96-05 program based on the review of static and dynamic test results. According to its letter dated March 31, 1998, the licensee is reviewing the WOG MOV risk-ranking methodology and justifying test frequencies beyond 5 years to implement the JOG interim MOV static test program. During a telephone conference with the NRC staff on April 28, 1999, the licensee provided additional information on the ongoing implementation of the GL 96-05 program at Catawba. As described in NRC Inspection Report (IR) 50-413 & 414/97-03, the licensee indicated that, until the JOG interim MOV static test matrix is fully implemented, MOVs in the more risk-significant group 1 will be tested at intervals not exceeding 5 years or three refueling outages and MOVs in the less risk-significant group 2 will be tested at intervals not exceeding 8 years or six refueling outages.

5.0 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 Catawba in response to GL 96-05. IR 50-413 & 414/96-02 provided the results of an inspection of the licensee's MOV program in response to GL 89-10. IR 50-413 & 414/97-03 provided the results of an inspection to evaluate the completion of the licensee's GL 89-10 program to verify the design-basis capability of safety-related MOVs at Catawba. The NRC staff closed the review of the GL 89-10 program at Catawba in IR 97-03 based on the licensee's verification of the design-basis capability of the safety-related MOVs and a documented plant process to confirm several program assumptions. IR 50-413 & 414/98-08 provided the results of an inspection to evaluate completion of the validation of those MOV program assumptions. 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 nonsafety position.

In IR 97-03, the NRC staff reviewed the scope of the licensee's MOV program in response to GL 89-10 at Catawba and found that the scope was consistent with GL 89-10 and its supplements. In its letter dated November 14, 1996, the licensee committed to implement the requested MOV periodic verification program at Catawba in response to GL 96-05 and did not take exception to the scope of the generic letter. The NRC 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 Catawba.

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 IRs 97-03 and 98-08, 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 Catawba. With certain long-term aspects discussed in the following section, the staff determined that the licensee had adequately justified the assumptions and methodologies used in its MOV program. IR 98-08 and the licensee's letter dated March 19, 1999, described ongoing licensee activities, such as review of motor actuator output, to update MOV program assumptions and methodologies at Catawba. The NRC 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 closing the NRC review of the GL 89-10 program at Catawba, the NRC staff discussed in IR 97-03 several aspects of the licensee's MOV program to be addressed over the long term. In IR 98-08, the NRC staff determined the licensee to have adequately addressed the items identified during the previous inspection, including (1) resolving concerns with application of the Electric Power Research Institute (EPRI) MOV Performance Prediction Methodology (PPM) to Anchor/Darling double-disc gate valves, (2) increasing the actuator capabilities for MOVs 1NC31 and 2NC33, (3) increasing the actuator capabilities for Group WL-01 valves, and (4) implementing a plan to improve MOV capability margin and to monitor future MOV performance for several gate and globe valve groups. In addition to these items, the licensee performed additional dynamic testing of selected Borg Warner valves (Group BW-01). The licensee will be expected to monitor its valve factor assumption for these Borg Warner gate valves in light of the variable results obtained from those tests. Further, in its letter dated March 19, 1999, and during the telephone conference on April 28, 1999, the licensee described its consideration of the range of valve factors obtained from test data together with an assumed 10% degradation margin to ensure that an appropriate valve factor is applied in its MOV capability calculations.

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 January 22, 1998.

In IR 96-02, the NRC staff discussed the licensee's program for trending MOV performance at Catawba by qualitative and quantitative methods. For example, the licensee develops quarterly trend reports that review valve failures based on valve type. New diagnostic test results are compared with previous test results. The licensee periodically evaluates this information to identify and correct recurring problems and to detect potential MOV failures before they occur.

In its letter dated March 19, 1999, the licensee noted its trending of MOV performance and failures. During the telephone conference on April 28, 1999, the licensee provided additional information on its trending of MOV performance, including failure analysis trending each quarter and evaluation of changes in stem friction coefficient, torque and thrust, and motor current from each previous test. The licensee noted that it is in the process of updating its MOV trending program.

In IR 97-03, the NRC staff concluded that the licensee had demonstrated the design-basis capability of its safety-related MOVs at Catawba. With the licensee's ongoing MOV activities and trending program, no outstanding issues regarding the licensee's GL 89-10 program remain at Catawba.

5.4 JOG Program on MOV Periodic Verification

In its letter dated March 31, 1998, the licensee updated its commitment to implement the JOG Program on MOV Periodic Verification as described in Topical Report MPR-1807, Revision 2, and responded to the conditions and limitations on use of the topical report identified in the NRC SE dated October 30, 1997. 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 commitments by the licensee to implement the JOG program at Catawba to be an acceptable response to GL 96-05 for valve age-related degradation. If the licensee proposes to implement an approach at Catawba 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 17, 1997, the licensee stated that the interim MOV static diagnostic test program would establish a test frequency based on the safety significance and functional capability of each GL 96-05 MOV. In its letter dated March 31, 1998, the licensee indicated that MOV ranking at Catawba was assigned based on the MOV risk-ranking approach and results presented in the WOG Engineering Report V-EC-1658-A. The licensee will be expected to address the conditions and limitations in the NRC SE dated April 14, 1998, which accepted WOG Engineering Report V-EC-1658.

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. 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. 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 March 19, 1999, the licensee indicated that it uses a combination of preventative maintenance activities, periodic as-found and as-left static testing, periodic dynamic testing as prescribed by the JOG program, trending of MOV performance and failures, and bench testing of actuators to assure adequate actuator output capability for safety-related MOVs at Catawba to perform their design-basis functions. In IR 97-03, 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 Catawba MOV program. During the telephone conference on April 28, 1999, the licensee stated that it is also obtaining data from the Motor Control Center (MCC) for information purposes during MOV tests. 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 motor actuators. In its letter dated March 19, 1999, the licensee reported that it had implemented the guidance contained in Technical Update 98-01 and its Supplement 1 into the Catawba MOV program. The licensee did not identify any deficiencies affecting MOV operability in its March 19 letter. The NRC staff notes that the licensee is responsible for resolving any MOV operability concerns in accordance with regulatory and plant-specific requirements.

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. During the telephone conference on April 28, 1999, the licensee stated that it had evaluated the capability of its six dc-powered butterfly valves at Catawba (three in each unit) in anticipation of new guidance on dc-powered MOV output. For example, the licensee assumed a 0.9 application factor and pullout efficiency to help obtain a conservative prediction of the output capability of the dc-powered motor actuators. The licensee also has considered the potential for ambient temperature effects on motor actuator output for these MOVs. The licensee stated that it is monitoring the industry effort on dc-powered MOV performance to determine any additional necessary action.

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

6.0 CONCLUSION

On the basis of this evaluation, the NRC staff finds that the licensee has established an acceptable program to verify periodically the design-basis capability of the safety-related MOVs at Catawba. Therefore, the staff concludes that the licensee has adequately addressed the actions requested in GL 96-05. The NRC staff may conduct inspections to verify the implementation of the MOV periodic verification program is in accordance with (1) Duke's commitments; (2) this SE; (3) the SE dated October 30, 1997, on the JOG Program on MOV Periodic Verification; and (4) the NRC SE dated April 14, 1998, on the Westinghouse Owners Group methodology for ranking MOVs by their safety significance.

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