



Post Office Box 2000, Decatur, Alabama 35609-2000

May 31, 2022

10 CFR 50.73

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

Browns Ferry Nuclear Plant, Unit 1
Renewed Facility Operating License No. DPR-33
NRC Docket No. 50-259

Subject: **Licensee Event Report 50-259/2022-001-01**

References: 1. Non-Emergency Event Notification 55706 – Degraded Condition
Discovered on Shutdown Cooling Test Line
2. Letter from TVA to NRC dated March 16, 2022, "Licensee Event
Report 50-259/2022-001-00"

The enclosed Licensee Event Report provides details of a pressure boundary leak on Browns Ferry Nuclear Plant, Unit 1. The Tennessee Valley Authority is submitting this report in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(i)(B), as any operation or condition which was prohibited by the plant's Technical Specifications; and 10 CFR 50.73(a)(2)(ii)(A), as any event or condition that resulted in the condition of the nuclear power plant, including its principal safety barriers, being seriously degraded.

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

Respectfully,

A handwritten signature in black ink, appearing to read 'M. Rasmussen', with a long horizontal flourish extending to the right.

Matthew Rasmussen
Site Vice President

Enclosure: Licensee Event Report 50-259/2022-001-01 - Pressure Boundary Leak on
Residual Heat Removal System Low Pressure Coolant Injection Test Line

U.S. Nuclear Regulatory Commission
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cc (w/ Enclosure):

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

ENCLOSURE

**Browns Ferry Nuclear Plant
Unit 1**

Licensee Event Report 50-259/2022-001-01

**Pressure Boundary Leak on Residual Heat Removal System Low Pressure Coolant Injection Test
Line**

See Enclosed



LICENSEE EVENT REPORT (LER)

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, Library, and Information Collections Branch T-6 A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and the OMB reviewer at: OMB Office of Information and Regulatory Affairs, (3150-0104), Attn: Desk ail: qira_submission@omb.eop.gov. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

1. Facility Name Browns Ferry Nuclear Plant, Unit 1		2. Docket Number 05000259	3. Page 1 OF 7
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4. Title
Pressure Boundary Leak on Residual Heat Removal System Low Pressure Coolant Injection Test Line

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
01	15	2022	2022	- 001	- 01	05	31	2022	N/A	N/A
									Facility Name	Docket Number
									N/A	N/A

9. Operating Mode 4	10. Power Level 0
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11. This Report is Submitted Pursuant to the Requirements of 10 CFR §: (Check all that apply)

<input type="checkbox"/> 10 CFR Part 20	<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)
<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	10 CFR Part 73
<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.69(g)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(4)
<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input type="checkbox"/> 73.71(a)(5)
<input type="checkbox"/> 20.2203(a)(2)(i)	10 CFR Part 21	<input checked="" type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	<input type="checkbox"/> 73.77(a)(1)
<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 21.2(c)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)	<input type="checkbox"/> 73.77(a)(2)(i)
<input type="checkbox"/> 20.2203(a)(2)(iii)	10 CFR Part 50	<input checked="" type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)	<input type="checkbox"/> 73.77(a)(2)(ii)
<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)	
<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)	

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

12. Licensee Contact for this LER

Licensee Contact Baruch Calkin, Licensing Engineer	Phone Number (Include area code) 256-278-1031
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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
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

14. Supplemental Report Expected)		15. Expected Submission Date		
<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes (If yes, complete 15. Expected Submission Date)	Month	Day	Year
		N/A	N/A	N/A

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

On January 15, 2022, at 2320 Central Standard Time (CST), during a drywell entry for leak identification, BFN Engineering personnel discovered a through-wall piping leak on a test line upstream of the Residual Heat Removal and Shutdown Cooling test shut-off valve. This test line is classified as American Society of Mechanical Engineers Code Class 1 piping and constitutes part of the Unit 1 Reactor Coolant System pressure boundary. Operations personnel declared the Unit 1 Low Pressure Coolant Injection system (LPCI) Loop I inoperable and maintained Unit 1 in Mode 4 or 5 until the leak was repaired. On January 16, 2022, at 0541 CST, eight-hour Event Notification 55706 was made to the NRC. The test line was cut and capped pending permanent repairs, and on January 20, 2022, at 1520 CST, Unit 1 LPCI Loop I was declared operable.

The root cause of this event was small bore piping which was not specifically analyzed for fatigue failure vulnerability due to operational or resonance vibration. The corrective action for this event is to implement Engineering Change Packages for all small bore piping with vulnerability to fatigue failure due to exceeding the endurance limit due to operational vibration.



**LICENSEE EVENT REPORT (LER)
CONTINUATION SHEET**

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, Library, and Information Collections Branch (T-6 A10M), U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and the OMB reviewer at: OMB Office of Information and Regulatory Affairs, (3150-0104), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street NW, Washington, DC 20503; e-mail: oir_submission@omb.eop.gov. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Browns Ferry Nuclear Plant, Unit 1	05000-259	2022	- 001	- 01

NARRATIVE

I. Plant Operating Conditions Before the Event

At the time of discovery, Browns Ferry Nuclear Plant (BFN) Unit 1 was in Mode 4 at approximately zero percent power.

II. Description of Event

A. Event Summary

On January 15, 2022, at 2320 Central Standard Time (CST), during a drywell (DW) entry for leak identification, BFN Engineering personnel discovered a through-wall piping leak on a test line [PSF] upstream of the Residual Heat Removal (RHR) [BO] and Shutdown Cooling test shut-off valve [SHV]. This test line is classified as American Society of Mechanical Engineers (ASME) Code Class 1 piping and constitutes part of the Unit 1 Reactor Coolant System (RCS) [AC] pressure boundary. Operations personnel declared the Unit 1 Low Pressure Coolant Injection system (LPCI) Loop I inoperable and maintained Unit 1 in Mode 4 or 5 until the leak was repaired. On January 16, 2022, at 0541 CST, eight-hour Event Notification (EN) 55706 was made to the NRC. The test line was cut and capped pending permanent repairs, and on January 20, 2022, at 1520 CST, Unit 1 LPCI Loop I was declared operable.

The TVA is submitting this report in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(i)(B), as any operation or condition which was prohibited by the plant's Technical Specifications (TS); and 10 CFR 50.73(a)(2)(ii)(A), as any event or condition that resulted in the condition of the nuclear power plant, including its principal safety barriers, being seriously degraded.

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.



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NARRATIVE

C. Dates and approximate times of occurrences

<u>Dates and Approximate Times</u>	<u>Occurrence</u>
September 11, 2021	Unidentified DW leakage from RCS discovered
January 15, 2022, at 1900 CST	BFN Unit 1 placed in Mode 4
January 15, 2022, at 2320 CST	Pressure boundary leak discovered on LPCI test line
January 20, 2022, at 1520 CST	<ul style="list-style-type: none"> • Temporary repairs complete on test line • Unit 1 LPCI Loop I declared operable.

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

There were no failed components related to 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

During the initial DW entry of the Unit 1 planned outage for leak identification, personnel observed water leaking from the blower [BLO] bank housing under the RHR Return Shutoff Valve. Upon further investigation, the source of the RCS leak was identified as a through-wall flaw at the pipe/weld interface.

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

A vendor analysis determined the pipe failed due to vibration induced high cycle fatigue originating at the outer diameter of the pipe where the valve and socket welds overlap.

H. Operator actions

There were no operator actions related to this event.



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NARRATIVE

I. Automatically and manually initiated safety system responses

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

III. Cause of the event

The root cause of this event was that small bore piping was not specifically analyzed for fatigue failure vulnerability due to operational or resonance vibration.

Additionally, two contributing causes were identified for this event:

1. During evaluations performed during Extended Power Uprate (EPU), the small bore piping was considered rigid in the seismic calculation and was not modeled separately from the large bore piping. That assessment was carried into the vibration acceptance calculation, and then into the vibration analysis report as the basis for determining whether the measured vibration was acceptable. As a result the small bore piping was not evaluated independently from the large bore piping during testing. When modeled independently with an accurate fatigue stress input, infinite vibration cycles no longer apply. The design calculation failed to identify that the stress caused by flow induced resonance vibration at pump speeds between 1500 and 1600 rpm was sufficient to exceed the endurance limit for the failed pipe assembly.
2. Problem Evaluation Report (PER) 98-011374-000 identified a trend of fatigue failures for ASME code class 1 equivalent socket welded connections in the Units 2 and 3 drywell on RHR shutdown cooling lines and the 3A Recirculation Loop. Had the learnings for PER 98-011374-000 been incorporated during U1 restart, the RHR Injection vent line pipe would have been reconfigured, eliminating the vulnerability for developing high cycle fatigue due to exceeding the endurance limit during certain recirc pump speeds. However, the learnings developed were not considered during U1 restart.

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

There were no component failures, system failures, or personnel errors associated with this event.



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NARRATIVE

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

At the time of the original plant design, no accurate method existed for modeling or collecting vibration data to evaluate the effects on small bore piping. When data collection became available, the RHR lines were erroneously excluded from further evaluation.

IV. Analysis of the event

The Radioactive Material Barrier is the systems, structures, or equipment that, together, physically prevent the uncontrolled release of radioactive materials. One of these is the Nuclear System Process Barrier, made up of a Primary Barrier and a Secondary Barrier, which includes the systems of vessels, pipes, pumps, tubes, and similar process equipment that contain the steam, water, gases, and radioactive materials coming from, going to, or in communication with the reactor core. The Primary Barrier, also known as the Reactor Coolant Pressure Boundary, consists of the reactor vessel and attached piping out to and including the second isolation valve in each attached pipe. A leak in the Pressure Boundary is therefore a significant degradation of one of the nuclear power plant's principal safety barriers.

BFN Unit 1 TS Limiting Condition for Operation (LCO) 3.4.4, RCS Operational Leakage, requires that there be no pressure boundary leakage while in Modes 1, 2, or 3. TS LCO 3.4.4 Condition C requires, when any pressure boundary leakage exists, that the unit be in Mode 3 within twelve hours, and Mode 4 within thirty-six hours. A Past Operability Evaluation (POE) determined that this condition is likely to have existed since September 11, 2021, when an increase in unidentified DW leakage from the RCS was detected. Pressure boundary leakage likely existed from this time until January 15, 2022, when Unit 1 was placed in Mode 4. Therefore, BFN Unit 1 was in violation of its TS during this time.

V. Assessment of Safety Consequences

The POE for this event determined that the LPCI mode of the Unit 1 RHR system can still meet the required LPCI flow to the reactor pressure vessel (RPV) in the worse-case scenario of a small break LOCA for the duration of the mission time. The safety significance was low because the normal reactor coolant makeup systems, the Reactor Core Isolation Cooling and Control Rod Drive systems, have adequate capacity to makeup reactor coolant in the worst-case scenario of a small break Loss of Coolant Accident (LOCA). Additionally, Calculation NDQ0074880118 Rev.5, "Evaluation of LPCI Flow to RPV with Failed Open Min Flow Bypass Valve" shows that the LPCI



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NARRATIVE

mode of the RHR system can still meet the required LPCI flow to the RPV in the worse-case scenario of a small break LOCA for the duration of its mission time.

During this time the HPCI system [BJ], both loops of the Core Spray system (CS) [BG], and all ADS valves remained operable and were available to provide coolant flow to the core during an emergency.

Based on the above, the TVA has concluded that sufficient systems were available to provide the required safety functions needed to protect the health and safety of the public.

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

There were no systems or components other than the RCS Pressure Boundary that failed during the 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

During the period concurrent with this event where Unit 1 was in Mode 4 or Mode 5, all systems or components required 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 in Mode 4 or Mode 5 remained operable.

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

This event did not result in the inoperability of any safety system train. Unit 1 LPCI Loop I remained operable during the event.

VI. Corrective Actions

Corrective Actions are being managed by the TVA's corrective action program under Condition Report (CR) 1747875.



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NARRATIVE

A. Immediate Corrective Actions

The immediate corrective actions for this event were to declare Unit 1 LPCI Loop I inoperable, and to cut and cap the valve's vent line under Work Order 122645957.

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

The corrective action for this event is to implement Engineering Change Packages for all small bore piping with vulnerability to fatigue failure due to exceeding the endurance limit due to operational vibration.

VII. Previous Similar Events at the Same Site

A search of BFN LERs and CRs found no examples within the last five years of degraded conditions or TS violations due to pressure boundary leaks.

VIII. Additional Information

There is no additional information.

IX. Commitments

There are no new commitments.