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DEC 0 5 2016

10 CFR 50.73

Serial: RNP-RA/16-0093

United States Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/RENEWED LICENSE NO. DPR-23

LICENSEE EVENT REPORT NO. 2016-005-00:
REACTOR TRIP AND AUTOMATIC SYSTEM ACTUATION DUE TO WEATHER-RELATED LOSS OF OFFSITE POWER

Ladies and Gentlemen:

Pursuant to 10 CFR 50.73, Duke Energy Progress, LLC is submitting the attached Licensee Event Report. There are no unresolved corrective actions necessary to restore compliance with NRC requirements. Should you have any questions regarding this matter, please contact Mr. Tony Pilo, Manager – Nuclear Regulatory Affairs at (843) 857-1409.

This document contains no new regulatory commitments.

Sincerely,

R. Michael Glover
Site Vice President

RMG/jmw

Attachment

c: Region Administrator, NRC, Region II
NRC Resident Inspector, HBRSEP
D. Galvin, NRR

United States Nuclear Regulatory Commission
Attachment to Serial: RNP-RA/16-0093
6 Pages (including this page)

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

REACTOR TRIP AND AUTOMATIC SYSTEM ACTUATION DUE TO WEATHER-RELATED LOSS OF OFFSITE POWER

NRC FORM 366 (06-2016) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

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

(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/)

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2018

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
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4. TITLE

Reactor Trip and Automatic System Actuation Due to Weather-Related Loss of Off-site Power

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
10	08	2016	2016	- 005 -	00	12	07	2016	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*			
1	☐ 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)
10. POWER LEVEL	☐ 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)
100	☐ 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)*
Tony Pilo, Manager, Nuclear Regulatory Affairs	(843) 857-1409

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
X	FK	RLY	G080	Y					

14. SUPPLEMENTAL REPORT EXPECTED	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☑ NO				

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

At 1302 hours Eastern Daylight Time on 10/08/2016 with the plant in Mode 1 at 100 percent power, H. B. Robinson Steam Electric Plant, Unit No. 2 (HBRSEP2), experienced an automatic reactor trip due to a loss of off-site power (LOOP). This resulted in the loss of both main feed pumps (MFP) and subsequent autostart of both motor-driven auxiliary feedwater (AFW) pumps, as designed. Coincident with the LOOP, both emergency diesel generators (EDG) automatically started and were providing power to the two vital 480V buses (E-1 and E-2), which power both AFW pumps. Once the power grid was stable, plant personnel commenced restoration of off-site power to allow shutdown of the the EDGs.

At approximately 2323 EDT on 10/08/2016, a second automatic actuation of the 'B' AFW pump occurred during the transfer of power from the 'B' EDG to off-site power due to improper breaker coordination that satisfied the auto-start logic for the AFW system.

The apparent cause of the LOOP is a failed relay in the phase-to-phase portion of the line trip circuitry, which prevented the grid fault from being immediately isolated in the HBRSEP2 switchyard.

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NARRATIVE

BACKGROUND

At the time this condition was identified, H. B. Robinson Steam Electric Plant, Unit No. 2 (HBRSEP2) was operating in Mode 1 at approximately 100 percent power. No structures, systems or components were out of service at the time of the event that contributed to this event.

This event is reportable under 10 CFR 50.73(a)(2)(iv)(A) due to automatic actuation of the reactor protection system (RPS)[AA], and the auxiliary feedwater system (AFW)[BA]. On 10/08/2016 at 1344 EDT, notification to the NRC Operations Center was made (EN# 52290) under 10 CFR 50.72(b)(2)(iv)(B) due to automatic actuation of the RPS, and under 10 CFR 50.72(b)(3)(iv)(A) due to the valid actuation of the AFW system.

The RPS monitors all parameters related to safe operation of the reactor[RCT]. The system is designed to protect the core and the reactor coolant system[AB] from damage by tripping the reactor when a reactor trip circuit's logic is met. The reactor trip protecting the core from a departure from nucleate boiling (DNB) monitors the power, voltage and frequency to each reactor coolant pump (RCP)[P]. The reactor is tripped on a loss of electrical power to the pump by undervoltage signal when above approximately ten percent power.

The AFW system can provide feedwater to the steam generators[SG] upon loss of the main feedwater pumps[P]. The two motor-driven pumps[P] are supplied power from the emergency buses E-1 and E-2.[BU]

EVENT DESCRIPTION - Reactor Trip - LOOP:

At 1302 hrs on 10/08/16, H. B. Robinson Steam Electric Plant, Unit No. 2 (HBRSEP2), experienced a reactor trip. The trip was initiated by the 4160 volt buses undervoltage relays[27], which was the result of a severe voltage depression in the HBRSEP2 switchyard. The voltage depression was caused by a fault on the Robinson-Rockingham 230kV transmission line that was not immediately isolated due to a failed fault detector (50L) relay[RLY] in the HBRSEP2 switchyard relay building. The grid fault was caused by trees hitting the 230kV transmission lines during Hurricane Matthew. The fault was isolated on the Rockingham end of the line in three cycles (50 milliseconds), but failure of the 50L relay prevented the transmission of a trip signal to the Rockingham 230kV line circuit breakers in the HBRSEP2 switchyard. The grid fault was originally a phase-to-phase fault, but propagated to a phase-to-phase-to-ground fault. When the ground fault occurred, a directional ground carrier relay[85] and a directional ground instantaneous relay[50] picked-up at approximately 4.7 seconds after the initial fault, sending trip signals to the HBRSEP2 switchyard breakers[BKR] for the Rockingham 230kV line and circuit breakers 52/2-230 and 52/3-230. Tripping these breakers isolated the grid fault and restored nominal voltage in the HBRSEP2 switchyard.

Since the Main Transformers and the Start-Up Transformer (SUT)[XFMR] are connected to the HBRSEP2 switchyard, their associated voltages also suffered a severe depression. This reduced voltage was then transferred into all of the HBRSEP2 auxiliary electrical buses, including 4kV buses 1 - 5. 4kV buses 1, 2, and 4 have undervoltage relays. The reactor tripped when a two out of three coincidence was satisfied for the 4kV bus undervoltage relays for 4kV buses 1, 2, & 4. The HBRSEP2 4kV undervoltage relays are calibrated to trip at 0.75 seconds for voltages less than 75% nominal, so the delay in isolating the grid fault from the HBRSEP2 switchyard allowed the HBRSEP2 4kV undervoltage relays to time-out and trip the reactor. Subsequent to the reactor trip, loss of the main feedwater pumps caused the motor-driven AFW pumps to automatically start to provide feedwater to the steam generators, as designed.

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EVENT DESCRIPTION - Auxiliary Feedwater System Actuation:
Coincident with the loss of off-site power (LOOP), the 'A' and 'B' emergency diesel generators (EDG)[DG] automatically started and were providing power to the two vital 480V emergency buses, E-1 and E-2, which power the 'A' and 'B' motor-driven AFW pumps, respectively. After grid stability was achieved, plant operations personnel commenced restoration of off-site power to allow the shutdown of the EDGs. At approximately 2323 on 10/08/2016, while restoring power to E-2 from off-site power, 'B' motor-driven AFW pump automatically started when the corresponding 'B' EDG output breaker was opened.

CAUSAL FACTORS
Reactor Trip - LOOP:
The 10/08/2016 grid fault on the Robinson-Rockingham 230kV line isolated immediately at Rockingham but not at HBRSEP2 The original fault was phase-to-phase between the B and C phases. 351 milliseconds into the fault, it propagated into a three-phase fault. The affected portion of the Rockingham 230kV line tripping circuit has three phase-to-phase relay contacts[CNTR] in parallel with each other, A-B, B-C, and C-A. The phase-to-phase contacts are then in series with the 50L fault detector relay. When the fault went from B-C to A-B-C, that indicated that the problem was not in the phase-to-phase relays, but in the 50L relay. If the problem was in the B-C relay, the line protection would have tripped when the fault propagated to the A phase since then the A-B and C-A relays would also have tripped. The only common relay to them all was the 50L relay contact. There is a primary and backup trip coil[CL], so a failed trip coil was unlikely. Transmission performed an in-place check of the 50L relay on 10/10/2016 and found the telephone relay (50A) coil[CL] on the 50L to be open circuited. A more thorough bench test was performed on 10/31/2016 with the same results. The basic design of this 50L relay is that it has an induction disk with a single contact[CNTR]. But this 50L needs two output contacts. When the single induction disk contact closes it energizes the 50A relay. The 50A relay is a small auxiliary relay that has two output contacts which are the 50L relay's output contacts that are wired into the primary and back-up trip circuits for the Robinson-Rockingham 230kV line. The 50A relay coil portion of the 50L relay was found to be open circuited. Since the relay coil was open circuited, the 50L was incapable of operating its trip output contacts in either the primary trip circuit or the backup trip circuit. The 50L relay was installed in January 1988 so it was approximately 28.7 years old at the time of failure. The 50L relay looks at the current on the affected line and the relay picks-up at 600 amps on the line. The Rockingham 230kV line normally runs with 1300-1500 amps during winter and summer months, and less loading during spring and fall. This indicates that the relay is energized most of the time. Forensic analysis on the 50A relay's outer varnish and paper found slight discoloration but no signs of burn marks. This indicated that the failure was age and long term heat related. The failed relay was well within its calibration and testing frequency, and operated properly between its last calibration and functional test and the failure. The relay original equipment manufacturer does not recommend periodic relay replacement. The event of the Robinson-Rockingham 230kV line failing to trip and isolate in the HBRSEP2 switchyard immediately was an unforeseeable equipment failure, and not human performance related.

Auxiliary Feedwater System Actuation:
Interviews with the Operations Crew revealed that the operators were in "knowledge space" due to a lack of procedural guidance regarding the AFW circuitry during restoration of power following a LOOP event. Though the operators understood the interlock[IEL] with the AFW pump auto-start, it was not considered during the restoration process. The operators' focus was on ensuring power was restored to emergency bus E-2 to ensure no errors occurred, which could result in an escalation to an ALERT condition. The cause of this event was inadequate procedural guidance to direct an infrequently performed task: off-site power restoration to vital buses post LOOP event, post outage or emergency operating procedure entry.

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CORRECTIVE ACTIONS - Reactor Trip - LOOP:
Complete:
1. Bypass the failed 50L Relay.
2. Enter condition into corrective action program.
3. Create Nuclear Switchyard Reliability Working Group Action Register item for Transmission Group to create a project to design/install solution to the single point vulnerability (SPV) for the 50L relays in the HBRSEP2 switchyard on the Rockingham, Florence, Darlington, and Sumter 230kV transmission lines.

Planned:
1. Replace Florence, Darlington and Sumter 230kV line 50L relays with newly calibrated relays. (Work Order 20120590)
2. Perform and evaluation of the HBRSEP switchyard relaying to determine if there are other SPVs associated with incoming transmission lines and switchyard buses, and to determine if there are other protective relays that have normally energized telephone relays. If so, initiate actions to eliminate/mitigate SPVs and periodically replace the telephone relays.
3. Replace failed 50L relay (Work Order 20119476)

CORRECTIVE ACTIONS - Auxiliary Feedwater System Actuation:
Complete:
1. Enter condition into corrective action program.

Planned:
1. Review power restoration procedures following a LOOP event, post outage or emergency operating procedure entry and generate Procedure Revision Requests to correct to re-establish configuration control. (CR 2068565)

SAFETY ANALYSIS - Reactor Trip - LOOP/AFW Pump Actuation:
The tripping of the HBRSEP2 reactor and resultant AFW pump actuation due to the undervoltage on the 4kV buses, and the actual tripping of the Robinson-Rockingham 230kV line due to the eventual ground fault occurred automatically per system and equipment design. The failure of the 50L fault detector relay on the Robinson-Rockingham 230kV line in the Robinson switchyard was self-revealing. The 50L relay is not a safety related relay, but its failure resulted in the reactor/ plant trip. There was no nuclear safety significance beyond a normal plant trip and the trip of the emergency buses with them reloading on the emergency diesel generators by the blackout sequencers. There were no industrial safety or radiological impacts. While isolated, the grid fault cleared itself. The Robinson-Rockingham 230kV line was re-energized 15 seconds after the start of the fault when one of the Rockingham substation breakers re-closed. Breaker 52/3-230 in the HBRSEP2 switchyard re-closed at 16 seconds. The two Darlington County Electric Plant (DCEP) lines had their DCEP switchyard breakers re-close at 17 seconds.

HBRSEP2 experienced a reduced switchyard voltage to less than 50% nominal voltage for 4.67 seconds. The HBRSEP2 SUT never disconnected from the switchyard and remained energized throughout the event. The HBRSEP2 4kV buses remained energized throughout the event. The RNP 480V buses tripped on undervoltage, with the Emergency Buses and Dedicated Shutdown Bus being re-energized from diesel generators. 480V Bus 5 should have tripped, but did not trip on undervoltage. This failure is being evaluated under CR 2068442.

SAFETY ANALYSIS - Auxiliary Feedwater System Actuation During Restoration of Off-site Power:
The automatic actuation of the AFW system was valid, and the system responded to plant conditions as designed. There is no safety consequence to this aspect of the event.

LICENSEE EVENT REPORT (LER) CONTINUATION SHEET

(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/)

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

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NARRATIVE

SAFETY ANALYSIS - Auxiliary Feedwater System Actuation: (continued)
The cause was related to inadequate procedural guidance and not attributed to any equipment failures.

This event resulted in no significant impact to the health and safety of the public.

ADDITIONAL INFORMATION
Conclusions From Operating Experience (OE) Review:

No OE was found that would have led to searching for and eliminating the transmission line single point vulnerabilities (SPV) that resulted in the HBRSEP2 reactor trip. However, SPVs are well known to nuclear plants. Past OE has caused nuclear plants including HBRSEP2 to search for and eliminate or mitigate the SPVs in the plant. This has not been done for Transmission Department equipment in the HBRSEP2 switchyard beyond the breakers that are directly connected to the plant; the Generator Output breakers [BKR] and the Start-up/Span Bus breakers[BKR].

Energy Industry Identification System (EIIS) codes for systems and components relevant to this event are identified in the text of this document within brackets [ ].