TENNESSEE VALLEY AUTHORITY

Post Office Box 2000, Decatur, Alabama 35609-2000

December 19, 2022

10 CFR 50.73
10 CFR 50.4(a)

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Unit 3
Renewed Facility Operating License No. DPR-68
NRC Docket No. 50-296

Subject: **Licensee Event Report 50-296/2022-002-00 – Both Standby Liquid Control Subsystems Inoperable Due to an Insufficient Boron Injection Rate**

The enclosed Licensee Event Report provides details of the inoperability of both Standby Liquid Control subsystems due to an insufficient boron injection rate. Tennessee Valley Authority is submitting this report in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(vii) as an event where a single cause or condition caused 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.

There are no new regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact Chris L. Vaughn, Site Licensing Manager, at (256) 729-2636.

Respectfully,

Manu Sivaraman
Site Vice President

Enclosure: Licensee Event Report 50-296/2022-002-00 – Both Standby Liquid Control Subsystems Inoperable Due to an Insufficient Boron Injection Rate

cc (w/ Enclosure):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant

NRC FORM 366 (08-2020) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 08/31/2023

1. Facility Name	2. Docket Number	3. Page
Browns Ferry Nuclear Plant, Unit 3	**05000**296	1 OF 7

4. Title

Both Standby Liquid Control Subsystems Inoperable Due to an Insufficient Boron Injection Rate

5. Event Date			6. LER Number			7. Report Date			8. Other Facilities Involved	
Month	Day	Year	Year	Sequential Number	Revision No.	Month	Day	Year	Facility Name	Docket Number
10	18	2022	2022	- 002 -	00	12	19	2022	N/A	**05000** N/A
									Facility Name	Docket Number
									N/A	**05000** N/A

9. Operating Mode	10. Power Level
1	100

11. This Report is Submitted Pursuant to the Requirements of 10 CFR §: *(Check all that apply)*

10 CFR Part 20	☐ 20.2203(a)(2)(vi)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(A)	**10 CFR Part 73**
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.69(g)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(4)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(i)	**10 CFR Part 21**	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	☐ 73.77(a)(1)
☐ 20.2203(a)(2)(ii)	☐ 21.2(c)	☐ 50.73(a)(2)(i)(C)	☒ 50.73(a)(2)(vii)	☐ 73.77(a)(2)(i)
☐ 20.2203(a)(2)(iii)	**10 CFR Part 50**	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)	☐ 73.77(a)(2)(ii)
☐ 20.2203(a)(2)(iv)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)	
☐ 20.2203(a)(2)(v)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)	

☐ **OTHER** (Specify here, in abstract, or NRC 366A).

12. Licensee Contact for this LER

Licensee Contact	Phone Number (Include area code)
Ryan Coons, Licensing Engineer	256-729-2070

13. Complete One Line for each Component Failure Described in this Report

Cause	System	Component	Manufacturer	Reportable to IRIS	Cause	System	Component	Manufacturer	Reportable to IRIS
E	BR	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A

14. Supplemental Report Expected)		15. Expected Submission Date	Month	Day	Year
☒ No	☐ Yes (If yes, complete 15. Expected Submission Date		N/A	N/A	N/A

16. Abstract (Limit to 1560 spaces, i.e., approximately 15 single-spaced typewritten lines)

On October 18, 2022 at 1440 Central Daylight Time (CDT), following a routine surveillance test, Browns Ferry Nuclear Plant, (BFN), Unit 3 declared both trains of the Standby Liquid Control (SLC) system inoperable for failing to meet boron injection rate acceptance criteria.

This resulted in a single cause or condition that caused 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. At the time, it was believed that this could have prevented the SLC system from fulfilling its safety function to shut down the reactor and maintain it in a safe shutdown condition. However, an engineering evaluation later determined that the SLC system remained capable of fulfilling its required safety function throughout this event.

Upon investigation, it was discovered that this event resulted from an ineffective corrective action for the issue identified in Condition Report (CR) 1439832, where all of parameters used in the Anticipated Transient Without Scram (ATWS) equivalency equation could individually meet Technical Specifications (TS), yet still fail the acceptance criteria. SLC system operability was restored on October 18, 2022 at 2053 CDT, after an additional 80 kg of sodium pentaborate was added to the BFN, Unit 3 SLC tank. This increased the boron concentration of the SLC solution, which raised the boron injection rate to an acceptable level. As a corrective action to prevent or reduce the probability of recurrence, BFN will develop and implement an improved method for determining SLC pump flow rates. This will include benchmarking other plants to incorporate their best practices to improve the accuracy and repeatability of SLC pump flow rate measurements.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Browns Ferry Nuclear Plant, Unit 3	**05000-**296	2022	- 002	- 00

NARRATIVE

I. Plant Operating Conditions before the Event

At the time of discovery, Browns Ferry Nuclear Plant (BFN) Unit 3 was in Mode 1 at approximately 100 percent power.

II. Description of Event

A. Event Summary

On October 18, 2022 at 1440 Central Daylight Time (CDT), BFN, Unit 3 declared both trains of Standby Liquid Control (SLC) [BR] inoperable for failure to meet the acceptance criteria in 3-SI-3.1.7.6, “Standby Liquid Control System ATWS Equivalency Calculation for Newly Established Pump Flow Rate.” This surveillance ensures the Anticipated Transient without Scram (ATWS) calculation criteria is met after each pump flow test. Following Operations’ performance of 3-SI-4.4.A.1, “Standby Liquid Control Pump Functional Test,” which is used to determine the SLC pump flow rates, Chemistry personnel entered the new pump flow rates into the ATWS equivalency calculation of 3-SI-3.1.7.6. Due to the change in pump flow rates, the new result of the ATWS equivalency calculation was less than 1. This caused both trains of SLC to fail their Technical Specification (TS) Surveillance Requirements (SR) of being greater than or equal to 1. As a result, both SLC trains were declared inoperable, causing BFN Unit 3 to enter an Unplanned Shutdown Limiting Condition of Operability (LCO).

In accordance with 0-TI-18, “Sodium Pentaborate Concentration and Level Adjustment of the Standby Liquid Control System”, an additional 80 kg of sodium pentaborate (SPB) was added to the BFN, Unit 3 SLC tank [TK]. Chemistry personnel performed 3-SR-3.1.7.3, “Standby Liquid Control System Enriched Sodium Pentaborate (SPB) Solution, Concentration, Quantity Calculation, and ATWS Equivalency Calculation,” and confirmed that the result of the ATWS equivalency calculation was greater than or equal to 1.

Upon investigation, it was discovered that this event resulted from an ineffective corrective action for the issue identified in Condition Report (CR) 1439832, where all of the parameters used in the ATWS equivalency equation could individually meet TS requirements, yet still fail the acceptance criteria. Procedures 1/2/3-SR-3.1.7.3 and 1/2/3-SI-3.1.7.6 were only revised to add calculating the ATWS equivalency equation for both SLC pumps without considering how the methodology used to calculate flow rate variations could impact the ATWS calculation.

However, an engineering evaluation later determined that SLC remained capable of performing its required safety function throughout this event. Based on the pump design, the minimal time of operation, the methods used to calculate pump flowrate, and the variation in pump flow rates observed during quarterly functional tests, the calculated flow rate which was determined on October 18, 2022 was acceptable. There is no evidence to suggest that the capacity of the Unit 3 SLC Pumps had changed due to pump degradation or wear. In addition,

there was no evidence that the concentration of the SLC SPB solution had changed because there were no recent dilution events or chemical additions performed which would have affected the validity of that input into the ATWS Equivalency calculation. The BFN, Unit 3 SLC System was capable of performing its design functions and was operable throughout this event. All surveillance tests were in periodicity and were completed satisfactory prior to the time of discovery.

Tennessee Valley Authority is submitting this report in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(vii) as an event where a single cause or condition caused 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.

B. Status of structures, components, or systems that were inoperable at the start of the event and that contributed to the event

There were no structures, systems, or components (SSCs) whose inoperability contributed to this event.

C. Dates and approximate times of occurrences

DATE AND APPROXIMATE TIMES	OCCURENCE
October 18, 2022, 1440 CDT	Ops declares both BFN, Unit 3 SLC subsystems inoperable, following the unsatisfactory performance of 3-SI-3.1.7.6. TS LCO 3.1.7, Conditions A and B were entered, requiring one SLC subsystem to be restored to operability within 8 hours, and restoring both SLC subsystems to operability within 7 days.
October 18, 2022, 1627 CDT	Chemistry personnel commenced 3-SR-1.7.3, to add boron to the BFN, Unit 3 SLC tank.
October 18, 2022, 2050 CDT	Chemistry personnel complete the satisfactory performance of 3-SR-1.7.3.
October 18, 2022, 2053 CDT	Ops declares both BFN, Unit 3 SLC subsystems operable, following the satisfactory performance of 3-SI-1.7.3, and exited TS LCO 3.1.7, Conditions A and B within their required completion times.

D. Manufacturer and model number of each component that failed during the event

No components failed during this event.

E. Other systems or secondary functions affected

No other systems or secondary functions were affected.

F. Method of discovery of each component or system failure or procedural error

SLC inoperability was discovered when Chemistry personnel entered the pump flow rates measured during the performance of 3-SI-4.4.A.1 into the ATWS equivalency calculation of 3-SI-3.1.7.6.

G. The failure mode, mechanism, and effect of each failed component

No components failed during this event.

H. Operator actions

There were no operator actions associated with this event.

I. Automatically and manually initiated safety system responses

There were no automatic or manual safety system responses associated with this event.

III. Cause of the event

A. Cause of each component or system failure or personnel error

The apparent cause of this event was an ineffective corrective action for a previously identified issue where all of the ATWS equivalency equation parameters could individually meet TS requirements, yet when combined, still fail the acceptance criteria.

Additional contributing causes of this event include:

- A lack of precision in the ruler-and-stopwatch methods used to measure SLC pump flow rates can result in fluctuating surveillance results without an actual change in pump performance.
- There was a lack of communication between performing groups, related to knowing how the individual pump flow rates correlate to the concentration level and operability, resulted in a failure by both groups to understand the other group's impact to the functioning of the system.
- The percent concentration of sodium pentaborate within the SLC tank was at the lower end of the TS-allowable band.

B. Cause(s) and circumstances for each human performance related root cause

No human performance related root causes were identified.

IV. Analysis of the event

The SLC System provides a means to assure, and maintain, reactor shutdown from the most reactive steady-state operating condition at any time in the core life, independent of control rod movement. Additionally, the SLC system is used to control suppression pool pH in the event of a design basis accident (DBA) loss of coolant accident (LOCA) by injecting sodium pentaborate into the reactor vessel.

FSAR Chapter 3.8, Standby Liquid Control System, states that each positive displacement pump is sized to inject the SLC solution into the reactor within 50 to 125 minutes (at approximately 50 gpm), depending on the amount of solution in the tank, at the reactor vessel maximum operating pressure. The pump and system design pressure is 1500 psig. The two relief valves are set at approximately 1425 psig to exceed the reactor operating pressure by a sufficient margin to avoid valve leakage. To prevent bypass flow from one pump, in case of relief valve failure in the line from the other pump, a check valve is installed downstream of each relief valve line in the pump discharge pipe. Each positive displacement pump is sized to inject enough neutron-absorbing poison solution into the reactor vessel to:

1. shut down the reactor from full power with no control rod motion, and
2. maintain the reactor in a subcritical condition as the plant operators cool the plant down.

In addition to its shutdown capabilities, the SLC system may be used as a high pressure injection source during low water level conditions in the emergency operating procedures.
According to EWR 09-MEB-999-023, Revision 4, the mission time of the SLC system is 2 hours. This is the time necessary to empty the SLC storage tank into the reactor at a rate of 39 gpm.

The pump flow rates recorded during the performance of 3-SI-4.4.A.1 did not meet the required boron injection rate, as determined by the ATWS equivalence calculation of TS Surveillance Requirement (SR) 3.1.7.6. The addition of SPB to the SLC tank increased the amount of boron being injected into the core, which restored the boron injection rate to an acceptable level.

Based on the pump design, the minimal time of the pump's operation, the methods used to calculate pump flowrate, and the variation in pump flow rates observed during quarterly functional tests, the flow rate observed during the surveillance test prior to the event were acceptable and not unexpected. There is no evidence to suggest that the capacity of the Unit 3 SLC pumps has recently changed due to pump degradation or wear. In addition, there is no evidence that the SLC system SPB solution concentration had changed because there were no recent dilution events or chemical additions performed that would have affected the validity of that input into the ATWS equivalency calculation which revealed the event. Therefore, since the surveillance tests were in periodicity, it was concluded that both SLC subsystems became inoperable at the time of its discovery because there was no firm evidence indicating otherwise.

V. Assessment of Safety Consequences

This event resulted in a single cause or condition which caused both independent trains of the SLC system to become inoperable. SLC is a single system designed to shut down the reactor and maintain it in a safe shutdown condition. BFN, Unit 3 remained capable of shutting down in the event of an emergency because the Reactor Protection System (RPS) [JD] remained operable throughout the duration of this event. An analysis performed by GE Hitachi Nuclear Energy determined that the reduced flow rates had a small impact on overall system performance, and concluded that SLC was expected to continue to meet all applicable ATWS acceptance criteria. Based on the above, during the time period that the SLC system was inoperable, sufficient safety systems were available to provide the required safety functions to protect the health and safety of the public. There was no significant reduction to the health and safety of the public or plant personnel for this event. This event was resolved within the TS-required completion time.

A. Availability of systems or components that could have performed the same function as the components and systems that failed during the event

RPS remained operable throughout this event.

B. For events that occurred when the reactor was shut down, availability of systems or components needed to shutdown the reactor and maintain safe shutdown conditions, remove residual heat, control the release of radioactive material, or mitigate the consequences of an accident

This event did not occur when the reactor was shutdown.

C. For failure that rendered a train of a safety system inoperable, estimate of the elapsed time from discovery of the failure until the train was returned to service

TVA determined that SLC was inoperable from the time of discovery on October 18, 2022, at 1440 CDT. Once the additional SPB was added the SLC tank, and Chemistry re-performed the ATWS equivalence calculation, the system returned to Operable status on October 18, 2022, at 2053 CDT. Both trains of the BFN, Unit 3, SLC system were inoperable for approximately six (6) hours.

VI. Corrective Actions

Corrective Actions are being managed by the TVA's corrective action program under CR 1810303.

A. Immediate Corrective Actions

The addition of SPB into the BFN, Unit 3 SLC tank restored the boron injection rate to an acceptable level, as indicated by the re-calculated value of the ATWS equivalence calculation performed as part of 3-SR-3.1.7.3

B. Corrective Actions to Prevent Recurrence or to reduce the probability of similar events occurring in the future

As a corrective action to prevent or reduce the probability of event recurrence, BFN will develop and implement an improved method for determining SLC pump flow rates. This will include benchmarking other plants to incorporate their best practices to improve the accuracy and repeatability of SLC pump flow rates measurements.

VII. Previous Similar Events at the Same Site

A search of LERs from BFN, Units 1, 2, and 3 over the last five years identified no similar events.

VIII. Additional Information

There is no additional information.

IX. Commitments

There are no new commitments.