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

October 3, 2017

Mr. Fadi Diya
Senior Vice President and
Chief Nuclear Officer
Union Electric Company
P.O. Box 620
Fulton, MO 65251

SUBJECT: CALLAWAY PLANT, UNIT NO. 1 – REQUEST FOR ALTERNATIVE I4R-04 APPLICABLE TO THE FOURTH 10-YEAR INSPECTION PROGRAM INTERVAL (CAC NO. MF8524)

Dear Mr. Diya:

By letter dated October 25, 2016, as supplemented by letter dated May 15, 2017, Union Electric Company, dba Ameren Missouri (the licensee), submitted a relief request to the U.S. Nuclear Regulatory Commission (NRC) with regard to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI requirements for examination of reactor coolant piping welds to the reactor pressure vessel concerning flaw depth size associated with ultrasonic testing. This request is for the Callaway Plant, Unit No. 1 (Callaway).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(g)(5)(iii), the licensee requested relief for the fourth inspection interval concerning this inservice inspection (ISI) impracticality.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(g)(5)(iii). Therefore, the NRC staff grants Relief Request I4R-04, at Callaway for the fourth 10-year ISI interval.

If you have any questions, please contact the Project Manager, John Klos, at 301-415-5136 or via e-mail at John.Klos@nrc.gov.

Sincerely,

Robert J. Pascarelli, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST I4R-04 REGARDING ALTERNATIVE DEPTH SIZING ROOT MEAN SQUARE ERROR CRITERIA

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT NO. 1

DOCKET NO. 50-483

1.0 INTRODUCTION

By letter dated October 25, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16299A451), as supplemented by letter dated May 15, 2017 (ADAMS Accession No. ML17135A395), Union Electric Company, dba Ameren Missouri (the licensee), requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). This request, I4R-04, specifically related to the inner diameter (ID) flaw depth sizing root mean square error (RMSE) criteria of Appendix VIII (Section XI) for the ultrasonic testing (UT) performance demonstration is for the Callaway Plant, Unit No. 1 (Callaway).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(g)(5)(iii), "ISI program update: Notification of impractical ISI Code requirements," the licensee requested relief and to use alternative requirements (if necessary), for inservice inspection (ISI) on the basis that the ASME Code requirement is impractical.

2.0 REGULATORY EVALUATION

Paragraph 50.55a(g)(4) of 10 CFR, "Inservice inspection standards requirement for operating plants," requires, that throughout the service life of a boiling or pressurized water-cooled nuclear power facility, components (including supports) that are classified as ASME Code Class 1, Class 2, and Class 3 must meet the requirements, except design and access provisions and preservice examination requirements, set forth in Section XI of editions and addenda of the ASME Code that become effective subsequent to editions specified in paragraphs (g)(2) and (3) of 10 CFR 50.55a and that are incorporated by reference in paragraph (a)(1)(ii) of 10 CFR 50.55a, to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Paragraph 50.55a(g)(4)(ii) of 10 CFR, "Applicable ISI Code: Successive 120-month intervals," requires inservice examination of components and system pressure tests conducted during successive 120-month inspection intervals must comply with the requirements of the latest edition and addenda of the ASME Code incorporated by reference in paragraph (a) of [50.55a] 12 months before the start of the 120-month inspection interval (or the optional ASME Code

Cases listed in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.147, Revision 17, when using Section XI, that are incorporated by reference in paragraphs (a)(3)(ii) or (iii) of 10 CFR 50.55a, subject to the conditions listed in paragraph (b) of 10 CFR 50.55a. However, a licensee whose inservice inspection interval commences during the 12 through 18-month period after August 17, 2017, may delay the update of their Appendix VIII program by up to 18 months after August 17,2017.

Paragraph 50.55a(g)(5)(iii) of 10 CFR, states, that "If the licensee has determined that conformance with the Code requirement is impractical for its facility, the licensee must notify the NRC and submit, as specified in § 50.4, information to support the determinations. Determinations of impracticality in accordance with [50.55a] must be based on the demonstrated limitations experienced when attempting to comply with the Code requirements during the inservice inspection interval for which the request is being submitted. Requests for relief made in accordance with [50.55a] must be submitted to the NRC no later than 12 months after the expiration of the initial or subsequent 120-month inspection interval for which relief is sought."

Paragraph 50.55a(g)(6)(i) of 10 CFR, "Impractical ISI requirements: Granting of relief," states that "The Commission will evaluate determinations under paragraph (g)(5) of [50.55a] that Code requirements are impractical. The Commission may grant such relief and may impose such alternative requirements as it determines are authorized by law, and will not endanger life or property or the common defense and security, and are otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility."

Paragraph 50.55a(g)(6)(ii)(F) of 10 CFR, "Augmented ISI requirements: Examination requirements for Class 1 piping and nozzle dissimilar-metal butt welds –(1) Implementation," requires, that holders of operating pressurized-water reactors (PWRs) as of August 17, 2017, must implement the requirements of ASME Code Case N-770-2 instead of ASME Code Case N-770-1 "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities Section XI, Division 1," subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (13) of 10 CFR 50.55a, by the first refueling outage after August 17, 2017.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request and the NRC to authorize the alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 Background

By letters dated March 15, 2007 (ADAMS Accession No. ML070580333), and March 29, 2007 (ADAMS Accession No. ML070871014), the NRC granted similar relief for the second and third 10-year ISI intervals of Callaway, Unit 1.

During the fourth 10-year ISI interval at Callaway, the licensee has implemented the risk informed inservice inspection (RI-ISI) program in accordance with ASME Code Case N-716-1 "Alternative Piping Classification and Examination Requirements, Section XI, Division 1" for the Class 1 piping welds (Examination Category B-F and B-J) and the Class 2 piping welds

(Examination Category C-F-I and C-F-2). This code case has been incorporated by reference into 10 CFR 50.55a by inclusion in RG 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1, Revision 17."

3.2 Component Affected

The affected components are ASME Code Class 1 piping welds in the reactor coolant system, which include:

- Dissimilar metal (DM) welds

  - Four reactor pressure vessel (RPV) outlet (hot leg) nozzle to safe-end DM butt welds with ID of 29 inches and wall thickness of 2.5 inches. The licensee classified these welds as Inspection Item A-2 in accordance with ASME Code Case N-770-1 (Table 1).

    2-RV-301-121-A Loop 1
    2-RV-301-121-B Loop 2
    2-RV-301-121-C Loop 3
    2-RV-301-121-D Loop 4

  - Four RPV inlet (cold leg) nozzle to safe-end DM butt welds with ID of 27.5 inches and wall thickness of 2.38 inches. The licensee classified these welds as Inspection Item B in accordance with ASME Code Case N-770-1 (Table 1).

    2-RV-302-121-A Loop 1
    2-RV-302-121-B Loop 2
    2-RV-302-121-C Loop 3
    2-RV-302-121-D Loop 4

The licensee stated that the materials of construction of the above welds and the associated components (hot and cold legs) are low alloy steel nozzles welded to austenitic stainless steel safe-ends by nickel based alloy (e.g., Alloy 82/182) weld metal.

- Similar metal welds

  - Four RPV outlet (hot leg) safe-end to pipe butt welds with ID of 29 inches and wall thickness of 2.5 inches. The licensee classified these welds as Examination Category R-A, Item Number R1.20 (elements not subject to a damage mechanism), in accordance with ASME Code N-716-1 (Table 1).

    2-BB-01-F103 Loop 1
    2-BB-01-F203 Loop 2
    2-BB-01-F303 Loop 3
    2-BB-01-F403 Loop 4

- Four RPV inlet (cold leg) safe-end to elbow butt welds with ID of 27.5 inches and wall thickness of 2.38 inches. The licensee classified these welds as Examination Category R-A, Item Number R1.20 (elements not subject to a damage mechanism), in accordance with ASME Code N-716-1 (Table 1).

  2-BB-01-F102 Loop 1
  2-BB-01-F202 Loop 2
  2-BB-01-F302 Loop 3
  2-BB-01-F402 Loop 4

The licensee stated that the materials of construction of the above welds and the associated components are austenitic stainless steel safe-ends welded to cast austenitic stainless steel (CASS) elbows or austenitic stainless steel pipes by austenitic stainless steel weld metal. The also licensee stated that prior to utilizing the UT for the examination of the above welds, the UT procedures demonstration, equipment, and personnel qualification shall meet applicable Appendix VIII supplements (Section XI) requirements.

3.3 Applicable Code Edition and Addenda

The Code of record for the fourth 10-year ISI interval is the 2007 Edition through 2008 Addenda of the ASME Code.

3.4 Duration of Relief Request

The licensee submitted this relief request for the fourth 10-year ISI interval which started on December 19, 2014, and is scheduled to end on December 18, 2024.

3.5 ASME Code Requirement

Requirements for the ISI of DM welds

The ASME Code ISI requirements applicable to the DM welds in this relief request originate in Table IWB-2500-1 (Section XI). However, the regulations under 10 CFR 50.55a(g)(6)(ii)(F) mandate augmented inspection in accordance with ASME Code Case N-770-2 with conditions, for the DM welds that contain Alloy 82/182. ASME Code Case N-770-2 (Table 1), Inspection Items A-2 and B, require that the RPV hot and cold leg nozzle to safe-end DM butt welds be volumetrically examined by the UT. Footnote No. 4 of Case N-770-2 (Table 1) requires that the UT procedures demonstration, equipment, and personnel qualification meet applicable supplements of Appendix VIII (Section XI).

Requirements for the ISI of similar metal welds

The ASME Code ISI requirements applicable to the similar metal welds in this relief request originate in Table IWB-2500-1 (Section XI). Alternative to the Code requirements is the Callaway RI-ISI program in accordance with ASME Code Case N-716-1. In both the ASME Code requirements and the Callaway RI-ISI program, it is required that the austenitic welds under this request be volumetrically examined by the UT, and that the UT procedures, equipment, and personnel be demonstrated and qualified in accordance with applicable supplements of Appendix VIII (Section XI).

For the CASS elbow side of the welds in this relief request, it is required that the UT procedures, instrument, and personnel qualification meet the requirements of Supplement 1, "Austenitic and Dissimilar Metal Welds," of Appendix III (Section XI).

Applicable Supplement of Appendix VIII (Section XI)

For the welds in this relief request, applicable supplement of Appendix VIII is Supplement 14 "Qualification Requirements for Coordinated Implementation of Supplements 10, 2, and 3 for Piping Examinations Performed from the Inside Surface." In accordance with Supplement 14, it is required that the UT procedures, equipment, and personnel be demonstrated and qualified for flaw depth sizing, and that the flaw depths estimated by the UT as compared with the true depths do not exceed 0.125 inch RMSE.

3.6 Impracticality of Compliance and Basis for Relief

The licensee stated that, although utilities' contracted vendors have qualified for flaw detection and length sizing for inspections performed from ID surface of the weld, the UT qualification for flaw depth sizing has not yet been successful to meet the ASME Code, Appendix VIII required 0.125 inch RMSE. To date, no vendor has been capable of meeting the 0.125 inch RMSE criteria for flaw depth sizing from the ID surface. Consequently, relief from the ASME Code required 0.125 inch RMSE for the ID depth sizing is sought due to impracticality to meet the required RMSE criteria.

There are UT procedures and personnel qualified in accordance with Appendix VIII to examine the welds and depth-size detected flaws from the outer diameter (OD) surface of pipe and weld. For the welds in this relief request, the licensee described the difficulties associated with inspecting them from the OD. The licensee stated that while the OD surface of the welds in this relief request could be accessed through removable covers in the refueling cavity floor that lead to an annulus that surrounds the reactor vessel, there would be a significant radiological dose associated with inspecting them from the OD. Attempts to reduce dose levels by shielding are impractical due to the essentially omnidirectional source from the reactor and coolant piping. In addition, the cold leg safe-end to CASS elbow welds are not suitable for the OD examinations due to the weld and component configuration.

3.7 Proposed Alternative

The licensee proposed alternatives to the ID flaw depth sizing RMSE criteria in Supplement 14 of Appendix VIII for the welds in this relief request. The proposed alternatives are:

i. In the event that a flaw is detected in the nozzle to safe end DM welds and/or the safe end to pipe/elbow austenitic welds and required depth sizing, the licensee will add the difference of the ASME Code required RMSE (0.125 inch) and the vendor demonstrated RMSE (0.245 inch) to the measured depth of a detected flaw. Therefore, the licensee will add 0.12 inch (i.e., 0.245 - 0.125 = 0.12) to the measured depth of a detected flaw.

   - For flaws detected and measured by the UT as less than 50 percent through wall depth, adding the proposed correction factor (0.245 inch - 0.125 inch = 0.12 inch) to the depth of any flaw found by the UT prior to flaw evaluation for flaws less than 50 percent through wall, satisfactorily

reduces the effect of the increased sizing error associated with not meeting the ASME Code required 0.125 inch RMSE.

- For flaws detected and measured by the UT as 50 percent through wall depth or greater, and to remain in service without mitigation or repair, the licensee will perform a flaw evaluation, and submit for the NRC review and approval prior to reactor startup. The flaw evaluations shall include the inner profile of the weld, pipe and nozzle in the region at and surrounding the flaw, an estimate of the percentage of potential surface areas with UT probe lift-off, and information on mechanism which caused the flaw.

ii. All ID examinations will be augmented with the ID surface eddy current testing (ET).

iii. The Appendix VIII qualified UT will also be used to inspect the CASS side of the cold leg elbow to safe-end austenitic welds in lieu of the requirements in Supplement 1 of Appendix III, Section XI.

3.8 NRC Staff Evaluation

The NRC staff has evaluated this relief request pursuant to 10 CFR 50.55a(g)(6)(i). The NRC staff's evaluation focused on: (1) whether a technical justification exists to support the determination that the ASME Code requirement is impractical; (2) that imposition of the Code required RMSE criteria would result in a burden to the licensee; and (3) that the licensee's proposed alternative (accepting a correction factor in this case) provides reasonable assurance of structural integrity and leak tightness of the subject welds. The NRC staff finds that if these three criteria are met that the requirements of 10 CFR 50.55a(g)(6)(i) will also be met.

Impracticality of Compliance

The NRC staff confirmed that continuous efforts have been made by the industry to qualify the inspection vendors' UT procedures and personnel for depth sizing examinations performed from the ID surface of DM butt welds and austenitic stainless steel butt welds in piping since 2002. To date, there has not been any inspection vendor capable to meet the qualification requirement of the RMSE of not greater than 0.125 inch established by the ASME Code for the UT procedures from the ID surface. Even enhancements in examination such as use of commercially available advanced UT systems, advances in UT procedure, transducer design, electronics, and software have not been resulted in the desired improvements in performance to meet the required RMSE criteria. Therefore, the NRC staff found that obtaining 0.125 inch RMSE for the ID depth sizing examinations, as is required by the ASME Code (Appendix VIII's qualification limit of 0.125 inch RMSE), is impractical.

Burden of Compliance

The NRC staff notes that utilities, inspection vendors, and industry have made every effort, including enhancements and repeated attempts to meet the ASME Code required ID depth sizing RMSE criteria, but, all efforts were unsuccessful. The NRC staff found that the industry's efforts have shown the impracticality of obtaining the required RMSE, given the challenges of weld geometry, rough ID surfaces, multiple materials, and microstructural anisotropies. Therefore, imposing the ASME Code requirements could result in a burden upon the facility.

Safety Significance of Correction Factor

In July 2012, the NRC staff reviewed the proprietary Performance Demonstration Initiative (PDI) program which is administered by the Electric Power Research Institute (EPRI) for data used in blind tests. This review was conducted to verify the information and analysis presented by industry in the public meeting held between the NRC, PDI, EPRI, and industry on March 16, 2012 (ADAMS Accession No. ML12097A071), and June 19, 2012 (ADAMS Accession Nos. ML12173A517 and ML12173A522). Based on this review, the NRC staff determined that adding the industry proposed correction factor satisfactorily reduces the effect of the increased sizing error associated with not meeting the ASME Code required 0.125 inch RMSE. If any cracks are detected and measured by the UT as 50 percent through wall depth or greater and to remain in service without mitigation or repair, a flaw evaluation shall be performed and submitted for the NRC review and approval prior to reactor startup.

The flaw evaluations shall include:

a. The inner profile of the weld, pipe, and nozzle in the region at and surrounding the flaw,
b. An estimate of the percentage of potential surface areas with UT probe lift-off, and
c. Information on mechanism which caused the crack.

Requiring the NRC approval for restart when a flaw with 50 percent through wall or greater is discovered and is to be remain in service without mitigation or repair, addresses the NRC staff concerns with the possibilities of large undersizing errors in deep flaws.

Therefore, the NRC staff finds that for flaws measured less than 50 percent through wall depth, adding the licensee's proposed correction factor of the vendor-demonstrated procedure for RMSE of 0.125 inch, to the depths of any flaw found by the inspections, and obtaining the NRC review and approval prior to startup for any flaws measured as 50 percent through wall depth or greater, provide reasonable assurance of structural integrity and leak tightness of the subject welds.

4.0 CONCLUSION

As set forth above, the NRC staff determines that it is impractical for the licensee to comply with the ASME Code, Section XI, Appendix VIII, qualification requirement. The NRC staff also determines that the proposed alternative provides reasonable assurance of structural integrity and leak tightness of the subject welds. Granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(g)(5)(iii). Therefore, the NRC staff grants Relief Request I4R-04, at Callaway for the fourth 10-year ISI interval which started on December 19, 2014, and is scheduled to end on December 18, 2024.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and approved herein by the NRC staff remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: A. Rezai, NRR

Date: October 3, 2017

SUBJECT: CALLAWAY PLANT, UNIT NO. 1 – REQUEST FOR ALTERNATIVE I4R-04 APPLICABLE TO THE FOURTH 10-YEAR INSPECTION PROGRAM INTERVAL (CAC NO. MF8524) DATED OCTOBER 3, 2017

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ADAMS Accession No.: ML17262A700 ***by memo dated**

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