Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

July 7, 2017

10 CFR 50.73

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

Browns Ferry Nuclear Plant, Unit 2
Renewed Facility Operating License No. DPR-52
NRC Docket No. 50-260

Subject: **Licensee Event Report 50-260/2017-004-00**

The enclosed Licensee Event Report provides details of the inoperability of four Main Steam Relief Valves for longer than allowed by plant Technical Specifications. The Tennessee Valley Authority is submitting this report in accordance with Title 10 of the Code of Federal Regulations 50.73(a)(2)(i)(B), as any operation or condition which was prohibited by the plant's Technical Specifications.

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

Respectfully,

S. M. Bono
Site Vice President

Enclosure: Licensee Event Report 50-260/2017-004-00 – Main Steam Relief Valves Lift Settings Outside of Technical Specifications Required Setpoints

cc (w/ Enclosure):

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

ENCLOSURE

Browns Ferry Nuclear Plant
Unit 2

Licensee Event Report 50-260/2017-004-00

Main Steam Relief Valves Lift Settings Outside of Technical Specifications Required Setpoints

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See Enclosed

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

LICENSEE EVENT REPORT (LER)

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

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Browns Ferry Nuclear Plant, Unit 2	05000260	1 OF 7

4. TITLE

Main Steam Relief Valves Lift Settings Outside of Technical Specifications Required Setpoints

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
									N/A	N/A
05	08	2017	2017	- 004	- 00	07	07	2017	FACILITY NAME	DOCKET NUMBER
									N/A	N/A

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)
100	☐ 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)*
Ryan Coons, Licensing Engineer	256-729-2070

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
B	SB	RV	T020	Y	N/A	N/A	N/A	N/A	N/A

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

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

On May 8, 2017, the Tennessee Valley Authority was presented with as-found testing results indicating that four of the thirteen Main Steam Relief Valves (MSRVs) from Browns Ferry Nuclear Plant, Unit 2, were outside the +/- 3 percent setpoint band required for their operability. Troubleshooting determined that three MSRVs exceeded their setpoints when their valve discs failed by corrosion bonding to their valve seats. The valve discs were previously platinum coated to prevent this, but the valve seat's rough Stellite surface caused the coating to delaminate. This was the first Unit 2 MSRV service interval to implement the improved surface treatment since a resolution to the delamination issue was identified in 2015. The valve which failed below its setpoint band was determined to have a faulty pilot spring.

These four MSRVs were found to have been inoperable for an indeterminate period of time between April 9, 2015, and February 25, 2017, and longer than permitted by Technical Specifications. The affected valves remained capable of maintaining reactor pressure within American Society of Mechanical Engineers code limits. Additionally, the valves' ability to open under remote-manual operation, activation through the Automatic Depressurization System, or MSRV Automatic Actuation Logics were not affected. The valves remained capable of performing their required safety function.

Corrective Actions were to replace all thirteen Unit 2 MSRV pilot valves with pilot valves which had the platinum coating applied in accordance with the revised procedure, and to analyze the pilot valves of the inoperable MSRVs. The pilot spring was replaced inside the valve which failed below its specification.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Browns Ferry Nuclear Plant, Unit 2	05000-260	2017	- 004	- 00

NARRATIVE

I. Plant Operating Conditions Before the Event

At the time of discovery, Browns Ferry Nuclear Plant (BFN), Unit 2, was in Mode 1 at 100 percent power.

II. Description of Event

A. Event Summary

On May 8, 2017, National Technical Systems (NTS) Laboratories provided Tennessee Valley Authority (TVA) with the as-found testing results of the thirteen Main Steam [SB] Relief Valves (MSRVs) [RV] which were removed during the Spring 2017 Unit 2 Refueling Outage 19 (U2R19). Four of the Main Steam Line B, C, and D Relief Valves (BFN-2-PCV-001-0022, BFN-2-PCV-001-0023, BFN-2-PCV-001-0030, and BFN-2-PCV-001-0041) had as-found lift settings which were outside of the +/- 3 percent band of their setpoints required for their operability.

Technical Specification (TS) 3.4.3 requires twelve of the thirteen Safety/Relief Valves (S/RVs) to be operable for S/RV system operability. These four MSRVs were found to have been inoperable for an indeterminate period of time between April 9, 2015, and February 25, 2017, and longer than permitted by TS 3.4.3.

MSRV operability was restored on April 1, 2017, upon completion of post-maintenance testing (PMT) following the biennial scheduled replacement of the MSRV pilot valves with refurbished valves which were certified to lift within +/- 1 percent of their setpoints.

Throughout this event, the two-stage MSRV pilot valves remained capable of maintaining the reactor pressure below 1375 psig, which is the American Society of Mechanical Engineers (ASME) code limit of 110 percent of the vessel design pressure. The valves remained capable of performing their required safety function.

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

Dates & Approximate Times	Occurrence
April 9, 2015	Unit 2 entered Mode 2, beginning the cycle.
February 25, 2017	BFN, Unit 2, entered Mode 4, beginning the U2R19.
April 1, 2017	Replacement of MSRV pilot valves and their associated PMT is completed, as part of the U2R19.
May 8, 2017	NTS Laboratories provided TVA with the as-found testing results of the thirteen Unit 2 MSRV pilot valves removed during the U2R19.

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

The failed components were all Target Rock Corporation two-stage pressure control valves, model number 7567F.

E. Other systems or secondary functions affected

No other systems or secondary functions were affected by this event.

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

Failure was discovered at NTS Laboratories, during their as-found testing of the thirteen MSRV two-stage pilot valves which were removed during the U2R19.

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

Three of the four two-stage pilot valves failed due to the corrosion bonding of the valve disc to the valve seat. The remaining pilot valve failed to meet its setpoint band requirements due to a weak spring.

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

Three two-stage pilot valves failed above their setpoint bands due to their valve discs corrosion bonding to the valve seat, which is apparently caused by a valve disc surface finish that does not make allowance for corrosion bonding.

One two-stage pilot valve failed below its setpoint band due to a faulty valve spring.

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 TVA is submitting this report in accordance with Title 10 of the Code of Federal Regulations 50.73(a)(2)(i)(B), as any operation or condition which was prohibited by the plant's TS. It was determined that the MSRV pilot valve inoperability resulted from their setpoints gradually drifting during the course of their operating cycle, which began when Unit 2 entered Mode 2 on April 9, 2015, and lasted until February 25, 2017, when Unit 2 entered Mode 3.

BFN, Unit 2, TS Limiting Condition for Operation (LCO) 3.4.3 requires twelve Operable S/RVs during Modes 1, 2, and 3. If one or more required S/RVs becomes inoperable, Required Action A.1 requires BFN, Unit 2, to enter Mode 3 within 12 hours, and Required Action A.2 requires entering Mode 4 within 36 hours. S/RV Operability is defined as being within a +/- 3 percent band of their setpoint values, in accordance with Surveillance Requirement 3.4.3.1. BFN, Unit 2, has thirteen MSRVs to satisfy this requirement with margin.

After the installation of the S/RVs, the as-left lift setpoint for S/RVs BFN-2-PCV-001-0022 and BFN-2-PCV-001-0030 was 1145 psig, S/RV BFN-2-PCV-001-0023 was 1135 psig, and SR/V BFN-2-PCV-001-0041 was 1155 psig. However, during as-found testing at NTS Laboratories, the Main Steam Line B Relief Valve, BFN-2-PCV-001-0022, lifted at 1179.5 psig (+3.01 percent); the Main Steam Line C Relief Valves, BFN-2-PCV-001-0023 and BFN-2-PCV-001-0030, lifted at 1183 psig (+4.22 percent) and 1105 psig (-5.76 percent), respectively; and the Main Steam Line D Relief Valve, BFN-2-PCV-001-0041, lifted at 1198 psig (+3.72 percent). During the fuel cycle, these valve lift setpoints gradually drifted outside of the +/- 3 percent margin which is required for their operability. The valves which exceeded their setpoint bands failed due to corrosion bonding between the valve discs and their seats. The valve which failed below its setpoint band was determined to have a faulty pilot spring. These valve failures occurred after their installation but before Unit 2 entered Mode 4 on February 25, 2017. Therefore, BFN, Unit 2, operated with inoperable S/RVs for longer than allowed by TS.

Prior to startup from the Unit 2 Refueling Outage 18, all thirteen BFN, Unit 2 MSRV pilot valves were replaced with refurbished valves which were certified to lift within +/- 1 percent of their setpoint. Operating Experience (OE) has shown that Target Rock two-stage MSRV setpoint drift is not a uniform, linear process. The corrosion bonding increases at a random rate, and the faulty pilot spring gradually lost its tension over its lifetime. Without an accurate and reliable model for predicting or estimating the setpoint drift development, the point in time where the setpoint exceeded the +/- 3 percent limit cannot be reliably determined. Since this drift occurred between the beginning of the fuel cycle on April 9, 2015, and February 25, 2017, when Unit 2 entered Mode 3, the MSRV inoperability was conservatively declared to have been inoperable for an indeterminate period of time between April 9, 2015, and February 25, 2017, and longer than permitted by plant TS 3.4.3.

V. Assessment of Safety Consequences

System availability was not impacted by this event. The failure of the Automatic Depressurization System (ADS) valves, BFN-2-PCV-001-0022 and BFN-2-PCV-001-0030, to meet the mechanical setpoint identified in TS 3.4.3 does not impact its remote-manual operation, or activation through the ADS or MSRV Automatic Actuation Logics since these operating modes and functions rely upon an electrical signal to energize the MSRV control air solenoid which electrically opens the pilot valve.

TS Bases 3.4.3 states that the overpressure protection system must accommodate the most severe pressurization transient. The MSRVs remained capable of maintaining the reactor pressure below 1375 psig, which is the ASME code limit (110 percent of the vessel design pressure). The valves remained capable of performing their required safety function.

The bounding maximum over-pressurization analyses are performed each fuel cycle to show that the requirements of the ASME code regarding overpressure protection are met. The analyses are performed specifically to show that the dome pressure TS limit of 1325 psig is not exceeded and that the vessel pressure does not exceed the limit of 1375 psig. In addition, the Anticipated Transient Without Scram (ATWS) pressurization analyses are also performed to demonstrate that the 1500 psig peak vessel pressure limit is not exceeded.

NUREG-0800 defines bases the acceptance criteria for reactor coolant pressure on the ASME Service Level C limits, which are approximately 10.3 MPa (1500 psig) for Boiling Water Reactors (BWRs). For the ATWS analysis, the setpoint groupings conservatively bound the ten lowest as-found MSRV opening setpoints; however, the three highest valve setpoints fall outside the bounds of the valve groupings. Therefore, the limiting ATWS overpressurization event, identified as the ATWS pressure regulator failed open at 100% rated power and 81% rated flow at the beginning of cycle exposure, was re-analyzed by AREVA. The results from this analysis indicates that despite that four MSRV pilot valves were outside their as-found setpoint band, the maximum vessel pressure and maximum dome pressure reaches a maximum of 1398 psig, and therefore does not exceed the ATWS vessel pressure limit of 1500 psig. Therefore, there was no impact on the MSRVs to perform their specified safety function.

Based on the above, 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

Each BFN operating unit has a non-safety related, electrical logic system (MSRV Actuation Logic) installed, which provides defense-in-depth against MSRV setpoint drift by electrically opening MSRV groups based upon setpoints at 1135 psig, 1145 psig, and 1155 psig. Therefore, during a reactor pressure transient event, the four 1135 psig group MSRVs, followed by the four 1145 psig group MSRVs, and finally the five 1155 psig group MSRVs would receive an electrical open signal, providing a defense-in-depth function to allow the valves to perform their safety function.

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

TS 3.4.3 requires twelve of the thirteen S/RVs to be operable for S/RV system operability. The four failed MSRV pilot valves rendered the entire S/RV system inoperable for the duration of the fuel cycle, from April 9, 2015, to February 25, 2017.

VI. Corrective Actions

Corrective Actions are being managed by TVA's corrective action program under Condition Reports (CRs) 962223 and 1294336.

A. Immediate Corrective Actions

All thirteen of the Unit 2 MSRV pilot valves were replaced with refurbished valves during the U2R19. These valves had platinum coatings applied in accordance with the revised procedure. As-left testing verified that these refurbished pilot valves were within +/- 1 percent of their name plate setpoints.

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

Steps were added to the Main Steam Relief Valves Target Rock Model 7567 Disassembly, Inspection, Rework and Reassembly procedure, to use a borescope, microscope and a Root Mean Square (RMS) optical comparator to verify that the pilot disc finish quality is 32 RMS or better, optimally 16 RMS, prior to platinum coating.

The pilot spring was replaced inside the valve which failed below its specification.

VII. Previous Similar Events at the Same Site

A search of BFN LERs for Units 1, 2, and 3, identified nine LERs for this same issue within the last nine years.

A search of the Corrective Action Program for BFN, Units 1, 2, and 3, identified eighteen MSRV failure events since 1999. These failures were captured by CRs 37328, 59786, 50084, 61823, 81376, 102298, 124944, 146189, 175990, 159200, 226627, 294506, 372047, 558488, 962223, 1157981, 1237184, and 1294336. These individual failures were collectively evaluated and addressed by CR 112190.

CR 55557 identified that corrosion bonding between the valve discs and their seat surfaces were strong enough to cause significant drifts in their opening pressure and reset setpoints. As a corrective action, a design change was implemented to update/install a safety related pressure switch logic that was endorsed by the BWR Owners Group to resolve setpoint drift issues.

CR 56793 identifies the corrosion-prone materials used in the construction of Target Rock two-stage S/RVs presented a fundamental design deficiency. An alternate MSRV design/logic/manufacturer was sought, but industry OE demonstrated that the use of platinum coated valve discs provided the best results.

The Corrective Actions for CR 146189 required platinum coated MSRV discs to be installed in future outages to prevent recurrence. CR 166147 verified that these platinum coatings were in place.

VIII. Additional Information

There is no additional information.

IX. Commitments

There are no new commitments.