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

November 26, 2018

Mr. Fadi Diya
Senior Vice President and
Chief Nuclear Officer
Ameren Missouri
Callaway Energy Center
8315 County Road 459
Steedman, MO 65077

SUBJECT: CALLAWAY PLANT, UNIT 1 – REQUEST FOR RELIEF RELATED TO THE INSERVICE INSPECTION PROGRAM FOR CLASS 3 BURIED HIGH-DENSITY POLYETHYLENE PIPING (EPID L-2018-LLR-0039)

Dear Mr. Diya:

By letter dated March 27, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18086B243), Union Electric Company (dba Ameren Missouri, the licensee), submitted a relief request for Callaway Plant, Unit 1 (Callaway), to utilize a system leakage test, per Subsubarticle IWD-5220 of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, for the buried Class 3 high-density polyethylene (HDPE) piping found in the Essential Service Water system, in lieu of a periodic hydrostatic pressure test which had previously been authorized via a relief request on May 12, 2015 (ADAMS Accession No. ML15064A125).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all the regulatory requirements as set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC authorizes the use of a system leakage test in lieu of a periodic hydrostatic pressure test for the remaining life of Callaway, including plant life extension through October 18, 2044.

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

If you have any questions, please contact 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: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF I4R-01 RELATED TO THE

INSERVICE INSPECTION PROGRAM FOR CLASS 3 BURIED

HIGH-DENSITY POLYETHYLENE PIPING

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT 1

DOCKET NO. 50-483

1.0 INTRODUCTION

By letter dated March 27, 2018 (Reference 1), Union Electric Company (dba Ameren Missouri, the licensee), proposed an alternative for Callaway Plant, Unit 1 (Callaway) related to the previously approved Relief Request I4R-01 dated May 12, 2015 (Reference 2). Specifically, by letters dated June 10, 2014, September 30, 2014, and April 24, 2015 (References 3, 4, and 5), the licensee requested relief from certain requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, associated with certain Class 3 buried piping systems at Callaway. By letter dated May 12, 2015, the U.S. Nuclear Regulatory Commission (NRC) staff reviewed and authorized the use of Relief Request I4R-01 for the remaining life of Callaway (i.e., October 18, 2044). As part of its submittals for Relief Request I4R-01, the licensee committed to perform periodic hydrostatic pressure testing of the buried ASME Code Class 3 high-density polyethylene (HDPE) piping installed in the supply and return lines of the Essential Service Water (ESW) system. The subject HDPE piping was installed during Callaway's third 10-year inservice inspection (ISI) interval in accordance with Relief Request I3R-10, which was authorized by letter dated October 31, 2008 (Reference 6), as supplemented by letter dated November 7, 2008 (Reference 7), which replaced ASME Code, Class 3 buried ESW piping with HDPE piping to address reoccurring corrosion issues with the existing piping.

The licensee's current relief request submission requests the use of a system leakage test per ASME Code, Section XI, Subsubarticle IWD-5220, in lieu of a hydrostatic pressure test.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements set forth in the ASME Code, Section XI, to the extent practical within the limitations of design, geometry, and materials of construction of the components.

The regulations in 10 CFR 50.55a(z) state that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if the licensee demonstrates (1) the proposed alternatives would provide an acceptable level of quality and safety or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

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 Commission to authorize the proposed alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 Proposed Request for Relief I4R-01

The ASME Code components affected by the licensee's request are as follows:

ESW Supply Piping Lines:

- EF-003-AZC, A Train, 36-inch diameter, 411 feet
- EF-007-AZC, B Train, 36-inch diameter, 518 feet

ESW Return Piping Lines:

- EF-083-AZC, A Train, 36-inch diameter, 279 feet
- EF-140-AZC, B Train, 36-inch diameter, 288 feet

Callaway's Code of record for the fourth 10-year ISI interval, which began on December 19, 2014, is the ASME Code, Section XI, Division 1, 2007 Edition through the 2008 Addenda. Relief is requested for the remaining life of the plant, including plant life extension through October 18, 2044.

The applicable ASME Code requirement is Subparagraph IWA-4221(b), which requires that "An item to be used for repair/replacement activities shall meet the Construction Code specified in accordance with (1), (2), or (3)," and ASME Code, Section XI, IWA-4221(b)(1), which requires that "when replacing an existing item, the new item shall meet the Construction Code to which the original item was constructed."

The Construction Code of record for buried ASME Class 3 ESW piping is ASME Code, Section III, Division 1, Subsection ND, 1974 Edition, through Summer 1975 Addenda. This Construction Code and later editions and addenda of this Construction Code do not provide rules for the design, fabrication, installation, examination, and testing of piping constructed using polyethylene material. By letter dated October 31, 2008, as supplemented by letter dated November 7, 2008, the NRC approved HDPE for use for the buried section of the ESW system in lieu of the carbon steel piping for Callaway's third 10-year ISI interval.

As part of its proposed alternative and basis for use for Relief Request I4R-01, the licensee stated in its letter dated April 24, 2015, that

> In regard to continued use of the HDPE piping at Callaway, and to address the regulator's position that periodic testing would serve as a means to ensure integrity of the piping throughout the remainder of plant life, (as acknowledged in Ameren Missouri's letter ULNRC-06146, "Supplement to 10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Class 3 Buried Piping," dated September 30, 2014), 10-year periodic hydrostatic pressure testing of the HDPE piping will be performed prior to the end of the second period of the fourth 10-year ISI interval, and then once during each of the subsequent 10-year ISI intervals for the remainder of life of Callaway Plant.

3.2 NRC Staff Evaluation

The use of HDPE was approved for Callaway's third 10-year ISI interval (Relief Request I3R-10) by letter dated October 31, 2008, as supplemented by letter dated November 7, 2008. At that time, HDPE was not in use in nuclear power facilities in the United States, which warranted a 10-year limit to the NRC staff's approval and later, continued use as approved via the May 12, 2015, Relief Request I4R-01. At the time of the HDPE approval for the Callaway plant, industry research and inservice history provided compelling evidence that the use of HDPE would provide an acceptable level of quality and safety for the remainder of plant life provided that periodic testing is performed. With the approval of the 2015 relief request, it was also reasoned that periodic hydrostatic testing would ensure that if any slow crack growth (SCG) or failures in the piping have occurred, the licensee would have the ability to perform repair/replacement activities before any adverse effects to the operation of the ESW piping system could occur.

In this current relief request, the licensee stated that since the approval of Relief Request I4R-01 in 2015, industry studies have been performed to examine the resistance of HDPE material to SCG. As a result of these tests, and testing performed on this material prior to installation, it was determined that the HDPE piping used for the ESW is highly resistant to SCG. The licensee further stated that the currently specified hydrostatic testing does not provide a corresponding increase in plant safety. Based on Electrical Power Research Institute (EPRI) testing in EPRI 1022565, "Slow Crack Growth Testing of High-Density Polyethylene Pipe: 2011 Update," August 31, 2011 (Reference 8), EPRI 3002003089, "Pennsylvania Edge Notched Tensile Resistance of High Density Polyethylene Butt Fusion Joints," August 16, 2016 (Reference 9), and *EPRI Journal*, "A Corrosion Free Alternative to Steel Pipes: EPRI Looks at High Density Polyethylene for Pipes in Nuclear Plants," November 10, 2017 (Reference 10); industry reports by JANA Corporation ("Bimodal PE's Contribution to the Life Expectancy Extension of Gas Distribution Pipelines"; Reference 11) and WL Plastics Corporation ("WL123-High Performance PE4710"; Reference 12); NRC-sponsored confirmatory testing ("A Review of Service Life Prediction Models for HDPE Piping for Nuclear Safety-Related Applications"; Reference 13 and "Comparison of Parent and Butt Fusion Material Properties of Unimodal High-Density Polyethylene"; Reference 14), as well as the inservice history and operating experience subsequent to Callaway's HDPE installation, the NRC staff notes that the bimodal resin, PE4710 with cell classification 445574C, used at Callaway for the ESW system is more resistant to SCG than the earlier unimodal resins. The engineering parameter generally used to determine SCG resistance is Pennsylvania Edge Notch Test (PENT). In a letter dated April 17, 2008 (Reference 15), the licensee stated that the bimodal resin HDPE material used at Callaway has a PENT value of greater than 10,000 hours whereas the SCG resistance for unimodal resins is 500 hours as noted in Reference 11. The ASME Code, Section III Mandatory

Appendix XXVI requires SCG resistance of 2000 hours or greater for the parent material, and Callaway's HDPE material has 10,000 hours or greater. Thus, it can be concluded that Callaway's HDPE material has adequate SCG resistance, providing reasonable assurance of long term structural integrity of Callaway's HDPE piping. In lieu of periodic hydrostatic testing at 1.1 times the design pressure, the NRC staff finds the licensee's proposed alternative of system leakage test per Subsubarticle IWD-5220 at the system pressure during each inspection period is acceptable because of the adequate SCG resistance of Callaway's HDPE material.

Additionally, EPRI 3002003089 (Reference 9), and "Comparison of Parent and Butt Fusion Material Properties of Unimodal High-Density Polyethylene" (Reference 14) indicate that the SCG resistance (the time to failure in the PENT test) for butt fusion joint material was an order of magnitude lower than that of the parent material. The primary concern with butt fusion joints is that indications of lowering SCG resistance in butt fusion joints could initiate SCG in the joint and may result in through-wall leaks. Therefore, the ASME Code requires that any joint found with such an indication needs to be removed and replaced regardless of the size of the indication. Callaway used only butt fusion joints in its HDPE installation and included adequate control of essential variables and implemented many requirements to ensure structural integrity of HDPE butt fusion joints (see the licensee's letter dated July 10, 2008; Reference 16). These measures included:

(a) the performance demonstration of butt fusion joints samples in tensile tests to verify that fusion joints are stronger than the pipe;

(b) not allowing repaired of fused joints to be used and requiring any unacceptable joint to be cut out and replaced;

(c) visual examination of surfaces of fusion joints, for proper bead configuration with no evidence of cracks, incomplete fusion, nor cleavage between fusion beads extending to the outside pipe surface or below;

(d) time of flight diffraction examination of completed fusion joints (except where geometry prohibits) and rejection of any joints with any unbonded areas;

(e) high-speed tensile impact tests on samples with only the acceptance of ductile type failure modes (where possible); and

(f) bend tests on fusion joint samples that demonstrate no cracks or fractures.

Additionally, there is no indication of joint issues and the piping system is operating satisfactorily during plant operation. Based on a review of the above measures implemented by the licensee during installation of HDPE, the NRC staff concludes that there is reasonable assurance that Callaway's HDPE piping, including butt fusion joints, are sound with adequate SCG resistance and will maintain their structural integrity during the entire plant life. Therefore, there is no additional benefit from periodic hydrostatic testing of Callaway's ESW HDPE piping system. Instead, an inservice system leakage test per Subsubarticle IWD-5220 during each inspection interval proposed by the licensee is an acceptable alternative.

4.0 CONCLUSION

As set forth above, the NRC staff's review has determined that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that

the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1). The staff also concludes that Callaway's HDPE provides reasonable assurance of the long-term structural integrity of Callaway's HDPE piping, and that the licensee's proposed alternative of a system leakage test per ASME Code, Section XI, Subsubarticle IWD-5220 at the system pressure during each inspection period, in lieu of periodic hydrostatic testing at 1.1 times the design pressure, is acceptable. Therefore, the NRC staff authorizes the proposed alternative to a periodic hydrostatic test of the HDPE for the remaining life of Callaway, including plant life extension through October 18, 2044.

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

5.0 REFERENCES

1. Wink, Roger C., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Proposed Supplement to NRC-Approved 10 CFR 50.55a Request (Relief Request I4R-01) Regarding Proposed Alternative to ASME Section XI Requirements for Class 3 Buried Piping," dated March 27, 2018 (ADAMS Accession No. ML18086B243).

2. Markley, Michael T., U.S. Nuclear Regulatory Commission, letter to Fadi Diya, Union Electric Company, "Callaway Plant, Unit 1 - Request for Relief I4R-01, Alternative to ASME Code Inservice Inspection Requirements for Class 3 Buried Piping (TAC No. MF4271)," dated May 12, 2015 (ADAMS Accession No. ML15064A125).

3. Maglio, Scott A., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Class 3 Buried Piping," dated June 10, 2014 (ADAMS Accession No. ML14161A399).

4. Maglio, Scott A., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Supplement to 10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Class 3 Buried Piping," dated September 30, 2014 (ADAMS Accession No. ML14273A528).

5. Maglio, Scott A., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Revision of 10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Class 3 Buried Piping," dated April 24, 2015 (ADAMS Accession No. ML15114A172).

6. Markley, Michael T., U.S. Nuclear Regulatory Commission, letter to Adam C. Heflin, Union Electric Company, "Callaway Plant, Unit 1 – Relief Request I3R-10 for Third 10-Year Inservice Inspection Interval – Use of Polyethylene Pipe in Lieu of Carbon Steel Pipe in Buried Essential Service Water Piping System (TAC No. MD6792)," dated October 31, 2008 (ADAMS Accession No. ML082640007).

7. Markley, Michael T., U.S. Nuclear Regulatory Commission, letter to Adam C. Heflin, Union Electric Company, "Callaway Plant, Unit 1 – Relief Request I3R-10 Approved on October 31, 2008 for Third 10-Year Inservice Inspection Interval – Use of Polyethylene Pipe in Lieu of Carbon Steel Pipe in Buried Essential Service Water Piping System (TAC No. MD6792)," dated November 7, 2008 (ADAMS Accession No. ML083100288).

8. Electric Power Research Institute, "Slow Crack Growth Testing of High-Density Polyethylene Pipe: 2011 Update," EPRI Report 1022565, August 31, 2011.

9. Electric Power Research Institute, "Pennsylvania Edge Notched Tensile Resistance of High Density Polyethylene Butt Fusion Joints," EPRI Report No. 3002003089, August 16, 2016.

10. Electric Power Research Institute, "A Corrosion Free Alternative to Steel Pipes: EPRI Looks at High Density Polyethylene for Pipes in Nuclear Plants," S. Stankorb, EPRI Journal, November 10, 2017.

11. JANA Corporation, JANA Technology, "Bimodal PE's Contribution to the Life Expectancy Extension of Gas Distribution Pipelines," Dr. K. Oliphant, Dr. P. Angelo, and P. Vibien, D., JANA Corporation: Chang, J. Brodil, The Dow Chemical Company, 2015.

12. WL Plastics Corporation, "WL123-High Performance PE4710," Document No. WL123-0412, April 2012.

13. Engineering Mechanics Corporation of Columbus, Presentation, "A Review of Service Life Prediction Models for HDPE Piping for Nuclear Safety-Related Applications," Dr. P. Krishnaswamy, and D. J. Shim, Engineering Mechanics Corporation of Columbus, Conference Session Title: "Slow Crack Growth - A Global Survey" Presented at Plastics Pipes XV Conference, Vancouver, Canada, September 22, 2010 (ADAMS Accession No. ML102500340).

14. "Comparison of Parent and Butt Fusion Material Properties of Unimodal High-Density Polyethylene," P. Krishnaswamy, D. J. Shim, and S. Kalyanam, Journal of Pressure Vessel Technology, Volume 139, May 2017.

15. Graessle, Luke H., Union Electric Company (Ameren UE), letter to U.S. Nuclear Regulatory Commission "Docket Number 50-483, Callaway Plant Unit 1, Union Electric Company, Facility Operating License NPF-30, 10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Replacement of Class 3 Buried Piping (TAC No. MD6792)," dated April 17, 2008 (ADAMS Accession No. ML081190648).

16. Mills, Keith, A., Union Electric Company (Ameren UE), letter to U.S. Nuclear Regulatory Commission, "Docket Number 50-483, Callaway Plant Unit 1, Union Electric Company, Facility Operating License NFP-30, 10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Replacement of Class 3 Buried Piping (TAC Number MD6792)," dated July 10, 2008 (ADAMS Accession No. ML082470210).

Principal Contributors: Chakrapani Basavaraju
Roger Kalikian

Date: November 26, 2018

SUBJECT: CALLAWAY PLANT, UNIT 1 – REQUEST FOR RELIEF RELATED TO THE INSERVICE INSPECTION PROGRAM FOR CLASS 3 BURIED HIGH-DENSITY POLYETHYLENE PIPING (EPID L-2018-LLR-0039) DATED NOVEMBER 26, 2018

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