Ameren MISSOURI

Callaway Plant

August 06, 2015

ULNRC-06237

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

10 CFR 50.73(a)(2)(i)(B)

Ladies and Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
RENEWED FACILITY OPERATING LICENSE NPF-30
LICENSEE EVENT REPORT 2014-003-02
INVERTER NN11 INADVERTANTLY TRANSFERRED
TO ITS ALTERNATE AC SOURCE

On August 7, 2014, Ameren Missouri submitted Licensee Event Report (LER) 2014-003-00 for Callaway Plant to report a condition prohibited by Technical Specifications in accordance with 10 CFR 50.73(a)(2)(i)(B). Specifically, 120-volt vital AC instrument system power inverter NN11 was inoperable for a period of time longer than that allowed by Technical Specification 3.8.7.

An expected supplemental LER to update the causes and corrective actions for the identified condition was submitted to the NRC on March 05, 2015.

The enclosed supplemental LER, 2014-003-02, is hereby submitted to include additional information in the event description regarding the momentary de-energization of an instrumentation and control power cabinet.

This letter does not contain new commitments.

Sincerely,

Barry Cox
Senior Director, Nuclear Operations

Enclosure

cc: Mr. Marc L. Dapas
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LICENSEE EVENT REPORT (LER)

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

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Callaway Plant Unit 1	05000483	1 OF 8

4. TITLE

INVERTER NN11 INADVERTANTLY TRANSFERRED TO ITS ALTERNATE AC SOURCE

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
06	09	2014	2014	- 003 -	02	08	06	2015	FACILITY NAME	DOCKET NUMBER

9. OPERATING 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)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☐ 50.73(a)(2)(i)(A)
- ☒ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☐ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	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
G	EF	INVT	Solid State Controls	Y					

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 6/9/2014, during a maintenance activity, inverter NN11 unexpectedly transferred from its normal direct current (DC) source to its bypass alternating current (AC) source. This inverter provides power to the NN01 bus which is one of four vital 120-VAC instrument buses at Callaway Plant. In addition to other vital instrumentation, the bus provides power to cabinet SB038 which supports instrumentation and controls for systems such as the Reactor Trip System (RTS) and the Engineered Safety Feature Actuation System (ESFAS).

Investigation identified a loose mounting screw that secures disconnect switch NN01-11 to bus NN01. Maintenance work in the area of the loose termination led to a momentary interruption of power to cabinet SB038, which appeared as a fault condition to the inverter, thus causing the inverter to transfer to its alternate power source. The cabinet, bus, and inverter are seismically qualified and are required to be capable of performing their design basis accident mitigation functions following a Safe Shutdown Earthquake (SSE). Per Callaway's licensing basis, this capability is an Operability requirement. With the degraded electrical termination, which existed for an extended period of time before discovery and repair, the inverter and SB038 loads would not have been capable of performing their design basis function following an SSE, thus rendering the components inoperable.

The direct cause of this event was inadequate thread engagement of the screw securing the switch to the NN01 bus. Corrective actions include changes to job planning aids and maintenance procedures.

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

The onsite Class 1E AC, DC, and AC vital bus electrical power distribution systems at Callaway are divided by train into two redundant and independent AC, DC, and AC vital bus electrical power distribution subsystems.

The AC electrical power subsystem for each train consists of an Engineered Safety Feature (ESF) 4.16-kV bus [EIIS system EB], 480-V buses [EIIS system ED], and load centers. Each 4.16-kV ESF bus may be supplied power from either of two offsite power sources or from a dedicated onsite emergency diesel generator (DG) source. Each 4.16-kV ESF bus is normally connected to a preferred offsite source. After a loss of the preferred offsite power source to a 4.16-kV ESF bus, the onsite emergency DG automatically supplies power to the bus. A transfer to the alternate offsite source is accomplished by manually repositioning breakers, if required. Control power for the 4.16-kV breakers is supplied from the Class 1E DC system.

The 120-VAC vital buses [EIIS system EF] are arranged in two load groups per train and are normally powered through the inverters from the 125-VDC electrical power subsystem [EIIS system EJ]. The 125-VDC electrical power distribution system is arranged into two buses per train.

Each 125-VDC bus is supported by a 125-VDC Class 1E battery bank [EIIS system EJ] and associated 125-VDC Class 1E battery charger which is supported by a 480-VAC source.

The table below provides the overall scheme for the above-described distribution buses.

AC and DC Electrical Power Distribution Systems

TYPE	VOLTAGE	TRAIN A	TRAIN B
AC safety buses	4160 V	ESF Bus NB01	ESF Bus NB02
	480 V	Load Centers NG01, NG03	Load Centers NG02, NG04
DC buses	125 V	Bus NK01	Bus NK02
		Bus NK03	Bus NK04
AC vital buses	120 V	Bus NN01	Bus NN02
		Bus NN03	Bus NN04

The four independent Class 1E 120-VAC vital buses independently provide power to the four

channels of the protection systems and reactor control systems. The power supply for each 120-VAC vital bus consists of one inverter/uninterruptible power supply (UPS) and one external standby regulating transformer which can be connected to the bus through the manual transfer switch.

Each inverter/UPS [EIIS component INVT] (i.e., NN11, NN12, NN13 and NNI4) consists of a 7.5-kVA solid-state inverter with an integral 480-VAC to 120-VAC single-phase regulating transformer [EIIS component XFMR] for use as a backup/alternate source, an automatic static transfer switch that will switch to the backup source in the event of inverter failure, and a manual maintenance bypass switch that can be used to switch to the external backup supply (external standby regulating transformer) during maintenance activities or in the event of an inverter failure. The normal supply for each UPS/inverter is from the associated Class 1E DC bus. The UPS/inverter backup source (i.e., the integral regulating transformer) for each unit is supplied from Class 1E 480 VAC.

2. INITIAL PLANT CONDITIONS:

On 06/09/2014, Callaway Plant was in Mode 1 (Power Operations) at 100-percent rated thermal power and normal operating temperature and pressure when the event (described below) occurred. No other significant equipment was concurrently inoperable.

3. EVENT DESCRIPTION:

On 06/09/2014, thermography inspections and clamp-on ammeter readings were being conducted on disconnect switch NN01-11. During this activity, an unexpected transfer of inverter NN11 from its normal DC source to its bypass AC source occurred. The NN11 inverter provides power to the NN01 bus which is one of four vital 120-volt AC instrument buses at Callaway Plant. The transfer caused a momentary de-energization of cabinet SB038 (explained later), which resulted in the following plant impacts:

- Control Rod insertion of 6 ½ steps, with an associated pressurizer level and pressure perturbation and subsequent xenon transient,
- Opening of the 'A' Centrifugal Charging Pump suction from the Reactor Water Storage Tank isolation valve due to momentary loss of the associated Volume Control Tank level channel, and
- Steam Generator Environmental Allowance Modifier (EAM) circuit actuation resulting in the resetting of the low level setpoint from 17% to 21% narrow range level.

None of these effects posed a significant challenge to plant operators.

In response to the inverter transfer, which is considered to render the inverter and its uninterruptible power supply (UPS) function inoperable, the applicable Condition and Required Action under Technical Specification (TS) 3.8.7, "Inverters – Operating," were entered. In addition, the applicable

NARRATIVE

Conditions and Required Actions under the following Technical Specifications were entered for normally deenergized bistables that are powered by the NN01 bus: TS 3.3.2, "Engineered Safety Feature Actuation System (ESFAS) Instrumentation," for the affected Refueling Water Storage Tank Low Low Level and Containment Pressure – High 3 trip channels, and TS 3.3.5, "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation," for the affected 4.16-kV bus undervoltage relaying.

Following the event, troubleshooting was performed which identified that a screw that secures the NN01 bus to the line side of disconnect switch NN01-11 was loose. Electrical Maintenance subsequently tightened the mounting screw 10 revolutions. This disconnect switch is part of the feed from the NN01 bus to the SB038 cabinet, which supports instrumentation and controls for the Reactor Trip System (RTS), Engineered Safety Feature Actuation System (ESFAS), Post Accident Monitoring System (PAMS), and the Remote Shutdown System. It was thus determined that the loose termination, in conjunction with the maintenance work, contributed to a disturbance of power to cabinet SB038. The momentary interruption in power to cabinet SB038 resulted in a power transient on bus NN01 that appeared as a fault condition to the NN11 inverter. The detected fault condition resulted in the inverter transferring to its alternate AC power source.

Cabinet SB038, vital bus NN01, and inverter NN11 are required to be seismically qualified and are thus designed to remain capable of performing their design basis accident mitigation functions following a Safe Shutdown Earthquake (SSE). In light of this design requirement, it was determined that, in the event of a seismic event with the degraded electrical termination condition present, the inverter would be subject to a spurious transfer and loss of its UPS function, and the SB038 cabinet would be subject to a power supply disruption. Consequently, it could not be assumed that the NN11 inverter and the loads associated with the SB038 cabinet would be capable of performing their design basis function following an SSE, with the degraded electrical termination condition present.

Removal of the disconnect switch and inspections of the bus bar mounting interface were performed during the subsequent refueling outage in October 2014. During the refuel, evaluations of the switch compartment were performed. The evaluations confirmed that 10 revolutions of the bus bar termination screw results in removal from the bus bar connection. With this bus termination screw removed, slight agitation of the back of the switch resulted in complete interruption of circuit continuity. Inspection of the bus bar with the switch subsequently removed confirmed that the threads in the bus bar were not stripped.

It was thus concluded that insufficient thread engagement at this mating surface resulted in a configuration that was not seismically qualified. This configuration was determined to have most likely been established when the disconnect switch was last replaced in 2008.

Affected Components and Associated Technical Specifications

As detailed above, the SB038 cabinet and its loads, along with the NN11 inverter, are designed to be seismically qualified. With the degraded electrical termination condition present, the inverter was subject to spurious transferring and the SB038 cabinet was subject to power supply disruption, in the event of a seismic event. Consequently, it cannot be assumed that with the degraded electrical termination condition present, the NN11 inverter and the loads associated with the SB038 cabinet would be capable of performing their design basis function following an SSE.

Section 3.1.2 of the Callaway Final Safety Analysis Report (FSAR) provides a summary of the key assumptions, including single-failure assumptions, that were factored into the design and accident analysis for Callaway Plant. As noted therein, "In designing for and analyzing for DBAs [design basis accidents],...for a LBLOCA [large break loss-of-coolant accident]... no credit is taken for the functioning of non-seismic Category 1 components." This guidance is part of Callaway's licensing basis wherein seismic qualification is considered to be a requirement for Operability of systems, structures and components needed to mitigate a DBA LOCA.

Per Callaway's accident analysis as described in the FSAR, a DBA is postulated to occur with a loss of offsite power, but not with a seismic event. Nevertheless, based on the above, it is a requirement that in order for SSCs to be considered Operable with respect to their required DBA mitigation functions, they must be seismically qualified. With the degraded electrical termination condition present at the noted disconnect switch, the NN11 inverter and loads associated with the SB038 cabinet were, in effect, not seismically qualified due to their capability to be disabled by a seismic event. With this vulnerability present, the inverter and SB038 loads must be considered inoperable.

As noted previously, the degraded electrical termination condition was determined to have most likely been established when the disconnect switch was last replaced in 2008. Based on the last time when work was performed on the disconnect switch, it may be presumed that the condition existed for a significant period of time relative to the allowed out-of-service times permitted by the Technical Specifications for all of the affected components. The affected Technical Specifications are identified as follows.

The NN11 inverter is subject to the requirements of Callaway Technical Specification (TS) 3.8.7, "Inverters – Operating." Per the Limiting Condition for Operation (LCO) of this Technical Specification, all four required inverters must be Operable during plant operation, i.e., during Modes 1, 2, 3, and 4. With one required inverter inoperable, Condition A applies and associated Required Action A.1 must be entered, which requires restoring the inoperable inverter to Operable status within the specified Completion Time of 24 hours. Otherwise, Condition B is entered, and in this Condition a controlled plant shutdown is required such that per Required Actions B.l and B.2, the plant must be in Mode 3 in 6 hours and in Mode 5 in 36 hours, respectively.

With an inverter inoperable, other Technical Specifications (beside TS 3.8.7) are affected as well. They were identified in Section 3, wherein it was noted that when the NN11 inverter was initially declared inoperable on 6/9/2014, the applicable Conditions and Required Actions under TS 3.3.2,

"Engineered Safety Feature Actuation System (ESFAS) Instrumentation," for the affected Refueling Water Storage Tank Low Low Level and Containment Pressure – High 3 trip channels, and TS 3.3.5, "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation," for the affected 4.16-kV bus undervoltage relaying, were entered due to the impact on normally deenergized bistables powered by the NN01 bus.

For the affected loads associated with the SB038 cabinet, the loads are numerous. (A detailed listing is included with the corrective action document initiated in response to the event.) They primarily consist of one division/channel of various trip units (bistables) associated with the RPS, ESFAS, PAMS, and Remote Shutdown System, which are subject to the requirements of TS 3.3.1, "Reactor Trip System (RTS) Instrumentation," TS 3.3.2, "Engineering Safety Feature Actuation System (ESFAS) Instrumentation," TS 3.3.3, "Post Accident Monitoring (PAM) Instrumentation," and TS 3.3.4, "Remote Shutdown System," respectively. From review of the various Conditions and Required Actions under these Technical Specifications, which applied with the noted instrumentation inoperable, the most severe Completion Times (i.e., allowed out-of-service times) are on the order of 12 hours.

The degraded terminal connection condition was determined to have most likely been established when the disconnect switch was last replaced in 2008. The resultant "past" inoperability of the various affected instruments/components identified above must be presumed to have existed for that length of time.

4. ASSESSMENT OF SAFETY CONSEQUENCES:

Although the identified condition affected numerous loads, including the NN11 inverter and the various instrument channels associated with the RTS, ESFAS, PAMS, and Remote Shutdown System instrumentation, the condition did not prevent LOCA mitigation equipment from performing required mitigation functions assuming no concurrent seismic event. In addition, in the event of a seismic event, the condition would not have prevented the achievement of safe shutdown for such a hazard, since sufficient shutdown capability remained due to the availability of redundant equipment not affected by the condition.

It should also be noted that, for much of the RTS and ESFAS instrumentation potentially affected by the condition, in the event of a seismic event and the resultant loss of power to the affected instrumentation due to the identified condition, the affected bistables would trip to their tripped state due to the instrumentation's deenergize-to-trip design.

Based on the above considerations, the event/condition is not considered to be safety significant.

Risk Assessment

The plant risk associated with the unqualified SB038 electrical connection is related to seismic events where mitigation is complicated by the induced failure of SB038 and its affected loads. A qualitative risk assessment was conducted based on the range of seismic impacts and the effect of the unqualified SB038 electrical connection.

The range of seismic magnitudes was divided into three intervals associated with step changes in damage states. The seismic impacts were evaluated by considering the consequences, required plant response, effects of the unqualified SB038 connection and the expected frequency of the associated seismic events for these intervals. The evaluation of overall risk associated with the effect of the unqualified SB038 electrical connection indicates this condition had very low risk significance.

5. REPORTING REQUIREMENTS:

This LER is submitted pursuant to 10 CFR 50.73(a)(2)(i)(B) to report a condition prohibited by the plant's Technical Specifications.

The Technical Specifications affected by the past inoperability of the various components due to the degraded electrical termination at the noted disconnect switch are identified in Section 3 of this LER. The allowed out-of-service times (i.e., Completion Times) specified in the Required Actions of the affected Technical Specifications are also identified or discussed. For the inoperable NN11 inverter, an allowed out-of service time of 24 hours is specified in the TS 3.8.7. For some of the instrument channels made inoperable by the identified condition (as previously explained), allowed out-of-service times on the order of 12 hours apply, under TS 3.3.1 and TS 3.3.2.

Since the degraded terminal connection has been presumed to exist since 2008, the resultant "past" inoperability of the various affected instruments/components (including the NN11 inverter itself) must be presumed to have existed for a period of time that exceeds the allowed out-of-service times permitted by the Technical Specifications. The condition must thus be reported as an operation or condition prohibited by the plant's Technical Specifications.

6. CAUSE OF THE EVENT:

The direct cause of the event/condition is attributed to inadequate thread engagement of the screw that secures disconnect switch NN01-11 to the NN01 bus. This loose termination contributed to an interruption in power to the circuit load (SB038) when personnel accessed this disconnect switch compartment for thermography inspections and clamp-on ammeter readings on 06/09/14.

7. CORRECTIVE ACTIONS:

Corrective actions include enhancements to job planning aids. Specifically, location planning notes will be added to specify that verification of proper alignment and thread engagement of the screw securing the switch to the bus bar is performed.

In addition, the bus maintenance procedure will be revised to include back panel verification for proper switch alignment / thread engagement for bus bar termination screws that have been disturbed during bus cleaning / inspection activities.

8. PREVIOUS SIMILAR EVENTS:

Although there have been previous instances of inverters spuriously transferring to their alternate source at Callaway, there have not been previous cases of inverter failure at Callaway that were found to have been caused by a degraded (inadequate thread engagement) bus mounting screw.