April 27, 2000

Mr. Charles M. Dugger
Vice President Operations
Entergy Operations, Inc.
17265 River Road
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SUBJECT: WATERFORD STEAM ELECTRIC STATION, UNIT 3 - RE: CLOSEOUT OF GENERIC LETTER 96-05 (TAC NO. M97117)

On September 18, 1996, the U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," requesting each nuclear power plant licensee to establish a program, or to ensure the effectiveness of its current program, to verify on a periodic basis that safety-related motor-operated valves (MOVs) continue to be capable of performing their safety functions within the current licensing bases of the facility.

On November 15, 1996, Entergy Operations, Inc. (EOI) submitted a 60-day response to GL 96-05 notifying the NRC that it was preparing an MOV periodic verification program at Waterford Steam Electric Station, Unit 3 (Waterford 3). On March 17, 1997, EOI submitted a 180-day response to GL 96-05 providing a summary description of the MOV periodic verification program to ensure the long-term design-basis capability of the safety-related MOVs within the scope of GL 96-05 at Waterford 3, and in a letter dated January 11, 1999, EOI updated its commitment to GL 96-05. On April 12, 1999, EOI provided a response to a request for additional information regarding GL 96-05, forwarded by the NRC staff on February 11, 1999, and, on February 10, 2000, provided a list of the MOVs with high risk significance at Waterford 3.

After review of the submittals and applicable NRC inspection reports for the MOV program at Waterford 3, we find that EOI has established an acceptable program to verify periodically the design-basis capability of the safety-related MOVs at Waterford 3 through its commitment to all three phases of the Joint Owners Group (JOG) Program on MOV Periodic Verification and the additional actions described in its submittals. As discussed in the attached safety evaluation (SE), it is concluded that EOI is adequately addressing the actions requested in GL 96-05. The NRC staff may conduct inspections at Waterford 3 to verify implementation of the MOV periodic verification program in accordance with EOI's commitments in its submittals, this NRC SE, and the NRC SE dated October 30, 1997, on the JOG Program on MOV Periodic Verification.

This completes NRC's efforts on TAC No. M97117.

Sincerely,

/RA/

N. Kalyanam, Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

This completes NRC's efforts on TAC No. M97117.

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N. Kalyanam, Project Manager, Section 1
Project Directorate IV & Decommissioning
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cc w/encl: See next page

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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,"

WATERFORD STEAM ELECTRIC STATION, UNIT 3

DOCKET NUMBER 50-382

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 Entergy Operations, Inc., (EOI, the licensee) to verify periodically the design-basis capability of safety-related MOVs at Waterford Steam Electric Station, Unit 3 (Waterford 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. Appendix A to Part 50, "General Design Criteria for Nuclear Power Plants," of Title 10 of the *Code of Federal Regulations* (10 CFR Part 50), Criterion 1, states, in part, that "[s]tructures, 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 to Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

ENCLOSURE

In 10 CFR 50.55a, the NRC requires licensees to establish inservice testing (IST) programs in accordance with Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

In response to the concerns regarding MOV performance, NRC staff issued Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," on June 28, 1989, 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 five 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 that 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 [light-water reactor] 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 EOI 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 EOI’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 (BWR) Owners Group (BWROG), Westinghouse Owners Group (WOG), and Combustion Engineering Owners Group (CEOG) jointly developed an MOV periodic verification program to obtain benefits from the sharing of information between licensees. The Joint Owners Group (JOG) Program on MOV Periodic Verification is described by the BWROG in its Licensing Topical Report NEDC-32719, “BWR Owners’ Group Program on Motor-Operated Valve (MOV) Periodic Verification,” and described by the WOG and the CEOG in their separately submitted Topical Report MPR-1807, “Joint BWR, Westinghouse and Combustion Engineering Owners’ Group Program on Motor-Operated Valve (MOV) Periodic Verification.” The stated objectives of the JOG program on MOV Periodic Verification are: 1) to provide an approach for licensees to use immediately in their GL 96-05 programs; 2) to develop a basis for addressing the potential age-related increase in required thrust or torque under dynamic conditions; and 3) to use the developed basis to confirm, or if necessary to modify, the applied approach. The specific elements of the JOG program are 1) providing an "interim" MOV periodic verification program for applicable licensees to use in response to GL 96-05; 2) conducting a dynamic testing program over the next five 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 BWR 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 five-year interval with at least a one-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 WATERFORD 3 GL 96-05 PROGRAM

On November 15, 1996, EOI submitted a 60-day response to GL 96-05 notifying the NRC that it was preparing an MOV periodic verification program at Waterford 3. On March 17, 1997, EOI submitted a 180-day response to GL 96-05 providing a summary description of the MOV periodic verification program to ensure the long-term design-basis capability of the safety-related MOVs to be within the scope of GL 96-05 at Waterford 3. In a letter dated January 11, 1999, EOI 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 11, 1999, and provided on February 10, 2000, a list of the MOVs with high risk significance at Waterford 3.

In its letter dated March 17, 1997, EOI described its MOV periodic verification program, including scope, planned testing, capability margin, and plans to implement the JOG program at Waterford 3. For example, EOI described its interim static diagnostic test program, risk ranking approach, and dynamic diagnostic test program. EOI stated that the GL 96-05 periodic verification program would begin implementation at Waterford 3 within 120 days after completion of its 1997 refueling outage (RFO). In its letter dated January 11, 1999, EOI committed to participate in the JOG MOV Periodic Verification Program as a member of CEOG and to implement the JOG program elements described in the Topical Report NEDC-32719 (Revision 2). In a telephone conference with the NRC staff on December 14, 1999, EOI clarified certain aspects of its GL 96-05 program.

5.0 NRC STAFF EVALUATION

The NRC staff has reviewed the information provided in EOI's submittals describing the program to verify periodically the design-basis capability of safety-related MOVs at Waterford 3

in response to GL 96-05. NRC Inspection Report 50-382/94-23 (IR 94-23) provided the results of inspections to evaluate EOI's program to verify the design-basis capability of safety-related MOVs in response to GL 89-10. In a letter dated December 21, 1994, the staff closed the review of the GL 89-10 program at Waterford 3, based on verification of the design-basis capability of safety-related MOVs documented in IR 94-23 and additional information provided by EOI in a letter dated November 11, 1994. The staff's evaluation of EOI'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 that the system (or train) is not declared inoperable when the MOVs are in their non-safety position.

In IR 94-23, the NRC staff did not identify any concerns regarding the scope of EOI's MOV program in response to GL 89-10 at Waterford 3. In its letter dated March 17, 1997, EOI stated that its MOV periodic verification program at Waterford 3 would ensure the long-term design-basis capability of the safety-related MOVs within the scope of GL 96-05. The NRC staff considers that EOI has 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 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.

During the inspection documented in IR 94-23 and in reviewing EOI's submittal dated November 11, 1994, the NRC staff evaluated EOI's justification for the assumptions and methodologies used in the MOV program in response to GL 89-10 at Waterford 3. The staff determined that EOI had adequately justified the assumptions and methodologies used in its MOV program with certain long-term items discussed in the following section. EOI's letter dated April 12, 1999, indicated ongoing activities, such as review of motor actuator output, to update its MOV program assumptions and methodologies. The staff considers EOI 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 review of the GL 89-10 program at Waterford 3, several items of EOI's MOV program to be addressed over the long term were identified in IR 94-23, EOI's submittal dated November 11, 1994, and the NRC's letter dated December 21, 1994. In its letter dated April 12, 1999, EOI reported on the status of those long-term GL 89-10 aspects. For example, EOI revised its MOV setpoint calculations to incorporate the test results for each MOV including load sensitive behavior values that exceeded the original assumed values. EOI took actions to

enhance its MOV trending program. EOI revised its post-maintenance test matrix to identify maintenance activities that require performance of a post-maintenance differential pressure test. EOI applied the Electric Power Research Institute MOV Performance Prediction Methodology to the safety injection system sump isolation valves SI-602A/B and replaced the butterfly valve gearbox actuator units for these valves to accommodate the new torque requirements. 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 EOI's actions in response to GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," in an SE dated December 28, 1999.

In its letter dated April 12, 1999, EOI discussed qualitative and quantitative aspects of its improved MOV trending program at Waterford 3. For example, EOI's program includes both failure and performance trending that is maintained in a computer database. Failure trending includes component failures, procedure deficiencies, and personnel errors. Performance trending uses diagnostic test data to monitor MOV performance to detect degradation or adverse trends, and compares the data to applicable design-basis values. EOI prepares an MOV Trending Report following each RFO.

With EOI's ongoing MOV activities and trending program, no outstanding issues regarding EOI's GL 89-10 program remain at Waterford 3.

5.4 JOG Program on MOV Periodic Verification

In its letter dated January 11, 1999, EOI updated its commitment to implement the JOG Program on MOV Periodic Verification as described in Topical Report NEDC-32719 (Revision 2). In an SE dated October 30, 1997, the NRC staff accepted the JOG program as an industry-wide response to GL 96-05 with certain conditions and limitations. The JOG program includes 1) the JOG interim static diagnostic test program, 2) the JOG five-year dynamic test program, and 3) the JOG long-term periodic test program. The staff considers EOI's commitments in response to GL 96-05 to include implementation of all three phases of the JOG program at Waterford 3. The conditions and limitations discussed in the NRC SE dated October 30, 1997, apply to the JOG program at Waterford 3. The staff considers the commitments by EOI to implement all three phases of the JOG program at Waterford 3 to be an acceptable response to GL 96-05 for valve age-related degradation.

In its letter dated March 17, 1997, EOI noted that the interim MOV static diagnostic testing under the JOG program would be performed on a test frequency based on the risk significance and setup ratio (i.e., capability margin) of each GL 96-05 MOV. Initially, EOI's static MOV test frequency matrix appeared to differ from the JOG interim static diagnostic test program. In its letter dated January 11, 1999, EOI committed to implement the JOG program as described in the JOG topical report. EOI discussed this commitment with the NRC staff in a telephone conference on December 14, 1999. According to EOI's updated commitment, the interim MOV static diagnostic testing at Waterford 3 will be consistent with the JOG program.

In its letter dated March 17, 1997, EOI described its MOV risk ranking approach. In its letter dated April 12, 1999, EOI provided additional details regarding its MOV risk ranking approach. EOI assigns MOV ranking at Waterford 3 based on input from an expert panel and preliminary rankings provided by the Waterford 3 probabilistic safety assessment. For example, EOI calculated risk achievement worth and Fussel-Vesely importance measures for Category 1 and

safety-related Category 2 MOVs to determine the preliminary ranking. The multi-discipline expert panel reviewed the results of the analysis and made the final determination for risk ranking the MOVs as high, medium, or low safety significance. In a letter dated February 10, 2000, EOI provided a list of MOVs classified as high risk significant at Waterford 3. EOI stated that most of the power-operated valves in safety significant applications at Waterford 3 are air operated. Based on EOI's submittals, the staff finds that EOI's MOV risk ranking approach at Waterford 3 is 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 NRC staff recognizes that JOG has selected a broad range of MOVs and conditions for the dynamic testing program. 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 EOI 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 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 on the JOG program, dated October 30, 1997, 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 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 its letter dated April 12, 1999, EOI indicated that it uses a combination of diagnostic testing and data trending to ensure adequate actuator output capability for safety-related MOVs at Waterford 3 to perform their design-basis functions. For example, EOI reported that stem friction coefficients are routinely monitored and trended to identify degradation, and are compared with existing design-basis stem friction coefficient assumptions.

In Technical Update 98-01 and its Supplement 1, Limitorque Corporation provided updated guidance for predicting the torque output of its alternating current-powered motor actuators. In its letter dated April 12, 1999, EOI reported that this information was incorporated into the MOV sizing calculations at Waterford 3. Ten MOVs were scheduled for modifications to re-establish adequate design margin as a result of the review. EOI completed modifications to two of the ten valves during RFO 9 and plans to complete modifications to the remaining eight MOVs during RFO 10, scheduled for fall 2000. 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 direct current (dc)-powered MOVs. In its letter dated April 12, 1999, EOI stated that it had implemented modifications to increase actuator capability during RFO 9 for the two safety-related dc-powered MOVs at Waterford 3 in response to findings contained in NUREG/CR-6478, "MOV Actuator Motor and Gearbox Testing." EOI stated that it will continue to monitor dc motor test information, and will take any actions necessary in response to future Limitorque or regulatory guidance related to the thrust or torque delivered by the motor actuator and its potential degradation.

The NRC staff considers EOI to be establishing sufficient means to monitor MOV motor actuator output and its potential degradation.

6.0 CONCLUSION

The staff finds that EOI has established an acceptable program to verify periodically the design-basis capability of the safety-related MOVs at Waterford 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 EOI has adequately addressed the actions requested in GL 96-05. The staff may conduct inspections to verify implementation of the MOV periodic verification program in accordance with EOI's commitments in its submittals, this NRC SE, and the NRC SE on the JOG Program on MOV Periodic Verification, dated October 30, 1997.

Principal Contributor: Thomas G. Scarbrough

Date: April 27, 2000