Ameren MISSOURI

Callaway Plant

March 1, 2018

ULNRC-06409

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

10 CFR 50.73

Ladies and Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
RENEWED FACILITY OPERATING LICENSE NPF-30
LICENSEE EVENT REPORT (LER) 2017-002-01
TORNADO MISSILE VULNERABILITIES RESULT IN CONDITION PROHIBITED BY TECHNICAL SPECIFICATIONS

On October 17, 2017, Callaway submitted LER 2017-002-00 in accordance with 10 CFR50.73(a)(2)(i)(B); 10 CFR 50.73(a)(2)(ii)(B); 10 CFR 50.73(a)(2)(v)(A), -(B), and -(D); 10 CFR 50.73(a)(2)(vii)(A), -(B), and -(D); and 10 CFR 50.73(a)(2)(ix)(A)(1), -(2), and -(4) to report tornado missile vulnerabilities due to identified nonconforming conditions in which the design for certain structures, systems, or components may not ensure adequate protection against tornado-driven missiles.

The enclosed supplemental LER, 2017-002-01, is submitted to document additional tornado missile vulnerabilities identified in connection with the effort that initially identified the vulnerabilities reported in LER 2017-002-00 but which have been identified subsequent to submittal of that report.

This letter does not contain new commitments. If you have any questions concerning this report, please contact Tom Elwood at 314-225-1905.

Sincerely,

Barry L. Cox
Senior Director, Nuclear Operations

Enclosure: LER 2017-002-01

cc: Mr. Kriss M. Kennedy
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Index and send hardcopy to QA File A160.0761

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1NRC FORM 366 (04-2017) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

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APPROVED BY OMB: NO. 3150-0104 EXPIRES: 03/31/2020

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Callaway Plant Unit 1	05000-483	1 OF 6

4. TITLE

Tornado Missile Vulnerabilities Result in Condition Prohibited by Technical Specifications

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
08	15	2017	2017	- 002	- 01	03	06	2018	FACILITY NAME	DOCKET NUMBER
										05000

9. OPERATING MODE

Mode 1

10. POWER LEVEL

100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☒ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(iii)	☒ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☒ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☒ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	☐ 73.77(a)(1)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☒ 50.73(a)(2)(v)(D)	☐ 73.77(a)(2)(i)
☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☒ 50.73(a)(2)(vii)	☐ 73.77(a)(2)(ii)
	☐ 50.73(a)(2)(i)(C)	☐ OTHER Specify in Abstract below or in NRC Form 366A	

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT	TELEPHONE NUMBER *(Include Area Code)*
T.B. Elwood, Supervising Engineer, Regulatory Affairs and Licensing	314-225-1905

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On August 15, 2017, Callaway Plant was in Mode 1 at 100 percent power. During evaluation of protection for safety-related equipment from the damaging effects of tornados, Callaway Plant personnel determined that safety-related minimum-flow recirculation lines for the turbine-driven auxiliary feedwater pump (TDAFP) and both motor-driven auxiliary feedwater pumps (MDAFPs) could be damaged in the event that a postulated tornado generated missile were to penetrate a structure that is not resistant to tornado missiles (i.e., the condensate storage tank (CST) valve house) and strike the lines. Operations declared all three auxiliary feedwater pumps inoperable. On August 15, 2017, at 1407 Eastern Daylight Time (EDT), an 8-hour, non-emergency report to the Nuclear Regulatory Commission (NRC) (reference NRC Event Notification Number 52905) was made in accordance with 10 CFR 50.72. Compensatory measures were implemented consistent with Enforcement Guidance Memorandum (EGM) 15-002, "Enforcement Discretion for Tornado-Generated Missile Protection Noncompliance." The TDAFP and MDAFPs were then declared Operable but non-conforming.

Subsequent to the condition identified on August 15, 2017, continued investigation of tornado missile vulnerabilities led to discovery that the exposed steam exhaust stacks for the main steam safety valves and atmospheric steam dump valves, the exposed vents for the diesel generator fuel oil storage and day tanks, and the electrical power cable trays and/or conduits for the ultimate heat sink cooling tower fan motors were also susceptible to tornado missile damage to the extent that compliance with General Design Criterion 2 is not ensured. Compensatory measures were then promptly implemented for these conditions, as well, in accordance with EGM 15-002 such that the affected systems have been evaluated to be nonconforming but Operable.

It has been determined that the identified nonconformances are an original plant design legacy issue. Long-term resolution for establishing compliance is under development and will be completed within the timeframe described in the EGM, subject to any extensions that may be requested for Callaway Plant and subsequently approved by the NRC.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Callaway Plant Unit 1	05000-483	2017	- 002	- 01

NARRATIVE

1. DESCRIPTION OF STRUCTURE(S), SYSTEM(S) AND COMPONENT(S):

The Callaway Plant auxiliary feedwater system (AFS) [EIIS Code: BA] has two motor-driven auxiliary feedwater pumps (MDAFPs) [EIIS Code: P] and one turbine-driven auxiliary feedwater pump (TDAFP) [EIIS Code: P] which supply a flow of auxiliary feedwater to the steam generators during normal safe shutdown or accident conditions. During operation of the MDAFPs and TDAFP, the pumps' suction may be lined-up to safety-related essential service water (ESW) [EIIS Code: BI] or to the non-safety related condensate transfer and storage system [EIIS Code: KA] condensate storage tank (CST) [EIIS Code: TK] or hardened CST (HCST) [EIIS Code: TK]. Automatically controlled valves that are located in the AFS lines downstream of the MDAFPs and TDAFP maintain steam generator levels by providing sufficient flow to replace the liquid water that is converted to steam during decay heat removal without allowing steam generator levels to increase beyond design limits. To prevent damage to the MDAFPs and TDAFP, a minimum flow through the pumps must be maintained. The recirculation lines for the MDAFPs and TDAFP are designed to ensure that the minimum flow requirements for the pumps are maintained by returning a portion of discharge flow from each pump back to the CST

The Callaway Plant main steam supply system (MSSS) [EIIS Code: SB] functions to convey steam generated in the steam generators to the turbine-generator system and auxiliary systems for power generation. The main steam line from each steam generator is protected from overpressure by five main steam safety valves (MSSVs) [EIIS Code: RV], which open and close automatically to relieve pressure by releasing steam to the atmosphere when pressure exceeds the setpoint value. In addition, one power-operated atmospheric steam dump valve (ASD) [EIIS Code: RV] is installed in each main steam line, which may be opened and closed automatically or manually to release steam as needed to remove residual heat during reactor shutdown and cooldown. Steam flow from each MSSV and ASD is conveyed to the atmosphere through vent stacks. For the ASDs, the vent stacks incorporate silencers for noise reduction.

The Callaway Plant emergency diesel generator (DG) fuel oil storage and transfer system (EDEFSTS) [EIIS Code: DE] provides onsite storage and transfer of fuel oil to the DG engines [EIIS Code: ED]. For each of the two DGs, a transfer pump [EIIS Code P] transfers fuel oil from the DG's fuel oil storage tank [EIIS Code: TK] to its associated day tank [EIIS Code: TK]. In order to prevent a loss of suction head for the diesel fuel oil transfer pumps and the DG fuel pumps, both diesel fuel oil storage tanks and both day tanks are provided with vent pipes [EIIS Code: PSP].

The Callaway Plant ultimate heat sink (UHS) [EIIS Code: BS] consists of a seismic Category I mechanical draft cooling tower [EIIS Code: CTW] and a seismic Category I source of makeup water (retention pond) for the tower. The tower is divided into four cells with one fan assembly (fan [EIIS Code FAN], gear reducer [EIIS Code RGR], and motor [EIIS Code MO]) per cell. The cooling tower cells support the ESW system by providing heat dissipation for safe shutdown following an accident. Each ESW train is supported by a train of two cooling tower cells, with both cells in each train required to be Operable in order for the train to be able to accomplish its safety function.

The design of the each of these systems is subject to 10 CFR 50 Appendix A, General Design Criterion (GDC) 2, which states in part that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases listed in the Final Safety Evaluation Report (FSAR) that assure compliance with GDC 2 include the following.

- FSAR 10.4.9.1.1 states in part, "The AFS is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles."
- FSAR 10.3.1.1 states in part, "The safety-related portion of the MSSS is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles."
- FSAR 9.5.4.1.1 states in part, "The EDEFSTS is protected from the effects of natural phenomena, such as

earthquakes, tornadoes, hurricanes, floods, and external missiles."

- FSAR Site Addendum 9.2.5.2.2 states in part, "The cooling tower is protected from horizontal and vertical tornado missiles."

2. INITIAL PLANT CONDITIONS:

At the time of the initial identification of tornado missile protection nonconformances (beginning on August 15, 2017), the plant was in Mode 1 at 100% power. No inoperability of structures, systems, or components (SSCs) at the time of the initial discovery, or upon subsequent discoveries of additional nonconformances contributed to the condition.

3. EVENT DESCRIPTION:

On August 15, 2017, during the evaluation of protection for safety-related equipment from the damaging effects of tornados (i.e., tornado-generated missiles), Callaway Plant personnel identified an unanalyzed condition related to the recirculation lines for the auxiliary feedwater pumps. The recirculation lines penetrate the tornado missile resistant Auxiliary Building below grade level, and are routed underground to the CST valve house, where they connect to the CST. The CST and CST valve house are not designed to be resistant to tornado missiles, and therefore, the portion of recirculation lines within the CST valve house is not protected from damage from tornado missiles. The recirculation lines may be sheared or experience a pipe break without resulting in an adverse impact to the MDAFPs or TDAFP; however, crimping of the recirculation lines to the extent that flow rates are restricted below the minimum requirements would result in damage to the affected pumps, potentially rendering them incapable of performing their safety function. There is currently no analysis demonstrating that if a tornado missile were to strike the recirculation lines, they would still be able to provide sufficient flow to prevent damage to the MDAFPs or TDAFP. The tornado missile vulnerability of the portion of the recirculation lines located within the valve house has existed since the plant was originally designed and constructed.

At 1209 Central Daylight Time (CDT) on August 15, 2017, the Train A and B MDAFPs and the TDAFP were declared inoperable due to tornado missile vulnerability. Under Technical Specification (TS) Limiting Condition for Operation (LCO) 3.7.5, "Auxiliary Feedwater (AFW) System," Callaway Plant entered Condition C (for one AFS train inoperable for reasons other than ESW or steam supply source inoperable), Condition D (for two AFS trains inoperable), and Condition E (for three AFS trains inoperable). At 1222 CDT, initial compensatory measures for providing additional protection or minimizing plant vulnerability to tornado-driven missiles, such that the likelihood of adverse tornado missile effects was lessened, were confirmed to be in place. These measures included verification that applicable guidance in unit threat procedures, emergent issues response procedures, severe weather procedures, abnormal and emergency operating procedures, and FLEX procedures were in place and that training, as applicable, was current for those procedures. Measures were also taken to establish a heightened level of station awareness and preparedness relative to the identified tornado missile vulnerability. In accordance with the enforcement discretion provisions of NRC Enforcement Guidance Memorandum (EGM) 15-002, "Enforcement Discretion for Tornado-Generated Missile Protection Noncompliance," the Train A and B MDAFPs and the TDAFP were declared Operable but nonconforming, and TS LCO 3.7.5 Conditions C, D, and E were exited at 1225 CDT. In addition, at 1407 EDT, an 8-hour, non-emergency report to the Nuclear Regulatory Commission (NRC) was made in accordance with 10 CFR 50.72 (per Event Notification No. 52905). The initial compensatory measures were followed-up with a comprehensive compensatory measure that was implemented within 60 days, in accordance with the EGM.

Subsequent to identification of the tornado missile vulnerability for the auxiliary feedwater pump recirculation lines on August 15, 2017, continued extent-of-condition investigation led to the identification of additional tornado missile vulnerabilities (in which the design for the affected SSC(s) is not in conformance with GDC-2). On August 31, 2017, it was identified that the exposed MSSV and ASD stacks are vulnerable to tornado missile damage. The MSSVs and ASDs were thus declared inoperable at 1240 CDT on August 31, 2017. For the MSSVs, under TS 3.7.1, "Main Steam Safety

Valves (MSSVs)," Condition A (for one or more steam generators with one MSSV inoperable and the Moderator Temperature Coefficient (MTC) zero or negative at all power levels), Condition B (for one or more steam generators with two or more MSSVs inoperable), and Condition C (for one or more steam generators with >= 4 MSSVs inoperable) were entered. Likewise, for the ASDs, under TS 3.7.4, "Atmospheric Steam Dump Valves (ASDs)," Condition A (for one required ASD line inoperable for reasons other than excessive ASD seat leakage), Condition B (for two required ASD lines inoperable for reasons other than excessive ASD seat leakage), and Condition C (for three or more required ASD lines inoperable for reasons other than excessive ASD seat leakage) were entered (also at 1240 CDT).

Initial compensatory measures were promptly completed to address these nonconformances, and in accordance with the EGM 15-002 guidance, the MSSVs and ASDs were declared Operable (but nonconforming) such that all of the Conditions that had been entered under TS 3.7.1 and TS 3.7.4 for the identified nonconformances were able to be exited at 1322 CDT on August 31, 2017. Follow-up, 60-day comprehensive measures were also completed in accordance with the EGM guidance.

On September 21, 2017, the DG fuel oil storage tank and day tank vents were identified to be vulnerable to tornado missile damage (in noncompliance with GDC-2). In response, Operations declared both diesel generators inoperable, and under TS 3.8.1, "AC Sources – Operating," Condition B (for one DG inoperable) and Condition E (for two DGs inoperable) were entered at 1249 CDT. These Conditions were subsequently exited at 1258 CDT that same day, once appropriate, initial compensatory measures were completed, in accordance with EGM 15-002. These actions were followed up with completion of comprehensive actions within 60 days, also in accordance with the EGM.

At 1106 CDT on October 20, 2017, with Refuel Outage 22 in progress, and in response to a question raised by the Senior Resident Inspector, the electrical supply cable trays and/or conduits tor UHS cooling tower fan motors were identified to be vulnerable to tornado missile damage (in noncompliance with GDC-2). Since the plant was in No Mode at the time of discovery, TS 3.7.9, "Ultimate Heat Sink (UHS)," did not apply. Initial compensatory measures to address the nonconforming condition were completed on October 20, 2017 at 1208 CDT, and follow-up comprehensive measures were completed within 60 days, in accordance with the guidance of EGM 15-002.

4. ASSESSMENT OF SAFETY CONSEQUENCES:

During a postulated design basis tornado, the conditions documented could have resulted in a loss of safety function for the AFS, main steam supply system and the DGs. The affected structures, systems and components are used to achieve safe shutdown, remove decay heat, and mitigate the effects of postulated design-basis accidents.

However, as documented in EGM 15-002, tornado missile scenarios that may lead to core damage are very low probability events because safety-related SSCs are typically designed to withstand effects of tornados. For a tornado missile-induced scenario to occur, a tornado would have to strike the site and result in the generation of missiles that would hit and fail vulnerable, unprotected safety-related equipment, and/or unprotected safety-related subcomponents in a manner that is non-repairable and non-recoverable. In addition, because plants are designed with redundancy and diversity, the tornado missiles would have to affect multiple trains of safety systems and/or means of achieving safe shutdown.

The NRC has completed a generic risk analysis of potential tornado missile protection noncompliances to examine the risk significance of these scenarios. This assessment documents a conservative, bounding-type analysis of the risk significance for plant facilities. The generic analysis assumed that if a tornado were to strike a plant located in the most active tornado region in the country, it would cause a tornado-generated missile to fail all emergency core cooling equipment at the plant with no ability to recover, resulting in core damage. Given this conservative assumption, the staff's study established that the core damage frequency (CDF) associated with tornado missile-related noncompliances is well

below the CDF threshold requiring immediate regulatory action.

In summary, the generic bounding risk analysis performed by the NRC concluded that this issue is of low risk significance.

5. REPORTING REQUIREMENTS:

This LER is submitted pursuant to:

- 10 CFR 50.73(a)(2)(i)(B) as a condition that is prohibited by Technical Specifications;
- 10 CFR 50.73(a)(2)(ii)(B) as an event or condition that results in the plant being in an unanalyzed condition that
- significantly degrades plant safety;
- 10 CFR 50.73(a)(2)(v)(A), -(B), and -(D) as a condition that at the time of discovery could have prevented the fulfillment of a safety function of structures or systems needed to shut down the reactor and maintain it in a safe shutdown condition, remove residual heat, or mitigate the consequences of an accident;
- 10 CFR 50.73(a)(2)(vii)(A), -(B), and -(D) as an event where a single cause or condition that caused at least one independent train or channel to become inoperable in multiple systems or two independent trains or channels to become inoperable in a single system designed to shut down the reactor and maintain it in a safe shutdown condition, remove residual heat, or mitigate the consequences of an accident;
- 10 CFR 50.73(a)(2)(ix)(A)(1), -(2), and -(4) as a condition that as a result of a single cause could have prevented the fulfillment of a safety function for two or more trains or channels in different systems that are needed to shut down the reactor and maintain it in a safe shutdown condition, remove residual heat, or mitigate the consequences of an accident.

6. CAUSE OF THE EVENT:

The condition is an original plant legacy design issue. Preliminary evaluation has determined that the condition resulted from lack of clear understanding of the regulatory guidance, resulting in inadequate consideration of tornado missile protection during the plant's design and licensing phases.

7. CORRECTIVE ACTIONS:

Initial compensatory measures and subsequent comprehensive compensatory measures were implemented in accordance with the guidance of EGM 15-002 for each identified nonconforming condition. Long-term permanent resolution for each of the identified conditions will involve one or more of the following actions:

- A plant modification for providing tornado missile protection.
- The performance of additional analyses to more precisely analyze the impact of a tornado missile strike(s) on the vulnerable component, in order to further determine the degree to which a loss of function would occur.
- A license amendment request (LAR) for obtaining NRC approval of a permanent change to the licensing basis. One approach to the LAR being considered is use of the Tornado Missile Risk Evaluator (TMRE) methodology, that has been developed by the industry for evaluation of tornado missile protection/vulnerability.

8. PREVIOUS SIMILAR EVENTS:

In 2014, from performance of an NRC-conducted Problem Identification and Resolution inspection at Callaway Plant, a "green" non-cited violation of 10 CFR 50, Appendix B, Criterion III, "Design Control," was identified for Callaway due to failure to verify the adequacy of the design of the turbine-driven auxiliary feedwater pump exhaust stack for withstanding the effects of natural phenomena, specifically, a tornado-generated missile. For this condition, the auxiliary feedwater system was determined to be Operable but nonconforming. Long-term resolution of the condition is tied to the long-term effort for resolving the conditions identified in this LER.

NRC FORM 366B (04-2017) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 3/31/2020

LICENSEE EVENT REPORT (LER)
FAILURE CONTINUATION

(See NUREG-1022, R.3 for instruction and guidance for completing this form http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022/r3/)

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Callaway Plant Unit 1	05000-483	2017	- 02	- 01

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLETO EPIX