

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

March 31, 2015

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

# SUBJECT: CALLAWAY PLANT, UNIT 1 - ISSUANCE OF AMENDMENT RE: REVISION TO FINAL SAFETY ANALYSIS REPORT-STANDARD PLANT SECTION 3.6 TO INCLUDE A NEW PIPE CRACK EXCLUSION ALLOWANCE (TAC NO. MF3202)

Dear Mr. Diya:

The U.S. Nuclear Regulatory Commission (NRC, the Commission) has issued the enclosed Amendment No. 211 to Renewed Facility Operating License No. NPF-30 for the Callaway Plant, Unit 1. The amendment consists of changes to the licensing basis as described in the Final Safety Analysis Report (FSAR)-Standard Plant in response to your application dated December 6, 2013, as supplemented by letters dated September 2 and December 11, 2014, and February 3, 2015.

The amendment adds a new pipe crack exclusion allowance to FSAR-Standard Plant Section 3.6.2.1.2.4, "ASME [American Society of Mechanical Engineers] Section III and Non-Nuclear Piping-Moderate-Energy," and FSAR-Standard Plant Table 3.6-2, "Design Comparison to Regulatory Positions of Regulatory Guide 1.46, Revision 0, dated May 1973, titled 'Protection Against Pipe Whip Inside Containment," in particular regard to the high-density polyethylene (HDPE) piping installed in ASME Class 3 line segments of the essential service water system. Also, new Reference 25 is added to FSAR-Standard Plant Section 3.6.3 to cite the NRC-approved version of the HDPE requirements covered by Relief Request I3R-10 dated October 31, 2008. F. Diya

A copy of the related Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's next biweekly *Federal Register* notice.

Sincerely,

Balwantesinge for Carl F. Lyon, Project Manager

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Carl F. Lyon, Project Manager Plant Licensing Branch IV-1 Division of Operating Reactor Licensing Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosures:

1. Amendment No. 211 to NPF-30

2. Safety Evaluation

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

# UNION ELECTRIC COMPANY

# CALLAWAY PLANT, UNIT 1

# DOCKET NO. 50-483

# AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 211 License No. NPF-30

- 1. The Nuclear Regulatory Commission (the Commission) has found that:
  - A. The application for amendment by Union Electric Company (UE, the licensee), dated December 6, 2013, as supplemented by letters dated September 2 and December 11, 2014, and February 3, 2015, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's regulations set forth in 10 CFR Chapter I;
  - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
  - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
  - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
  - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

- 2. Accordingly, the license is amended by changes to the licensing basis as described in the Final Safety Analysis Report-Standard Plant, and Paragraph 2.C.(2) of Renewed Facility Operating License No. NPF-30 is hereby amended to read as follows:
  - (2) Technical Specifications and Environmental Protection Plan\*

The Technical Specifications contained in Appendix A, as revised through Amendment No. 211 and the Environmental Protection Plan contained in Appendix B, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This amendment is effective as of its date of issuance, and shall be implemented within 60 days of the date of issuance. In addition, the licensee shall include the revised information in the next Final Safety Analysis Report update submitted to the NRC in accordance with 10 CFR 50.71(e), as described in the licensee's application dated December 6, 2013, as supplemented by letters dated September 2 and December 11, 2014, and February 3, 2015, and evaluated in the staff's safety evaluation enclosed with this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

CFJyon for

Michael T. Markley, Chief Plant Licensing Branch IV-1 Division of Operating Reactor Licensing Office of Nuclear Reactor Regulation

Attachment: Changes to the Renewed Facility Operating License No. NPF-30

Date of Issuance: March 31, 2015

## ATTACHMENT TO LICENSE AMENDMENT NO. 211

## RENEWED FACILITY OPERATING LICENSE NO. NPF-30

#### DOCKET NO. 50-483

Replace the following page of the Renewed Facility Operating License No. NPF-30 with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

## Renewed Facility Operating License

REMOVE

**INSERT** 

-3-

-3-

- (3) UE, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;
- (4) UE, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source of special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
- (5) UE, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.
- C. This renewed license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:
  - (1) Maximum Power Level

UE is authorized to operate the facility at reactor core power levels not in excess of 3565 megawatts thermal (100% power) in accordance with the conditions specified herein.

(2) Technical Specifications and Environmental Protection Plan\*

The Technical Specifications contained in Appendix A, as revised through Amendment No. 211 and the Environmental Protection Plan contained in Appendix B, are hereby incorporated in the renewed license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Environmental Qualification (Section 3.11, SSER #3)\*\*

Deleted per Amendment No. 169.

<sup>\*</sup> Amendments 133, 134, & 135 were effective as of April 30, 2000 however these amendments were implemented on April 1, 2000.

<sup>\*\*</sup> The parenthetical notation following the title of many license conditions denotes the section of the Safety Evaluation Report and/or its supplements wherein the license condition is discussed.



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

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

# RELATED TO AMENDMENT NO. 211 TO

# RENEWED FACILITY OPERATING LICENSE NO. NPF-30

# UNION ELECTRIC COMPANY

# CALLAWAY PLANT, UNIT 1

# DOCKET NO. 50-483

# 1.0 INTRODUCTION

By application dated December 6, 2013 (Reference 1), as supplemented by letters dated September 2 and December 11, 2014, and February 3, 2015 (References 2, 3, and 4, respectively), Union Electric Company (dba Ameren Missouri, the licensee) requested changes to Renewed Facility Operating License No. NPF-30 for the Callaway Plant, Unit 1 (Callaway). The licensee proposed changes to the licensing basis as described in the Final Safety Analysis Report (FSAR)-Standard Plant.

The proposed amendment would add a new pipe crack exclusion allowance to FSAR-Standard Plant Section 3.6.2.1.2.4, "ASME [American Society of Mechanical Engineers] Section III and Non-Nuclear Piping-Moderate-Energy," and FSAR-Standard Plant Table 3.6-2, "Design Comparison to Regulatory Positions of Regulatory Guide 1.46, Revision 0, dated May 1973, titled 'Protection Against Pipe Whip Inside Containment," for the high-density polyethylene (HDPE) piping installed in ASME *Boiler and Pressure Vessel Code* (Code) Class 3 line segments of the essential service water (ESW) system. New Reference 25 would be added to FSAR-Standard Plant Section 3.6.3 to cite the NRC-approved version of the HDPE requirements covered by Relief Request (RR) I3R-10 dated October 31, 2008 (Attachment 3 of Reference 1).

Specifically, the proposed amendment adds a new crack exclusion for moderate energy HDPE piping based on computed stress levels. This HDPE piping is safety-related and is classified as ASME Code, Section III, Class 3. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), paragraph 50.55a(a)(3)(i), the NRC previously approved Callaway's RR I3R-10 pursuant to the licensee's letter dated July 10, 2008, as supplemented by letter dated July 24, 2008 (References 5.a and 5.b), for the replacement of carbon steel piping in ESW supply and return trains A and B with HDPE material, as an alternative to ASME Code, Section XI requirements. Section 50.55a(a)(3)(i) was renumbered as 50.55a(z)(1) as part of the revisions to 10 CFR 50.55a that were published in the *Federal Register* on November 5, 2014 (79 FR 65776), and became effective December 5, 2014.

The supplemental letters dated September 2 and December 11, 2014, and February 3, 2015, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the U.S. Nuclear Regulatory Commission (NRC) staff's original proposed no significant hazards consideration determination as published in the Federal Register on March 18, 2014 (79 FR 15150).

## 1.1 Background

The ESW system provides a heat sink for the removal of process and operating heat from safety-related components during a design-basis accident or transient. During normal operation and a normal shutdown, the ESW system also provides this function for various safety-related and non-safety related components and receives coolant flow from the non-safety related service water system. The principal safety-related function of the ESW system is the removal of decay heat from the reactor via the component cooling water system and removal of containment heat loads via the containment coolers.

The ESW system consists of two separate, 100 percent capacity, safety-related, cooling water trains A and B. Each train consists of a self-cleaning strainer, pre-lube tank, one 100-percent capacity pump, piping, valves, and instrumentation. The pumps and valves are remotely and manually aligned, except in the unlikely event of a loss-of-coolant accident. The pumps are automatically started upon receipt of a safety injection signal, low suction pressure to the auxiliary feedwater pumps coincident with an auxiliary feedwater actuation signal, or loss of offsite power. Upon receipt of one of these signals, the automatically actuated essential valves are aligned to their post-accident positions as required. The ESW system also provides emergency makeup to the spent fuel pool and component cooling water system and is the backup water supply to the auxiliary feedwater system.

The ultimate heat sink (UHS) provides a heat sink during a transient or accident, as well as during normal operation, via the ESW system. The two principal functions of the UHS are the dissipation of residual heat after reactor shutdown and dissipation of residual heat after an accident.

# 2.0 REGULATORY EVALUATION

The licensee's proposed amendment would allow use of a new pipe crack exclusion allowance for HDPE piping installed in ASME Code, Section III, Class 3 line segments of the ESW system. The proposed amendment would revise the licensing basis as described in FSAR-Standard Plant Section 3.6.2.1.2.4 related to ASME Code, Section III and Non-Nuclear Piping of Moderate-Energy, and FSAR-Standard Plant Table 3.6-2, Design Comparison to Regulatory Positions of Regulatory Guide (RG) 1.46 (Reference 7), Protection Against Pipe Whip Inside Containment, for the HDPE piping installed in ASME Code, Section III Class 3 line segments of the ESW system.

The change to FSAR-Standard Plant Table 3.6-2 involves Branch Technical Position (BTP) MEB 3-1 of NUREG-0800, Standard Review Plan, Section 3.6.2, Revision 1, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," July 1981, Position B.2.c (Reference 8). The methods in NRC BTPs (including MEB 3-1 as well as RG 1.46) are used to support FSAR analyses and to demonstrate that the intended design function of safe shutdown will be accomplished with consideration given to the dynamic effects of a moderate energy pipe break.

The proposed change, which involves applying an alternate method to add a low stress, leakage crack exception for HDPE piping, represents a change in method for postulating moderate energy leakage cracks. Based on its evaluation under 10 CFR 50.59(c)(2)(viii), the licensee determined that the proposed change for moderate energy HDPE crack exclusion needs to be submitted to the NRC for review and approval. Therefore, the licensee submitted a license amendment request pursuant to 10 CFR 50.90, as required by 10 CFR 50.59.

The licensee provided an evaluation of the proposed FSAR changes, which proposed that the applicable non-buried ESW HDPE piping segments in the Control Building Basement (CBB) and UHS Penetration Room experience low-stress levels such that a leakage crack need not be postulated.

The following regulatory requirements and guidance documents are also applicable to the ESW system:

- General Design Criterion (GDC) 2, "Design bases for protection against natural phenomena," of Appendix A to 10 CFR Part 50, requires, in part, that "[s]tructures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without the loss of the capability to perform their safety functions."
- GDC 4, "Environmental and dynamic effects design bases," requires that "[s]tructures, systems, and components important to safety be designed to accommodate the effects of and to be compatible with the environmental conditions associated with the normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, discharging fluids, that may result from equipment failures, and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping."
- GDC 44, "Cooling water," requires that "[a] system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for

onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure."

- GDC 45, "Inspection of cooling water system," requires that "[t]he cooling water system shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the system."
- GDC 46, "Testing of cooling water system," requires that "[t]he cooling water system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and the performance of the active components of the system, and (3) the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for loss-of-coolant accidents, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources."

RG 1.27, Revision 2, "Ultimate Heat Sink for Nuclear Power Plants," dated January 1976 (Reference 9), describes the methods acceptable to the NRC that may be used in the design of the UHS. According to this regulatory guide, a reliable source of cooling water that can assure the safe shutdown of the plant during a design-basis accident over a 30-day time frame is appropriate for a power reactor.

The NRC staff concludes that there are no changes proposed in the license amendment application that would conflict with any of the above regulatory requirements and guidance documents.

## 2.1 Licensee Description of the Need for License Amendment

By letter dated October 31, 2008 (Attachment 3 of Reference 1), the NRC approved ASME Code RR I3R-10, allowing Callaway Plant to replace some of the Class 3 metallic ESW piping with HDPE piping. The associated plant modification package included installation of ESW system supply and return headers of 36-inch diameter HDPE piping. The supply headers (EF-003-AZC-36" and EF-007- AZC-36") carry water from the ESW pump house to the CBB. Most of the HDPE piping is buried but there is a small portion that is not buried. The HDPE portion extends underground from the ESW supply line yard vaults (which are train-separated) to the CBB where, after penetrating the below-grade basement wall, it transitions to stainless steel piping via transition flanges within 45.25-inch of the centerline of the basement wall. The return headers (EF-083-AZC-36" and EF-140-AZC-36") are also HDPE and carry water from within 45.25-inch of the centerline below-grade CBB wall to the below-grade portions of the penetration rooms (which are train-separated) of the UHS cooling tower.

The evaluations performed in support of MP-07-0066 failed to include an internal flooding analysis for the HDPE piping that was installed in the CBB (room 3101), the UHS cooling tower penetration rooms, and the ESW supply line yard vaults. No licensing basis, regulatory

guidance, or industry guidance exists for postulating moderate energy cracks in non-metallic piping. The proposed FSAR change adds another crack exclusion criterion to FSAR-Standard Plant Section 3.6.2.1.2.4 with a similar change made to FSAR-Standard Plant Table 3.6-2. The licensee has determined that the proposed change requires prior NRC approval per 10 CFR 50.59(c)(2)(viii) since it involves a departure from a method of evaluation described in the updated FSAR and used in establishing the design bases or in the safety analyses.

A new method of evaluation is proposed to be added to the section of the updated FSAR that establishes the design bases for internal flooding. The licensee proposed to add a low stress exclusion for HDPE piping approved for use in the NRC's safety evaluation related to RR I3R-10 to the list of crack exclusions in FSAR-Standard Plant Section 3.6.2.1.2.4. This proposed FSAR change eliminates the need to postulate a moderate energy pipe crack in the non-buried HDPE piping installed by MP-07-0066, based on the stress levels.

Based on a review of the licensee's evaluation that MP-07-0066 failed to include an internal flooding analysis for the installed non-buried portions of HDPE piping, the NRC accepts the licensee's determination to submit an amendment to the NRC for review of the methodology for exclusion of moderate energy crack postulation for non-buried portions of ASME Code Class 3 ESW HDPE piping.

# 3.0 TECHNICAL EVALUATION

## 3.1 Mechanical and Civil Engineering Evaluation

According to BTP 3-3 (Reference 9), a moderate energy fluid system is one where maximum operating temperature is 200 degrees Fahrenheit (°F) or less and maximum operating pressure is 275 pounds per square inch gauge (psig) or less. The Callaway ESW supply lines have a maximum operating temperature of 95 °F and a maximum operating pressure of 190 psig, and the ESW return lines have a maximum operating temperature of 175 °F and a maximum operating pressure of 45 psig; therefore, the NRC staff concludes that the ESW supply and return lines can be classified as moderate energy fluid piping systems.

A moderate energy pipe failure is defined in NRC BTPs ASB 3-1 (MEB 3-1) (Reference 9) which is also discussed in FSAR-Standard Plant Table 3.6-2. According to BTP MEB 3-1 Position B.3.c.(2) in FSAR-Standard Plant Table 3.6-2 sheet 14 and FSAR-Standard Plant Section 3.6.2.1.3.2, moderate energy pipe failure for safety-related Class 3 piping is defined as a crack with an area characterized as a circular opening with a cross-sectional flow area equal to that of a rectangle one-half the pipe inside diameter in length and one-half the pipe wall thickness in width.

FSAR-Standard Plant Section 3.6.2.1.2.4 item "c" contains a crack exception for piping designed to ASME Code, Section III, Class 2 or 3, and non-nuclear seismic Category 1 class piping. This exception requires that the maximum stress range in the piping, as calculated by the sum of Equation (Eq.) 9 and Eq. 10 in the ASME Code, Section III, Subarticle NC-3652 for normal and upset plant conditions, to be less than 0.4  $(1.2S_h + S_A)$ , where  $S_h$  is the allowable stress at the maximum (hot) temperature and  $S_A$  is the allowable stress for thermal expansion. The maximum stress limit of 0.4  $(1.2S_h + S_A)$  is intended to be a stress threshold to identify piping sections of sufficiently low stress such that failure at these locations is unlikely and therefore

cracks need not be postulated in moderate energy lines. If this stress criterion is met, then a moderate energy pipe crack need not be postulated, otherwise moderate energy pipe failure for safety-related Class 3 piping needs to be postulated.

It should be noted that the HDPE piping installed under modification package MP-07-0066 was not designed to Subarticle ND-3652 of ASME Code, Section III, because the ASME Code, Section III, Subsection ND, 1974 Edition through Summer 1975 Addenda, which is the Construction Code, as well as the later editions and addenda, do not provide rules for the design, fabrication, installation, examination, and testing of piping constructed using HDPE material. The specific information for HDPE design was submitted to the NRC for review as Enclosure 5 to the licensee's letter dated July 10, 2008 (Reference 5.a), as revised by Attachment 1 to the licensee's letter dated July 24, 2008 (Reference 5.b), and subsequently approved by the NRC in the safety evaluation related to RR I3R-10 (Attachment 3 of Reference 1). The HDPE piping design requirements in the NRC's safety evaluation related to RR I3R-10 have been captured in APA-ZZ-00662 Appendix F (Attachment 2 of Reference 1). Since the HDPE piping was not designed to Subarticle NC/ND-3652 of ASME Code, Section III, the exception in FSAR Section 3.6.2.1.2.4 item "c" does not apply.

The proposed FSAR change would add an additional exception specifically for low-stress HDPE piping designed to Attachment 2 of Reference 1, which would include the 36-inch ESW supply and return lines EF-003-AZC-36", EF-007-AZC-36", EF-083-AZC-36", and EF-140- AZC-36" (i.e., the applicable HDPE piping segments in the CBB and UHS penetration rooms). The proposed Moderate Energy Crack exclusion is specifically for ASME Code, Section III Class 3 non-buried portions of HDPE piping with 36-inch nominal outside diameter, and wall thickness 3.789 inches, which corresponds to a Dimension Ratio (outside diameter to wall thickness ratio, DR) of 9.5. The design criteria in APA-ZZ-00662, Appendix F (RR I3R-10) are different than those of ASME Code. Section III; however, the stresses calculated can be combined to represent Eq. 9 and Eq. 10 of ASME Code, Section III NC-3652 as illustrated in Pipe Stress Calculation 2007-16760, Revision 2, Addendum 2 (Attachment 4 of Reference 1). That calculation supports a determination that cracks need not be postulated in this HDPE piping for the purpose of evaluating flooding impacts, based on the demonstration in that calculation that the maximum stress range in the Class 3 HDPE piping is less than 0.4 (1.2S + 1100), where S is allowable stress (equivalent to S<sub>h</sub>) for HDPE at the maximum operating temperature and 1100 pounds per square inch (psi) for HDPE is equivalent  $S_A$  for thermal expansion-contraction stresses based on testing.

The HDPE ESW piping is designed using the alternative approved by the NRC in RR I3R-10. During the NRC review and acceptance of RR I3R-10, the NRC considered allowable stress S that incorporated a design factor of 0.5 for HDPE as being equivalent to  $S_h$ , and fatigue testing based allowable value of 1100 psi including thermal cycles as being equivalent to  $S_A$ . The material properties and allowable stresses for HDPE are based on cell classification 445574C per ASTM D 3350-05 (PE 4710). The material may contain a color stripe with cell classification 445574E. However, there is no physical difference between 445574C and 445574E other than color.

Eq. 9 and Eq. 10 and the allowable pipe stresses,  $S_h$  and  $S_A$  of ASME Code, Section III ND-3652, were not used because they were typically developed for ductile metallic materials. However, equivalent design equations similar to Eq. 9 and Eq. 10 and stress values from the

previously approved RR I3R-10 can be used to evaluate the exception allowed in FSAR Section 3.6.2.1.2.4(c).

- The allowable stress, S with a design factor of 0.5, in RR I3R-10, is equivalent to the ND-3652 stress allowable of S<sub>h</sub>.
- The Service Level B Longitudinal Stress Equation utilized in calculation 2007-16760 for the HDPE piping via APA-ZZ-00662 App. F is equivalent to S<sub>h</sub> in ND-3652 Eq. 9, for Service Level B. FSAR Chapter 3.6.2.1.2.4(c) requires the sum of Eq. 9 and Eq. 10, considering normal and upset (service level B) plant conditions, to be less than 0.4 (1.2S<sub>h</sub>+S<sub>A</sub>).
- The Alternative Thermal Expansion or Contraction Evaluation equation in calculation 2007-16760 is comparable to ND-3652 Eq. 10 for thermal expansion.

A summary comparison of Eq. 9 and Eq. 10 in RR I3R-10 and ASME Code, Section III ND-3652 to show similarity is provided below.

Eq. 9 Level-B in ASME Code, Section III ND-3652;  $B_1 (P_0 D/2t) + B_2 (M/Z) < k S_h$ 

k value of 1.2 is allowed in ND-3652 and MEB 3-1

Eq. 9 Level-B in HDPE RR I3R-10,  $B_1 (P_0 D/2t) + 2B_1(F_a/A) + B_2 (M/Z) < kS$ 

Here  $B_1$  and  $B_2$  are stress indices,  $P_o$  is design pressure, D is outside diameter, t is wall thickness,  $F_a$  and M are axial force and bending moment from Level-B loadings; A and Z are cross sectional metal area and section modulus, and  $S_h$  and S are allowable stresses, Eq. 9 for HDPE contains an additional stress term to include stresses from axial force, and therefore is conservative compared to Eq. 9 in ND-3652.

Eq. 10 in ASME Code, Section III Subsection ND-3652:  $iM_C/Z < S_A$ Eq. 10 in HDPE RR I3R-10:  $iM_C/Z + F_{aC}/A < 1100$  psi

> The first term ( $iM_c/Z$ ) is identical for the *Alternative Thermal Expansion or Contraction Evaluation* equation and ND-3652 Eq. 10. Eq. 10 for HDPE contains an additional stress term ( $F_{ac}/A$ ) to include stresses from axial force, and therefore is conservative compared to Eq. 10 in ND-3652. Here, i is stress intensification factor,  $F_{ac}$  and  $M_c$  are axial force range due to thermal expansion or contraction and/or the restraint of free end displacement A and Z are cross sectional metal area and section modulus,  $S_A$  and 1100 psi are allowable stresses.

- The allowable stress of 1100 psi in the Alternative Thermal Expansion or Contraction Evaluation equation for HDPE is equivalent to ND-3600 allowable stress range, S<sub>A</sub> in Eq. 10 for thermal expansion.
- The allowable stress S for use in Eq. 9 level B for HDPE which incorporated NRC required design factor of 0.50 is equivalent to S<sub>h</sub> in ND-3652.

The NRC staff's comparison of the guidance of RG 1.46 to the licensee's implementation of BTP MEB 3-1 and ASB 3-1 is summarized below.

Through-wall leakage cracks were not postulated in ASME Code, Section III, Class 2 or 3 piping and stress analyzed non-nuclear seismic Category I class piping, provided that the maximum stress range in the piping, as calculated by the sum of Eq. 9 for level B and Eq. 10 in Subarticle NC/ND-3652 of the ASME Code, Section III, considering normal and upset plant conditions, is less than 0.4 (1.2 S<sub>h</sub> + S<sub>A</sub>).

Through-wall leakage cracks were not postulated in safety-related, Class 3, HDPE piping provided that the maximum stress range in the piping, as calculated by the sum of the Service Level B Longitudinal Stress Equation and the Alternate Thermal Expansion or Contraction is less than 0.4 (1.2S + 1100). The Service Level B Longitudinal Stress Equation and Alternate Thermal Expansion and Contraction for HDPE are equivalent to the Eq. 9 and Eq. 10 stresses per ASME Section III, NC/ND-3652, considering normal and upset conditions, respectively.

The NRC staff's review of moderate energy crack postulation evaluations, as summarized in the following table (Table 1), based on the licensee's December 11, 2014, response (Reference 3) to NRC's request for additional information RAI-9(b) dated October 28, 2014 (Reference 11), show that the combined equivalent Eq. 9 Level-B and Eq. 10 stresses adapted for HDPE are below the crack postulation threshold adapted limit for the non-buried sections of HDPE piping of the ESW system located in the Control Building Room 3101 and the UHS penetration room. Therefore, moderate energy cracks need not be postulated.

Non-buried section of HDPE piping Location and Description	Design/ Max Pressure (psig)	Design Temperature / Thermal Mode Analyzed (°F)	Computed (Eq. 9 +Eq. 10) Stress (psi )	Moderate Energy Crack (MEC) Postulation Threshold Limit: (0.4) (1.2S <sub>h</sub> +1100) (psi)	Comment
Control Building Basement (CBB) ESW Train A Supply	190/190	95/95	694	774	MEC Crack postulation not required
CBB ESW Train B Supply	190/190	95/95	731	774	MEC Crack postulation not required
CBB ESW Train A Return	45/45	175/175	326	734	MEC Crack postulation not required
CBB ESW Train B Return	45/45	175/175	449	734	MEC Crack postulation not required

#### TABLE 1 SUMMARY OF NRC STAFF'S MODERATE ENERGY CRACK POSTULATION EVALUATIONS

Non-buried section of HDPE piping Location and Description	Design/ Max Pressure (psig)	Design Temperature / Thermal Mode Analyzed (°F)	Computed (Eq. 9 +Eq. 10) Stress (psi )	Moderate Energy Crack (MEC) Postulation Threshold Limit: (0.4) (1.2S <sub>h</sub> +1100) (psi)	Comment
UHS Penetration Room: ESW Train A Return	45/45	175/175	267	734	MEC Crack postulation not required
UHS Penetration Room: ESW Train B Return	45/45	175/175	267	734	MEC Crack postulation not required

#### Conclusion

In support of the proposed changes, the licensee performed an analysis which demonstrated that the sum of the *Service Level B Longitudinal Stress* and the *Alternative Thermal Expansion or Contraction Stress* in HDPE piping within the control building and the UHS cooling tower penetration rooms is below the Crack Postulation Threshold for all locations. The Crack Postulation Threshold limit used for HDPE is similar or practically equivalent to the limit for ASME Code, Section III Class 3 in MEB 3-1 Section B.2.b and Callaway FSAR Section 3.6.2.1.2.4. Therefore, no crack need be postulated in the moderate energy HDPE piping.

The NRC staff reviewed the evaluations the licensee performed to demonstrate that cracks need not be postulated in the safety-related ASME Code Class 3 moderate energy HDPE piping in the ESW supply and return lines. The NRC staff concludes that the licensee does not need to postulate moderate energy cracks in ASME Code Class 3 ESW HDPE piping, because the combined stresses from (equivalent to ASME Code, Section III Subsection ND-3652) Eq. 9 level B and Eq. 10 secondary stresses are below the applicable crack postulation stress threshold limit. Therefore, the proposed changes to the licensing basis described in the FSAR-Standard Plant Section 3.6.2.1.2.4 and Table 3.6-2 comply with GDC 2, 4, and 44 for the design of the ESW system piping, and do not affect continued compliance with GDC 45 and 46 for the inspection and testing of the piping to insure its integrity and capability, and are acceptable.

#### 3.2 Fire Hazard Evaluation

The NRC staff evaluated the fire hazard of non-buried portions of HDPE piping to safety-related ASME Code Class 3 components in the ESW system. Exposed HDPE piping is installed in the CBB, the UHS Penetration Room, and the Yard Vault, which may be subject to damage if a fire were to occur.

For the CBB, the licensee considered the HDPE piping terminations, there are four terminations that are 2 feet in length, and the likelihood that they could be damaged by fire. The licensee analyzed based on fire modeling that the exposed HDPE material would not be subject to fire damage from any fixed or postulated ignition source. The Callaway license amendment regarding transition to a risk-informed, performance-based fire protection program in accordance with 10 CFR 50.48(c) (i.e., National Fire Protection Association (NFPA) 805), dated

January 13, 2014 (Reference 12), includes a discussion of the HDPE piping in Section 3.4.2.2, Fire Probabilistic Risk Assessment Model. As discussed in the NFPA 805 safety evaluation, the licensee concluded that no fire damage to the HDPE piping would occur, and the NRC staff accepted this conclusion in the January 13, 2014, safety evaluation.

For the UHS Penetration Room and the Yard Vault, the licensee has evaluated that for each of these areas redundant ESW system capability is available in the event of the loss of integrity of the HDPE piping in these areas. In the event of a fire in these two areas, the licensee assumes that the HDPE piping would fail. The licensee further determined that based on separation between fire areas a fire in these areas would not impact equipment in other plant areas. Also, in the assumed event of a loss of piping integrity in these areas due to fire, the licensee determined that neither the loss of inventory due to flooding, nor the flooding itself would not prevent the opposite train from performing its intended design function.

## Conclusion

Based on review of the fire hazard evaluation of HDPE piping in the CBB, UHS Penetration Room, and the Yard Vault, the NRC staff concludes that the licensee has demonstrated that redundant ESW system capability is available in the event of the loss of integrity of the HDPE piping in these areas.

#### 4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Missouri State official was notified of the proposed issuance of the amendment on March 9, 2015. The State official had no comments.

## 5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration and there has been no public comment on such finding published in *Federal Register* on March 18, 2014 (79 FR 15150). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

# 6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

- Maglio, S., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Application for Amendment, Revision to FSAR Standard Plant Section 3.6 for HDPE Crack Exclusion," dated December 6, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13340A775); Attachment 1: FSAR Changes; Attachment 2: Calculation APA-ZZ-00662, Appendix-F; Attachment 3: NRC Safety Evaluation for Relief Request I3R-10, dated October 31, 2008 (ADAMS Accession No. ML083100288); Attachment 4: Pipe Stress Calculation 2007-16760 Revision 2, Addendum 2.
- 2. Maglio, S., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Response to NRC Request for Additional Information Regarding Application for Amendment, Revision to FSAR-Standard Plant Section 3.6 for HDPE Crack Exclusion," dated September 2, 2014 (ADAMS Accession No. ML14245A653).
- Maglio, S., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information Round 2 re: Application for Amendment to Facility Operating License NPF-30 Revision to Final Safety Analysis Report Standard Plant Section 3.6 for High Density Polyethylene Pipe Crack Exclusion (TAC No. MF3202, LDCN 13-0016)," dated December 11, 2014 (ADAMS Accession No. ML14345B052).
- Maglio, S., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information Round 3 re: Application for Amendment to Facility Operating License NPF-30 Revision to Final Safety Analysis Report Standard Plant Section 3.6 for High Density Polyethylene Pipe Crack Exclusion (TAC No. MF3202, LDCN 13-0016)," dated February 3, 2015 (ADAMS Accession No. ML15034A615).
- 5.a Mills, K. A., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, Document Control Desk, "10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Replacement of Class 3 Buried Piping (TAC No. MD6792)," dated July 10, 2008 (ADAMS Accession No. ML082470210).
- 5.b Graessle, L. H., Ameren Missouri, letter to U.S. Nuclear Regulatory Commission, "10 CFR 50.55a Request: Proposed Alternative to ASME Section XI Requirements for Replacement of Class 3 Buried Piping (TAC No. MD6792)," dated July 24, 2008 (ADAMS Accession No. ML082900027).
- 6. not used
- 7. Regulatory Guide 1.46, "Protection Against Pipe Whip Inside Containment," 1973 (Withdrawn in 1985).
- 8. U.S. Nuclear Regulatory Commission, Branch Technical Position (BTP) MEB 3-1 of NUREG-0800, Standard Review Plan, Section 3.6.2, Revision 1, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," July 1981, Position B.2.c (ADAMS Accession No. ML052340555). Branch

Technical Position MEB 3-1, "Postulated Rupture Locations in Fluid System Piping Inside And Outside Containment," (attached to SRP Section 3.6.2). Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" (attached to SRP Section 3.6.1; ADAMS Accession No. ML070550032).

- U.S. Nuclear Regulatory Commission, Regulatory Guide 1.27, Revision 2, "Ultimate Heat Sink for Nuclear Power Plants," January 1976 (ADAMS Accession No. ML003739969).
- U.S. Nuclear Regulatory Commission, NUREG-0800, Standard Review Plan, Branch Technical Position BTP 3-3, Revision 3, "Protection against Postulated Piping Failures in Fluid Systems Outside Containment," March 2007 (ADAMS Accession No. ML070800027).
- Lyon, C. F., U.S. Nuclear Regulatory Commission, letter to Fadi Diya, Union Electric Company, "Callaway Plant, Unit 1 - Request For Additional Information Round 2 Re: Revision To Final Safety Analysis Report Standard Plant Section 3.6 For High Density Polyethylene Crack Exclusion (TAC No. MF3202)," dated October 28, 2014 (ADAMS Accession No. ML14294A775).
- Lyon, C. F., U.S. Nuclear Regulatory Commission, letter to Adam C. Heflin, Union Electric Company, "Callaway Plant, Unit 1 - Issuance of Amendment Regarding Transition to a Risk-Informed, Performance-Based Fire Protection Program in Accordance with 10 CFR 50.48(c) (TAC No. ME7046)," dated January 13, 2014 (ADAMS Accession No. ML13274A596).

Principal Contributor: C. Basavaraju, NRR/DE/EMCB

Date: March 31, 2015

F. Diya

A copy of the related Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's next biweekly *Federal Register* notice.

Sincerely,

## /RA Balwant Singal for/

Carl F. Lyon, Project Manager Plant Licensing Branch IV-1 Division of Operating Reactor Licensing Office of Nuclear Reactor Regulation

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Docket No. 50-483

Enclosures:

- 1. Amendment No. 211 to NPF-30
- 2. Safety Evaluation

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\*memo dated \*\*Previously concurred

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DATE	3/31/15	3/31/15	3/31/15	

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