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

October 16, 2020

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

SUBJECT: CALLAWAY PLANT, UNIT NO. 1 - ISSUANCE OF AMENDMENT NO. 223 RE: ONE-TIME DEFERRAL OF THE STEAM GENERATOR TUBE INSPECTIONS (EPID L-2020-LLA-0142)

Dear Mr. Diya:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 223 to Renewed Facility Operating License No. NPF-30 for the Callaway Plant, Unit No. 1. The amendment consists of changes to the technical specifications (TSs) in response to your application dated June 26, 2020, as supplemented by letters dated July 21, 2020, and August 25, 2020.

The amendment revises TS 5.5.9, "Steam Generator (SG) Program," paragraph d.2 to allow a one-time deferral of the steam generator tube inspections. The proposed changes were submitted in response to social distancing recommendations provided by the Centers for Disease Control and Prevention, which have been issued as a defensive measure against the spread of the Coronavirus Disease 2019.

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

Sincerely,

/RA/

Mahesh L. Chawla, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosures:
1. Amendment No. 223 to NPF-30
2. Safety Evaluation

cc: Listserv

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

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT NO. 1

DOCKET NO. 50-483

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 223
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 June 26, 2020, as supplemented by letters dated July 21, 2020, and August 25, 2020, 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 Technical Specifications as indicated in the attachment to this license amendment, 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. 223 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. This amendment is effective as of its date of issuance, and shall be implemented within 45 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Jennifer L. Dixon-Herrity
Digitally signed by Jennifer L. Dixon-Herrity
Date: 2020.10.16 10:48:26 -04'00'

Jennifer L. Dixon-Herrity, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

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

Date of Issuance: October 16, 2020

ATTACHMENT TO LICENSE AMENDMENT NO. 223

CALLAWAY PLANT, UNIT NO. 1

RENEWED FACILITY OPERATING LICENSE NO. NPF-30

DOCKET NO. 50-483

Replace the following pages of Renewed Facility Operating License No. NPF-30 and the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Renewed Facility Operating License

REMOVE	INSERT
-3-	-3-

Technical Specifications

REMOVE	INSERT
5.0-12	5.0-12
5.0-13	5.0-13

(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. 223 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.

---

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

** 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.

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Program (continued)

c. Provisions for SG tube plugging criteria. Tubes found by inservice inspection to contain flaws with a depth equal to or exceeding 40% of the nominal tube wall thickness shall be plugged.

d. Provisions for SG tube inspections. Periodic SG tube inspections shall be performed. The number and portions of the tubes inspected and methods of inspection shall be performed with the objective of detecting flaws of any type (e.g., volumetric flaws, axial and circumferential cracks) that may be present along the length of the tube, from the tube-to-tubesheet weld at the tube inlet to the tube-to-tubesheet weld at the tube outlet, and that may satisfy the applicable tube plugging criteria. The tube-to-tubesheet weld is not part of the tube. In addition to meeting the requirements of d.1, d.2, and d.3 below, the inspection scope, inspection methods, and inspection intervals shall be such as to ensure that SG tube integrity is maintained until the next SG inspection. A degradation assessment shall be performed to determine the type and location of flaws to which the tubes may be susceptible and, based on this assessment, to determine which inspection methods need to be employed and at what locations.

1. Inspect 100% of the tubes in each SG during the first refueling outage following SG installation.

2. After the first refueling outage following SG installation, inspect each SG at least every 72 effective full power months or at least every third refueling outage (whichever results in more frequent inspections).* In addition, the minimum number of tubes inspected at each scheduled inspection shall be the number of tubes in all SGs divided by the number of SG inspection outages scheduled in each inspection period as defined in a, b, c and d below. If a degradation assessment indicates the potential for a type of degradation to occur at a location not previously inspected with a technique capable of detecting this type of degradation at this location and that may satisfy the applicable tube plugging criteria, the minimum number of locations inspected with such a capable inspection technique during the remainder of the inspection period may be prorated. The fraction of locations to be inspected for this potential type of degradation at this location at the end of the inspection period shall be no less than the ratio of the number of times the SG is scheduled to be inspected in the inspection period

* As approved by Amendment No. 223, performance of the steam generator inspection scheduled for Refuel Outage 24 (fall 2020) may be deferred to Refuel Outage 25 (spring 2022) on a one-time basis.

(continued)

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Program (continued)

after the determination that a new form of degradation could potentially be occurring at this location divided by the total number of times the SG is scheduled to be inspected in the inspection period. Each inspection period defined below may be extended up to 3 effective full power months to include a SG inspection outage in an inspection period and the subsequent inspection period begins at the conclusion of the included SG inspection outage.

(a) After the first refueling outage following SG installation, inspect 100% of the tubes during the next 144 effective full power months. This constitutes the first inspection period;

(b) During the next 120 effective full power months, inspect 100% of the tubes. This constitutes the second inspection period;

(c) During the next 96 effective full power months, inspect 100% of the tubes. This constitutes the third inspection period; and

(d) During the remaining life of the SGs, inspect 100% of the tubes every 72 effective full power months. This constitutes the fourth and subsequent inspection periods.

3. If crack indications are found in any SG tube, then the next inspection for each affected and potentially affected SG for the degradation mechanism that caused the crack indication shall not exceed 24 effective full power months or one refueling outage (whichever results in more frequent inspections). If definitive information, such as from examination of a pulled tube, diagnostic non-destructive testing, or engineering evaluation indicates that a crack-like indication is not associated with a crack(s), then the indication need not be treated as a crack.

e. Provisions for monitoring operational primary to secondary LEAKAGE.

(continued)

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 223 TO

RENEWED FACILITY OPERATING LICENSE NO. NPF-30

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT NO. 1

DOCKET NO. 50-483

1.0 INTRODUCTION

By application dated June 26, 2020 (Reference 1), Union Electric Company doing business as Ameren Missouri (the licensee) requested one-time changes to the Technical Specifications (TSs) for the Callaway Plant, Unit No. 1 (Callaway). The licensee provided additional information supporting its request in letters dated July 21, 2020 (Reference 2), and August 25, 2020 (Reference 3). The proposed one-time changes would allow a one-time deferral of the steam generator (SG) tube inspections required in TS, 5.5.9, "Steam Generator (SG) Program," paragraph d.2 (hereafter TS 5.5.9.d.2). The proposed changes were submitted in response to social distancing recommendations provided by the Centers for Disease Control and Prevention, which have been issued as a defensive measure against the spread of the Coronavirus Disease 2019 (COVID-19). The licensee requested that the changes be approved as a license amendment in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.90.

The supplemental letters dated July 21, 2020, and August 25, 2020, 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, the Commission) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on July 24, 2020 (85 FR 44936).

2.0 REGULATORY EVALUATION

2.1 Description of System

The SG tubes function as an integral part of the reactor coolant pressure boundary (RCPB) and, in addition, serve to isolate radiological fission products in the primary coolant from the secondary coolant and the environment. For the purposes of this safety evaluation, SG tube integrity means that the tubes are capable of performing this safety function in accordance with the plant design and licensing basis.

2.2 Regulatory Requirements and Guidance

Fundamental regulatory requirements with respect to the integrity of the SG tubing are established in 10 CFR Part 50. Specifically, General Design Criterion (GDC) 14 of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, states that the RCPB shall be "designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture." GDC 15 states that the reactor coolant system and associated auxiliary, control, and protection systems "shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences." GDC 30 states that components which are part of the RCPB shall be "designed, fabricated, erected, and tested to the highest quality standards practical." GDC 31 states, in part, that the RCPB "shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized." GDC 32 states, in part, that RCPB components shall be "designed to permit periodic inspection and testing of important areas and features to assess their structural and leaktight integrity."

Section 182(a) of the Atomic Energy Act requires nuclear power plant operating licenses to include TSs as part of any license. In 10 CFR 50.36, "Technical specifications," NRC regulatory requirements related to the content of the TSs are established. The TSs for all current pressurized-water reactor (PWR) licenses require that an SG program be established and implemented to ensure that SG tube integrity is maintained.

2.3 Steam Generator Tube Integrity Requirements in the Callaway Technical Specifications

At Callaway, programs established by the licensee, including the SG program, are listed in the administrative controls section of the TSs to operate the facility in a safe manner. The requirements for performing SG tube inspections and plugging are in TS 5.5.9, while the requirements for reporting the SG tube inspections and plugging are in TS 5.6.10, "Steam Generator Tube Inspection Report."

For Callaway, SG tube integrity is maintained by meeting the performance criteria specified in TS 5.5.9.b for structural and leakage integrity, consistent with the plant design and licensing basis. TS 5.5.9.a requires that a condition monitoring assessment be performed during each outage in which the SG tubes are inspected to confirm that the performance criteria are being met. TS 5.5.9.d includes provisions regarding the scope, frequency, and methods of SG tube inspections. These provisions require that the inspections be performed with the objective of detecting flaws of any type that may be present along the length of a tube and that may satisfy the applicable tube plugging criteria. The applicable tube plugging criterion specified in TS 5.5.9.c is that tubes found during inservice inspection to contain flaws with a depth equal to or exceeding 40 percent of the nominal wall thickness shall be plugged.

Callaway TS 3.4.13, "RCS [Reactor Coolant System] Operational LEAKAGE," includes a limit on operational primary-to-secondary leakage beyond which the plant must be promptly shut down. Should a flaw exceeding the tube plugging limit not be detected during the periodic tube surveillance required by the plant TSs, the operational leakage limit provides added assurance of timely plant shutdown before tube structural and leakage integrity are impaired, consistent with the design and licensing bases.

As part of the plant's licensing basis, applicants for PWR licenses are required to analyze the consequences of postulated design-basis accidents such as an SG tube rupture and a steam line break. These analyses consider primary-to-secondary leakage that may occur during these events and must show that the radiological consequences do not exceed the applicable limits of 10 CFR 50.67 or 10 CFR 100.11 for offsite doses; GDC 19 of 10 CFR Part 50, Appendix A, for control room operator doses (or some fraction thereof, as appropriate to the accident); or the NRC-approved licensing basis (e.g., a small fraction of these limits). No accident analyses for Callaway are being changed because of the proposed amendment; thus, no radiological consequences of any accident analysis are being changed. The proposed changes maintain the accident analyses and consequences that the NRC has reviewed and approved for the postulated design-basis accidents for SG tubes.

3.0 TECHNICAL EVALUATION

3.1 Background

3.1.1 Steam Generator Design

Callaway had four Framatome Model 73/19T replacement SGs installed in 2005 during the Unit I refueling outage 14 (1R14). Each SG has 5,872 thermally treated Alloy 690 (Alloy 690TT) tubes with a nominal outside diameter of 0.750 inch and a nominal wall thickness of 0.043 inch. The tubes are hydraulically expanded over the full depth of the tubesheet. The tubes are supported by eight stainless steel tube support plates (TSPs) with trefoil-shaped holes and three sets of antivibration bars (AVBs). The support structure includes devices that are unique to Framatome-designed SGs. The tubes in rows 1-18 were thermally treated after bending to reduce residual stress.

3.1.2 Operating Experience

The last two SG inspections at Callaway were in fall 2011 (end-of-cycle (EOC) outage 18 (1R18)) and spring 2016 (1R21). More information regarding the SG inspections is available in the fall 2011 and spring 2016 tube inspection reports (Reference 4 and Reference 5, respectively). The existing degradation mechanisms detected in the Callaway SGs are AVB wear and TSP wear. Following 1R21, a total of 54 tubes had been plugged in the four SGs due to AVB wear (19 in SG A, 6 in SG B, 26 in SG C, and 3 in SG D). In addition, one tube in SG A was plugged during preservice activities for a total of 55 plugged tubes. Some of the tubes that were plugged due to AVB wear also have TSP wear. Table 1 below lists the number of wear indications returned to service following the 1R21 inspection.

Table 1: Callaway Number of SG Tube Wear Indications in Service Following 1R21

Wear Type	SG-A	SG-B	SG-C	SG-D	Total
AVB Wear	120	97	184	38	439 (222 tubes)
TSP Wear	55	29	30	16	130 (91 tubes)

The operational assessment (OA) for Callaway considers wear from the Framatome unique support devices and foreign object wear as potential degradation mechanisms, and inspections have been performed to detect these mechanisms. Wear at the Framatome unique support device has not been detected in the Callaway SGs but was considered a potential mechanism because it has been detected in two Framatome SGs in U.S. plants. Foreign object (FO) wear

has not been detected in the Callaway SGs but was considered a potential mechanism due to the inherent potential for foreign object and loose part wear in SGs.

There are several corrosion-related forms of degradation that have occurred in SG tubing, including stress corrosion cracking, intergranular corrosion, and pitting corrosion; however, none have been reported in Alloy 690TT tubing. One possible exception was an eddy current volumetric indication in the sludge pile region above the top of the tubesheet detected during an inspection at a U.S. plant (Reference 6). Pitting was identified as one of the possible explanations, but the tube was plugged, and the source of the indication could not be confirmed. The Callaway OA addresses pitting qualitatively as a “relevant” mechanism based on the potentially relevant operational experience.

The secondary-side activities for the Callaway SGs in the 1R21 (2016) refueling outage included sludge lancing FO search and retrieval (FOSAR) in all four SGs. The FOSAR was performed at the top of tubesheet (TTS) annulus area (hot leg and cold leg), the no-tube lane (post-lancing), and the inner bundle passes of the hot-leg TTS sludge pile region (post-lancing). Visual inspections were performed of the steam drums in SG A and SG D, including the loose part trapping screens; riser barrels; feedring; and J-nozzles 1, 2, 3, 4, 29, and 30. The same sludge lancing and FOSAR activities were performed during the previous inspection (1R18 in 2011), except that the steam drum inspections were performed in SG B and SG C. No FOs were found in the trapping screens or in the TTS region (post-lancing) during these inspections. Sludge lancing removed objects such as scale, rubber, plastic, sludge rocks, and tiny metallic pieces. There have been no known foreign material introductions into either the primary or secondary systems since the 2016 refueling.

3.2 Proposed TS Changes

3.2.1 Current TS Requirements

The SG program in Callaway TS 5.5.9 provides the SG tube inspection requirements. TS 5.5.9.d.2 requires, in part, that “After the first refueling outage following SG installation, inspect each SG at least every 72 effective full-power months or at least every third refueling outage (whichever results in more frequent inspections).”

TS 5.5.9.d for Callaway requires periodic SG tube inspections to be performed and specifies provisions to be met for such inspections. TS 5.5.9.d.1 specifies the tube inspection scope required to be met during the first refueling outage following installation. TS 5.5.9.d.2 states, “After the first refueling outage following SG installation, inspect each SG at least every 72 effective full-power months or at least every third refueling outage (whichever results in more frequent inspections).” Additionally, 100 percent of the tubes are required to be inspected during each sequential period of 144 effective full-power months (EFPM), 120 EFPM, 96 EFPM, and 72 EFPM. The 1R24 outage in fall 2020 is the end of the first operating cycle in the second inspection period. In practice, Callaway inspects 100 percent of the SG tubes every third refueling outage.

3.2.2 Description of Proposed TS Changes

The license amendment request proposes to add language in a footnote of Callaway TS 5.5.9.d.2 to indicate that the SG tube inspections scheduled for the fall 2020 refueling outage may be deferred on a one-time basis to the spring 2022 refueling outage.

TS 5.5.9.d.2 would be annotated by an asterisk at the end of the first sentence in the paragraph A footnote with an asterisk at the bottom of the page and would state:

> *As approved by Amendment No. 223, performance of the steam generator inspection scheduled for Refuel Outage 24 (fall 2020) may be deferred to Refuel Outage 25 (spring 2022) on a one-time basis.

3.3 NRC Staff Evaluation of Proposed TS Changes

The licensee provided the following information to support its need for this one-time deferral of the upcoming steam generator inspection. In its letter dated June 26, 2020, the licensee stated the following:

> Deferral of the required SG tube inspection is necessitated by Coronavirus Disease 2019 (COVID 19) for which a national emergency was declared on March 13, 2020. The upcoming steam generator inspection would require the working together, in close quarters, of numerous employees and vendor personnel from other states and areas. This deferral is being requested in the interest of personnel safety and to preclude the potential for transmittal and spread of the COVID-19 virus.

The NRC staff evaluation of the proposed one-time TS changes was performed within the context of the COVID-19 pandemic and the potential impacts of this virus to plant personnel safety. Therefore, this safety evaluation should not be considered precedent setting for future routine plant amendments or generic industry licensing actions related to SG inspection intervals.

The NRC staff evaluation of the proposed one-time TS changes focused on the potential for affecting SG tube integrity, since maintaining SG tube integrity ensures the plant will meet its SG program-related TSs, thereby protecting the public's health and safety. In particular, the staff evaluation assessed whether the license amendment request demonstrates that the structural integrity performance criterion (SIPC) and accident-induced leakage performance criterion (AILPC) will be met for Cycle 25, which ends in spring 2022. These criteria are defined in TS 5.5.9.b.

The Callaway inspections have detected tube degradation from wear at AVBs and TSPs, and the OA evaluates these as existing mechanisms using probabilistic analyses. FO wear and tear from the Framatome unique support device have occurred in other SGs of similar design and were evaluated as potential mechanisms. Wear from this support/positioning device was evaluated using a deterministic analysis. Since there are no FOs or indications of FO wear, the OA provides a discussion of ongoing FO prevention and inspection.

The probabilistic analysis approach, also referred to as "full bundle analysis" in the Electric Power Research Institute (EPRI), Steam Generator Management Program: Steam Generator Integrity Assessment Guidelines, Revision 4 (Integrity Assessment Guidelines) (Reference 7), uses probabilistic models with distributions of flaw size and growth to determine the probability of burst and leakage. The projected EOC results are compared with the SIPC and AILPC acceptance criteria. The deterministic OA method uses the worst-case single-tube analysis method from the EPRI Integrity Assessment Guidelines to provide a conservative estimate of the projected EOC condition, considering all uncertainties at 0.95 probability and 50 percent confidence. The applicable uncertainties are for burst relation, material strength, and

nondestructive examination flaw sizing. The single-tube methods are referred to as “worst-case degraded tube” methods, as the most severely flawed tube is selected for evaluation. The worst-case degraded tube OA methods involve determining the most limiting flaw at the beginning-of-cycle and applying conservative flaw growth over the intended inspection interval to arrive at the EOC flaw condition to determine if the SIPC and AILPC will be met at the EOC.

3.3.1 Evaluation of Existing Tube Degradation Mechanisms

Wear at AVBs

Wear at AVBs has occurred and resulted in tube plugging in all four of the Callaway SGs. In the most recent inspections at 1R21 in 2016, AVB wear was detected in each SG, and 25 tubes total were plugged in SG A, SG C, and SG D. The 1R21 examination for AVB wear consisted of full-length bobbin probe examination of 100 percent of the active tubes. Sizing of the AVB wear indications was based on the bobbin probe results using an EPRI-qualified technique. The deepest indications returned to service following 1R21 were 27, 30, 28, and 28 percent through wall (TW) in SG A, SG B, SG C, and SG D, respectively. Table 1 in TS 3.1.2 shows the number of indications returned to service in each SG.

The licensee’s OA for AVB wear was performed using a Framatome fully probabilistic model with full-bundle analyses for each SG. The model samples from a distribution of AVB flaws characterized by length and depth represent flaws undetected at 1R21, flaws detected and returned to service in 1R21, and flaws projected to initiate after 1R21. The model predicted more than 700 total new indications at 1R24 and 1R25 using an initiation rate higher than the trend in AVB wear flaw detection at Callaway and at most plants industrywide. The flaw dimensions, tube dimensions, tube properties, and limiting pressure differentials were combined with growth rates to predict the EOC flaw population and probability of burst (POB) for each SG at 1R25. Growth rates in the OA model were sampled from a probability distribution based on the combined growth rates determined at 1R18 and 1R21. The OA considered this a conservative approach because AVB wear growth rates at Callaway, both average and at the upper 95th percentile, have decreased with time in each SG.

The OA calculated a structural limit for AVB wear of 59.2 percent TW, which is based on the limiting TS criterion of three times the normal operating pressure differential and includes material property and burst pressure equation uncertainties. Using this structural limit, the OA projected POB values of 0.2 to 0.9 percent, which meet the 5 percent maximum POB criterion from Reference 7 and include flaw sizing uncertainty. Therefore, the SIPC will be satisfied. The cumulative projected accident leakage will be negligible over the next operational period based on the projected limiting depth sizes for this mechanism; therefore, the AILPC will be satisfied.

Wear at TSPs

Tube wear has occurred at TSPs in all four SGs. No tubes have been plugged because of TSP wear, but some of the tubes with TSP wear have been plugged because of AVB wear. In the most recent inspections at 1R21 in 2016, TSP wear was detected in each SG. The examination for TSP wear consisted of full-length bobbin probe examination of 100 percent of the active tubes. Sizing was performed using a +Point™ rotating probe with an EPRI-qualified technique. The deepest indications returned to service following 1R21 were 17, 16, 16, and 11 percent TW in SG A, SG B, SG C, and SG D, respectively. Table 1 above from TS 3.1.2 shows the number of indications returned to service in each SG.

The licensee used the same probabilistic OA model for TSP wear that was used for AVB wear. The model samples from a distribution of TSP flaws characterized by length and depth represent flaws undetected at 1R21, flaws detected and returned to service in 1R21, and flaws projected to initiate after 1R21. The model predicted more than 300 total new indications at 1R25. Growth rates in the OA model were sampled from a probability distribution based on a bounding rate determined from the 1R21 inspection, which was the first inspection with repeat TSP indications. This approach assumes that the growth rate will decrease over time, which is consistent with most operating experience.

The OA calculated a structural limit for TSP wear of 57.6 percent TW, which is based on the limiting TS criterion of three times the normal operating pressure differential and includes material property and burst pressure equation uncertainties. Using this structural limit, the OA projected a POB of 0.1 percent for each SG, which meets the 5 percent maximum POB criterion from Reference 7 and includes flaw sizing uncertainty. Therefore, the SIPC will be satisfied. The cumulative projected accident leakage will be negligible over the next operational period based on the projected limiting depth sizes for this mechanism. Therefore, the AILPC will be satisfied.

Evaluation Summary for Existing Mechanisms (Wear at AVBs and TSPs)

The NRC staff finds the licensee's evaluation of tube wear at AVBs and TSPs to be acceptable. Wear at these locations in the Callaway SGs has been effectively managed for six cycles without challenging tube integrity. Wear at support structures is readily detected with standard eddy current examination techniques, and wear sizing errors are considered in the projection of existing flaws to 1R25. During tube inspections, licensees are required to perform condition monitoring to assess whether the inspection results are bounded by the previous OA projections of additional tube degradation (wear, in this case). During the most recent Callaway SG inspections after 1R21, the OA worst-case projections for both tube wear mechanisms bound the tube inspection results with margin, providing confidence that the OA methods and input assumptions can conservatively predict future performance.

The licensee provided analyses for wear until refueling outage 1R25 at the AVBs and TSPs. The staff found the AVB flaw projections acceptable based on the Callaway specific tube AVB wear history from 1R15 to 1R21, the conservative number of new indications predicted, and the decrease in new AVB wear indications observed over time at most plants. For AVB wear growth, the licensee's analysis used a growth rate distribution that is conservative to the 1R21 distribution, and the Callaway operating history shows the growth rates continue to decrease over time. In a similar manner, the licensee's evaluation of TSP wear predicts a conservative number of new TSP indications and applies a growth rate distribution that bounds all repeat wear and most new wear indications from 1R18 and 1R21.

The results of the AVB and TSP wear analyses with projected conservative wear rates through 1R25 predict that tube integrity will be maintained. Therefore, the NRC staff finds the evaluation of wear at support structures to be acceptable since the SIPC and AILPC will be satisfied.

3.3.2 Evaluation of Potential Tube Degradation Mechanisms

Wear at Unique Support Device

Tube wear from the unique supports has not been found in the Callaway SGs. However, it has occurred at two units with Framatome-designed SGs. Therefore, the licensee evaluated this

wear as a potential degradation mechanism for Callaway. The evaluation was performed using a deterministic worst-case single-tube method based on the measurements at the two U.S. plants with this wear. A bounding beginning-of-cycle flaw length and depth were determined, and the depth was adjusted upward to the physically measured 95th percentile flaw depth corresponding to the EPRI-qualified bobbin probe AVB wear sizing technique used at Callaway. A bounding growth rate from the two plants with tube wear at this support device was then applied for 5.5 effective full-power years (EFPY) to calculate the EOC maximum depth at 1R25. The 5.5 EFPY is conservative compared to the expected four-cycle operating time of 5.375 EFPY. The calculated maximum EOC TW depth is less than the structural limit for the assumed flaw length. Therefore, the SIPC will be satisfied. The cumulative projected accident leakage will be negligible over the next operational period based on the projected limiting depth sizes for this mechanism. Therefore, the AILPC will be satisfied.

Foreign Object Wear

The Callaway SGs have loose part trapping screens and no detection of wear from FOs. The 1R21 examination for FO wear in each SG consisted of full-length bobbin probe examination of 100 percent of the active tubes and array probe examination of the hot-leg periphery and no-tube lane up to the first support structure. Visual examination of the periphery and no-tube lane extended approximately eight tubes into the bundle. TTS water lancing and post-lancing FOSAR was performed in all four SGs. Visual inspection of the steam drums was performed in SG A and SG D, including the loose part trapping screens, riser barrels, feedring, and selected J-nozzles. No FOs were detected during the 1R21 inspections other than benign materials in the lancing strainers (sludge rocks, scale, rubber, and plastic). Based on the experience at Callaway, and because no FO wear has been detected at any of the Framatome replacement SGs in the United States with loose part trapping screens, the licensee concluded it was unlikely that FO wear exceeding the structural limit of 57.6 percent TW would occur. The structural limit was calculated based on the limiting TS criterion of three times the normal operating pressure differential and includes material property and burst pressure equation uncertainties.

Evaluation Summary for Potential Mechanisms

The NRC staff finds the deterministic evaluation of wear at the Framatome design unique support device acceptable for Callaway. The evaluation accounts for wear sizing errors and assumes values for beginning-of-cycle flaw depth and for flaw growth that is bounding for the two U.S. plants with wear at this location. The projected wear depth at 1R25 using this approach is less than the structural limit, and this wear can be readily detected with standard eddy current examination techniques. Therefore, the evaluation provides reasonable assurance that the SG tube performance criteria will be maintained until 1R25.

The NRC staff finds the licensee's analysis of FO wear acceptable based on the lack of any detrimental FOs or loose parts in the Callaway SGs and other SGs with the same loose part catcher design. The staff acknowledges that predicting future loose part generation is not possible since past fleetwide operating experience has shown that new loose part generation, transport to the SG tube bundle, and interactions with the tubes cannot be reliably predicted; however, plants can reduce the probability of loose parts by maintaining robust foreign material exclusion programs and applying lessons learned from previous industry operating experience with loose parts. Plants in general have demonstrated the ability to conservatively manage loose parts once they are detected by eddy current examinations or by secondary-side FOSAR inspections. If unanticipated aggressive tube wear from new loose parts should occur in a Callaway SG, operating experience has shown that a primary-to-secondary leak will probably

occur, rather than a loss of tube integrity. In the event of a primary-to-secondary leak, the staff will interact with the licensee in accordance with established procedures in Inspection Manual Chapter 0327, "Steam Generator Tube Primary-to-Secondary Leakage," dated January 1, 2019 (Reference 8), to confirm the licensee's conservative decision making.

3.3.3 Evaluation of Pitting (Relevant Mechanism)

The licensee designated pitting a relevant mechanism based on an indication found during eddy current examination of the Alloy 690 TT tubes at another plant in 2015. In that case, a single volumetric indication was reported on at a location just above the hot-leg TTS and under hard sludge. Although the cause was not conclusively determined and the tube is plugged, pitting corrosion was identified as one possible cause. For this reason, the licensee considered pitting to be a mechanism relevant to Callaway. However, because no indications of this type have been detected with bobbin probes or rotating probes at Callaway, and since there have been no adverse chemistry conditions, the licensee concluded that pitting is unlikely to challenge tube integrity through 1R25. Since pitting is not an existing degradation mechanism at any plant with Alloy 690TT tubes, and since conditions at Callaway are not conducive to causing pitting, the staff finds the licensee's evaluation acceptable.

3.4 Primary to Secondary Leakage Actions

In Attachment 1 to the license amendment request, TS 3.3 describes the Callaway primary-to-secondary leakage program, including administrative limits versus TS limits. TS 3.4.13, "RCS Operational LEAKAGE," has a requirement to "Verify primary to secondary LEAKAGE is ≤ 150 gallons per day through any one SG." In addition to the TS requirements, Callaway has administrative limits for responding to primary-to-secondary leakage during operation. The first two limits require increasing levels of monitoring when the leakage reaches 5 gallons per day (gpd) or more and when it reaches 25 gpd or more. If leakage increases to 50 gpd for more than 1 hour, actions are initiated to shut down the plant within 24 hours, and at 75 gpd, a faster shutdown is required. The licensee proposes no changes to these existing TS and administrative limits. The NRC staff finds this acceptable since the administrative limits require prompt and controlled shutdown at a significantly lower primary-to-secondary leakage level compared to the TS operational leakage limits.

3.5 Technical Evaluation Conclusion

Based on the above, the NRC staff finds that the licensee made a timely application for the proposed amendment following its identification of the need to address COVID-19 personnel issues. In addition, the NRC staff finds that the licensee could not avoid the exigency due to the unforeseen circumstances related to the COVID-19 pandemic. Moreover, the NRC staff finds that the licensee has demonstrated there is reasonable assurance that the structural and leakage integrity of the Callaway SG tubes will be maintained until the next SG tube inspections during refueling outage 25 in spring 2022. Therefore, the NRC staff concludes that the licensee may incorporate the proposed changes into TS 5.5.9.d.2.

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 September 10, 2020. On September 17, 2020, the State official confirmed that the State of Missouri 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 and changes SRs. 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, published in *Federal Register* on July 24, 2020 (85 FR 44936), and there has been no public comment on such finding. 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.

7.0 REFERENCES

1. Ameren Missouri, Callaway Plant Unit 1, Request for One-Time License Amendment to Defer Upcoming Steam Generator Inspection (LDCN 20-0013), dated June 26, 2020 (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML20178A668).

2. Ameren Missouri, Callaway Plant Unit 1, Supplement to License Amendment Request Regarding Deferral of Upcoming Steam Generator Inspection (LDCN 20-0013), dated July 21, 2020 (ADAMS Accession No. ML20203M328).

3. Ameren Missouri, Callaway Plant, Unit 1, Response to Request for Additional Information Regarding License Amendment Request for Deferral of Upcoming Steam Generator Inspection (LDCN 20-0013), dated August 25, 2020 (ADAMS Package Accession No. ML20238C104).

4. Ameren Missouri, Callaway, Unit 1, Results of Steam Generator Tube In-Service Inspection, dated May 17, 2012 (ADAMS Accession No. ML12139A275).

5. Ameren Missouri, Callaway, Unit 1, Results of Steam Generator Tube In-Service Inspection, dated October 11, 2016 (ADAMS Accession No. ML16286A547).

6. South Texas Project, Unit 1 - 1RE19 Inspection Summary Report for Steam Generator Tubing, dated April 25, 2016 (ADAMS Accession No. ML16125A248).

7. Electric Power Research Institute, Steam Generator Management Program: Steam Generator Integrity Assessment Guidelines, Revision 4, Product ID 3002007571, dated July 18, 2016 (ADAMS Accession No. ML16208A272).

8. U.S. NRC, Inspection Manual Chapter (IMC) 0327, “Steam Generator Tube Primary-to-Secondary Leakage,” dated January 1, 2019 (ADAMS Accession No. ML18093B067).

Principal Contributors: P. Klein
G. Makar

Date: October 16, 2020

SUBJECT: CALLAWAY PLANT, UNIT NO. 1 - ISSUANCE OF AMENDMENT NO. 223 RE: ONE-TIME DEFERRAL OF THE STEAM GENERATOR TUBE INSPECTIONS (EPID L-2020-LLA-0142) DATED OCTOBER 16, 2020

DISTRIBUTION:

PUBLIC
PM File Copy
RidsACRS_MailCTR Resource
RidsNrrDorlLpl4 Resource
RidsNrrDssStsb Resource
RidsNrrLAPBlechman Resource
RidsNrrPMCallaway Resource
RidsRgn4MailCenter Resource
RidsNrrDnrlNcsg Resource
LTerry, NRR
NO'Keefe, R-IV
DBradley, R-IV
SJanicki, R-IV
GMakar, NRR
PKlein, NRR
CAshley, NRR
AJohnson, NRR

ADAMS Accession No.: ML20246G570 ***via email**

OFFICE	NRR/DORL/LPL4/PM*	NRR/DORL/LPL4/LA*	NRR/DSS/STSB/BC*	NRR/DNRL/NCSG/BC*
NAME	MChawla	PBlechman (LRonewicz for)	VCusumano	SBloom
DATE	9/08/2020	9/04/2020	9/12/2020	8/31/2020
OFFICE	OGC - NLO*	NRR/DORL/LPL4/BC*	NRR/DORL/LPL4/PM*	
NAME	STurk	JDixon-Herrity	MChawla	
DATE	10/14/2020	10/16/2020	10/16/2020	

OFFICIAL RECORD COPY