April 24, 2015

ULNRC-06214

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

10 CFR 50.55a

Ladies and Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
FACILITY OPERATING LICENSE NPF-30
REVISION OF 10 CFR 50.55a REQUEST: PROPOSED ALTERNATIVE TO ASME SECTION XI REQUIREMENTS FOR CLASS 3 BURIED PIPING (TAC NO. MF4271)

References: 1) Ameren Missouri Letter ULNRC-06115, "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)
2) Ameren Missouri 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 (ADAMS Accession No. ML14273A528)

Pursuant to 10CFR50.55a(z)(1), and by letter dated June 10, 2014 (Reference 1), as supplemented by letter dated September 30, 2014 (Reference 2), Union Electric Company (Ameren Missouri) submitted for NRC approval relief request I4R-01 regarding paragraph IWA-4221(b) of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI.

The requested relief is for an extension of the relief granted by the NRC for the third 10-year ISI Interval, which supported replacement of buried steel piping in Callaway's essential service water (ESW) system with high-density polyethylene (HDPE) piping. The proposed duration of the requested relief is for the remaining life of the Callaway Plant, Unit 1, including plant life extension through October 18, 2044, beginning with the fourth (i.e., current) 10-year Inservice Inspection (ISI) interval, which begins December 19, 2014. The Code Edition applicable to the fourth 10-year ISI interval for Callaway Plant is the 2007 Edition (up to and including the 2008 Addenda).

Ameren Missouri's relief request is presently under review by the NRC staff. To address the NRC staff position that periodic testing would serve as a means to ensure the integrity of the piping throughout the remainder of plant life, Reference 2 was submitted to supplement the relief request with a commitment for Ameren Missouri to perform a 10–year periodic hydrostatic pressure test of the HDPE piping in the ESW system. Subsequently, however, by electronic mail correspondence dated March 11, 2015, the NRC requested that the commitment be incorporated in the relief request itself. The revised relief request I4R-01, which now includes the requirement for a 10-year periodic hydrostatic pressure test of the HDPE piping in the ESW system, is attached.

This letter contains no new commitments.

If there are any questions, please contact J. P. Kovar at (314) 225-1478

Sincerely,

Scott A. M

Scott A. Maglio
Manager, Regulatory Affairs

JPK

Attachment: Relief Request I4R-01, "Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(z)(1)"

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10 CFR 50.55a Request I4R-01

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(z)(1)

--Alternative Provides Acceptable Level of Quality and Safety--

1. ASME Code Component(s) Affected

ASME Class 3 buried Essential Service Water (ESW) System supply and return piping replaced with high-density polyethylene (HDPE) piping in accordance with Relief Request I3R-10 during Callaway's third 10-year inservice inspection interval.

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

2. Applicable Code Edition and Addenda

The Code Edition and Addenda applicable to Callaway for its fourth Inservice Inspection (ISI) interval, that began December 19, 2014, is ASME Boiler and Pressure Vessel Code, Section XI, Division 1, 2007 Edition through 2008 Addenda.

3. Applicable Code Requirement

ASME Section XI, IWA-4221(b) 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 Section XI, IWA-4221(b)(1) requires that "When replacing an existing item, the new item shall meet the Construction Code to which the original item was constructed." ASME Section XI, IWA- 4221(c) states that as an alternative, Construction Code Cases may be used.

4. Reason for Request

The Construction Code of record for buried ASME Class 3 ESW piping is ASME Boiler and Pressure Vessel 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. Union Electric Company Relief Request I3R-10, which was transmitted to the U.S. Nuclear Regulatory Commission (NRC) through letter dated August 30, 2007, and supplemented by letters dated April 17, July 10, July 24, September 15, and October 9, 2008, provided conditions under which polyethylene material may be used for ASME Section III, Division 1, Class 3, buried piping systems. I3R-10 was accepted by the NRC as documented in their letter dated October 31, 2008, and amended by letter dated November 7, 2008, with the following three commitments:

[1] *AmerenUE [Union Electric, d.b.a. Ameren Missouri] will evaluate future investigations performed by the industry to confirm the short-duration (30-day) stress allowables and applicable design factors for PE4710 piping.* [2] *AmerenUE will also evaluate future evolution of the fusion technique to validate structural integrity of the installed fusion joints.* [3] *The results of the evaluations will be submitted to the NRC prior to submittal of Callaway's fourth 10-year interval ISI plan, and will include, if necessary, a fourth 10-year ISI interval alternative request.*

The NRC has determined that Callaway must submit an alternative request for the fourth 10-year ISI interval; therefore, this request is being submitted to allow the continued use of HDPE piping in those sections of the ESW system replaced with HDPE piping during the third ISI interval.

5. Proposed Alternative and Basis for Use

It is Callaway's intent to continue to use the HDPE piping installed in the ESW system for the remaining life of Callaway Plant, beginning with the fourth ISI interval, which began December 19, 2014. To support the continued, alternative use of HDPE piping in the ESW system, each of the three commitments agreed to in I3R-10 (and as noted above) are addressed, along with an updated evaluation or disposition for each commitment, as follows:

[1] *AmerenUE will evaluate future investigations performed by the industry to confirm the short-duration (30-day) stress allowables and applicable design factors for PE4710 piping.*

EPRI Report 1025254 *Tensile Stress-Strain Properties and Elastic Modulus of PE 4710 Cell Classification 445574C High Density Polyethylene Pipe Material* (2012), Section 3 states:

> The results obtained in this study show that the three materials used in the testing are all qualified to PE 4710 cell classification 445574C [the same as used at Callaway] and meet all requirements of Code

Case N755-1. The comparisons of test results and the allowable stress values in section 2.7 result in high safety factors of >4 for long-term duration (≤50 years) allowable stress values in Code Case N755-1 (500 psi @ 140°F) and >3 for short-term (<5 minutes) duration allowable stress values. The report further recommends that the allowable stress values in Code Case N755-1 (5-minute short term of 400 psi @ 176°F, interpolated for the EPRI testing as 306 psi @ 185°F) could be increased based on the tensile testing results. Although specific testing for load durations of up to 30 days at 175°F was not performed, test results do indicate that the allowable stresses for HDPE in Code Case N-755-1 are generally conservative by 3 to 4 orders of magnitude.

In addition to the results of EPRI Report 1025254 discussed above, it is important to recognize that all PE 4710 compounds are tested at more limiting conditions as part of the validation process in accordance with the requirements of Plastics Pipe Institute (PPI) TR-3, *Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe*. Per PPI TR-3, in order to validate an HDB of 1000 psi at 140°F (the same HDB as the PE compound utilized for the Callaway ESW piping), a PE compound must be tested at 193°F and 690 psi for at least 3,800 hours (~158 days) or at 176°F and 775 psi for at least 11,300 hours (~471 days).

As part of the validation process, the actual PE composition used for the Callaway ESW piping was tested at a higher temperature than the peak Callaway design temperature (tested at ≥ 176°F versus the maximum design temperature of 175°F), and at an initial stress 21% more than that necessary to support the Callaway short-term allowable stress of 340 psi. Tests were performed at 775 psi versus a required stress of 640 psi to support the 0.50 Design Factor for Callaway.

Furthermore, the tests extended over a duration of more than thirty (30) times the maximum design duration of the Callaway post-accident design conditions. Tests extended over 943 days with test results remaining above 725 psi (equating to 362 psi allowable), versus the Callaway post-accident design duration of 30 days and 340 psi allowable. The following is a tabulation of the test results provided by DOW Chemical for the actual Callaway PE 4710 compound.

Callaway PE4710 Elevated Temperature Hydrostatic Test Data

Callaway Condition			Hydrostatic Test Data			Safety Margin		
temperature. F	Time, hrs	Stress, psi	temperature. F	Time, hrs	Stress, psi	Tested Temperature versus Callaway temperature	tested times/Callaway design time	Tested stresses/Callaway design stress
175	720	340	176	7443	775	higher	10.3	2.3
175	720	340	176	9564	775	higher	13.3	2.3
175	720	340	176	17600	775	higher	24.4	2.3
175	720	340	176	14437	750	higher	20.1	2.2
175	720	340	176	21442	750	higher	29.8	2.2
175	720	340	176	21480	750	higher	29.8	2.2
175	720	340	176	21451	725	higher	29.8	2.1
175	720	340	176	21753	725	higher	30.2	2.1
175	720	340	176	22625	725	higher	31.4	2.1

The above test results provide conclusive evidence that the short term duration (30-day) stress allowables used for the Callaway HDPE Piping design are in fact conservative, resolving the question raised by the Regulator during review of the Callaway Relief Request I3R-10. In addition, Callaway actually used a heavier pipe wall than needed by design for the return piping (3.82" min wall vs. 2.24" required by design); therefore, additional design margin exists with the conservative short-term allowables actually incorporated in the design.

Conclusion (1): The allowable stress of 340 psi at 175 °F is a conservative value proven by actual test, and maintains a factor of safety of more than 2 (i.e. a Design Factor of 0.5 or less).
With respect to Design Factor, subsequent to submittal of the commitment Callaway actually decided to use the NRC-requested Design Factor of 0.50 for design of the HDPE piping system, in lieu of the industry recommended 0.63 for PE4710 (or 0.56 as originally proposed by Callaway). It may be noted that the latest versions of ASME Code Committee documents dealing with HDPE piping for nuclear applications have also invoked the 0.50 Design Factor for allowable stresses used in such design.

Conclusion (2): There are no unresolved issues with the Design Factor actually used in the Callaway design.

[2] *AmerenUE will also evaluate future evolution of the fusion technique to validate structural integrity of the installed fusion joints.*

The fusion technique used for the Callaway project was based on PPI, TR-33/2001, "Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe," developed at the request of U.S. Department of Transportation for use on gas transmission piping. On-going testing has been performed by PPI over the years to validate the suitability of the TR-33 Fusing Procedure for different polyethylene materials, in different sizes and thicknesses. Initially, this testing only involved fusing of 2DR11 and 8DR11 MDPE and HDPE (PE2406 and PE3408) piping to each other and to themselves (TR-33, 2001).

As of the time of the commitment to evaluate evolution of the fusing technique (ULNRC-05517, AmerenUE letter to NRC dated July 10, 2008) samples of PE2406 and PE3408 in sizes of 12DR6 through 22DR11 had been tested by PPI to validate the Standard Fusing Procedure for use with these larger sizes (TR-33, 2006). However, there had been no industry fusion testing of the new bimodal PE4710 material, or for any piping as large as the 36DR9.5 piping that was planned to be installed at Callaway.

DOW Chemical, the supplier of the DGDA 2490/92 PE4710 compound used for the Callaway pipe, had performed joint testing consisting of tensile, high speed tensile impact, quick burst and sustained pressure testing (> 1 year at elevated temperatures) on fused PE4710 piping up to 22DR9 in size, and those results were used as a basis for verifying fusibility of the material for the Callaway project (DOW letter to Ameren dated June 24, 2008).

Performance demonstration testing was subsequently performed by the Callaway project using the PPI Standard Fusing Procedure to validate fusibility of the actual PE4710 material, pipe diameter, wall thickness, and fusing machines to be employed. This involved 12 sample joints of 36DR9.5 pipe fused at the extremes of the fusing procedure, resulting in 48 coupons split into 96 test specimens. All 96 test specimens passed the High Speed Tensile Impact Test.

During the course of installation, 208 butt-fused joints were made in the 36DR9.5 piping and all were examined by the Time-of-Flight Diffraction (TOFD) technique of ultrasonic examination. The acceptance criterion was "no indication of a flaw or void," resulting in a total of 5 rejected fusion joints. Four of these rejected joints involved very minor indications of voids, causing the joints to be re-made. One (1) out of 208 36DR9.5 joints contained a relatively large area of voiding, which was attributed to improper application of external force during the fusing process.

In addition, all joints completed during the installation at Callaway were hydrostatically tested at 1.5 times the design pressure +10 psig, with no failures.

After the Callaway project was completed, the Plastics Pipe Institute continued with additional fusion testing under TR-33, using the same Standard Fusing Procedure with PE4710 material in sizes from 2DR11 through 36DR9 (reference TR-33, 2012). All of this testing reaffirmed that the standard fusing procedure applied at Callaway was appropriate for PE4710 material.

In the more than five years since the commitment was made to evaluate evolution of the fusion technique, extensive testing performed at Callaway and by the industry has reaffirmed applicability of the technique used during the project on 36DR9.5 piping consisting of PE4710 material. In addition, there have been no test results, no incidents in the industry, and no other evidence that would otherwise indicate non-suitability of the fusion technique applied at Callaway.

Conclusion (3): Structural integrity of the installed fusion joints in 36DR9.5 piping consisting of PE4710 material has been validated by test and experience.

[3] *The results of the evaluations will be submitted to the NRC prior to submittal of Callaway's fourth 10-year interval ISI plan, and will include, if necessary, a fourth 10-year ISI interval alternative request.*

The above results, and a fourth 10-year ISI interval alternative request were submitted to the NRC by Ameren Missouri (under cover of letter ULNRC-06115, "10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Class 3 Buried Piping," dated June 10, 2014) prior to the submittal of Callaway's fourth 10-year interval ISI plan.

Pursuant to 10 CFR 50.55a(a)(3)(i), in lieu of the requirement of Section XI IWA- 4221(b)(1), this alternative to the original Construction Code provides an acceptable level of quality and safety for repair/replacement activities for ASME Class 3 buried piping.

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.

6. Duration of Proposed Alternative

The use of the proposed alternative is requested for the remaining life of the Callaway Plant, Unit 1, including plant life extension that has been sought through October 18, 2044.

7. Precedents

The alternative to use HDPE piping in Callaway's ESW system was previously proposed in Relief Request I3R-10 submitted to the NRC via AmerenUE Letter ULNRC-05434 dated August 30, 2007, and was approved by NRC letter dated October 31, 2008, as supplemented by NRC letter dated November 7, 2008 (TAC No. MD6792).

8. References

1. *Tensile Stress-Strain Properties and Elastic Modulus of PE4710 Cell Classification 445574C High Density Polyethylene Pipe Material,* EPRI, Palo Alto, CA: 2012. Technical Report 1025254.
2. Plastics Pipe Institute, TR-3, "Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe"
3. Summary of test data for Callaway PE4710 resin submitted by DOW Chemical to PPI for ISO 9080 CRS Listing, and transmitted by J. Zhou to J. E. O'Sullivan of Procon1, LLC, on January 22, 2014.
4. Plastics Pipe Institute, TR-33/2001, "Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe."