



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

June 6, 2016

10 CFR 50.73

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 50-296/2016-004-00**

The enclosed Licensee Event Report provides details of the inoperability of three 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,

A handwritten signature in black ink, appearing to read "S. M. Bono", with a small flourish at the end.

S. M. Bono
Site Vice President

Enclosure: Licensee Event Report 50-296/2016-004-00 – 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 3**

Licensee Event Report 50-296/2016-004-00

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

See Enclosed

NRC FORM 366 (11-2015)		U.S. NUCLEAR REGULATORY COMMISSION			APPROVED BY OMB: NO. 3150-0104		EXPIRES: 10/31/2018				
 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, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet 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 Browns Ferry Nuclear Plant, Unit 3					2. DOCKET NUMBER 05000296		3. PAGE 1 OF 8				
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	
04	06	2016	2016	- 004	- 00	06	06	2016	N/A	N/A	
									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		<input type="checkbox"/> 20.2201(b)			<input type="checkbox"/> 20.2203(a)(3)(i)			<input type="checkbox"/> 50.73(a)(2)(ii)(A)		<input type="checkbox"/> 50.73(a)(2)(viii)(A)	
		<input type="checkbox"/> 20.2201(d)			<input type="checkbox"/> 20.2203(a)(3)(ii)			<input type="checkbox"/> 50.73(a)(2)(ii)(B)		<input type="checkbox"/> 50.73(a)(2)(viii)(B)	
		<input type="checkbox"/> 20.2203(a)(1)			<input type="checkbox"/> 20.2203(a)(4)			<input type="checkbox"/> 50.73(a)(2)(iii)		<input type="checkbox"/> 50.73(a)(2)(ix)(A)	
		<input type="checkbox"/> 20.2203(a)(2)(i)			<input type="checkbox"/> 50.36(c)(1)(i)(A)			<input type="checkbox"/> 50.73(a)(2)(iv)(A)		<input type="checkbox"/> 50.73(a)(2)(x)	
100		<input type="checkbox"/> 20.2203(a)(2)(ii)			<input type="checkbox"/> 50.36(c)(1)(ii)(A)			<input type="checkbox"/> 50.73(a)(2)(v)(A)		<input type="checkbox"/> 73.71(a)(4)	
		<input type="checkbox"/> 20.2203(a)(2)(iii)			<input type="checkbox"/> 50.36(c)(2)			<input type="checkbox"/> 50.73(a)(2)(v)(B)		<input type="checkbox"/> 73.71(a)(5)	
		<input type="checkbox"/> 20.2203(a)(2)(iv)			<input type="checkbox"/> 50.46(a)(3)(ii)			<input type="checkbox"/> 50.73(a)(2)(v)(C)		<input type="checkbox"/> 73.77(a)(1)	
		<input type="checkbox"/> 20.2203(a)(2)(v)			<input type="checkbox"/> 50.73(a)(2)(i)(A)			<input type="checkbox"/> 50.73(a)(2)(v)(D)		<input type="checkbox"/> 73.77(a)(2)(i)	
		<input type="checkbox"/> 20.2203(a)(2)(vi)			<input checked="" type="checkbox"/> 50.73(a)(2)(ii)(B)			<input type="checkbox"/> 50.73(a)(2)(vii)		<input type="checkbox"/> 73.77(a)(2)(ii)	
					<input type="checkbox"/> 50.73(a)(2)(i)(C)			<input type="checkbox"/> OTHER		Specify in Abstract below or in NRC Form 366A	
12. LICENSEE CONTACT FOR THIS LER											
LICENSEE CONTACT Ryan Coons, Licensing Engineer								TELEPHONE NUMBER (Include Area Code) 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	
<input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO								N/A	N/A	N/A	
ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) <p>On April 6, 2016, the Tennessee Valley Authority was presented with as-found testing results indicating that three of the thirteen Main Steam Relief Valves (MSRVs) from Browns Ferry Nuclear, Unit 3, exceeded the +/- 3 percent setpoint required for their operability. Troubleshooting determined that the MSRV 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 flake off.</p> <p>It was determined that the MSRVs were inoperable from March 19, 2014 to February 20, 2016. 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, or activation through the Automatic Depressurization System or MSRV Automatic Actuation Logics was not affected. The valves remained capable of performing their required safety function.</p> <p>Corrective Actions were to replace all Unit 3 MSRVs, to analyze the pilot valves of the inoperable MSRVs, and to revise procedures to verify the pilot disc finish meets its requirements prior to valve assembly.</p>											

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Browns Ferry Nuclear Plant, Unit 3	05000296	YEAR	SEQUENTIAL NUMBER	REV NO.
		2016	- 004	- 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 100 percent power.

II. Description of Events

A. Event:

On April 6, 2016, National Technical Systems (NTS) Laboratories provided Tennessee Valley Authority (TVA) with the as-found testing results of the thirteen Main Steam Relief Valves (MSRVs) [RV] which were removed from BFN, Unit 3 during its Spring 2016 refueling outage (U3R18). Three of the Main Steam Line A, B, and D Relief Valves (BFN-3-PCV-001-0004, BFN-3-PCV-001-0023, and BFN-3-PCV-001-0041) had as-found lift settings which exceeded the +/- 3 percent setpoint 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. The three failed MSRVs rendered the entire S/RV system inoperable for the duration of the fuel cycle, from March 19, 2014 to February 20, 2016.

MSRV operability was restored on March 28, 2016, upon completion of a Work Order (WO) 116592810, for the biennial scheduled replacement of the MSRVs with refurbished valves which were certified to lift within +/- 1 percent of their setpoints.

Throughout this event, the two-stage MSRVs 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.

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C. Dates and approximate times of occurrences:

<u>Dates & Approximate Times</u>	<u>Occurrence</u>
March 18, 2014	Replacement of MSRVS and their associated post-maintenance testing is completed, as part of the U3R16 refueling outage.
March 19, 2014	Unit 3 enters Mode 1, beginning the fuel cycle.
February 20, 2016	BFN Unit 3 enters Mode 5, to begin the U3R17 refueling outage.
April 6, 2016	NTS Laboratories provided TVA with the as-found testing results of the thirteen U3 MSRVS removed during the U3R17 outage.

D. Manufacturer and model number (or other identification) 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 MSRVS two-stage pilot valves which were removed from BFN, Unit 3, during its Spring 2016 refueling outage.

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

The two-stage pilot valves failed due to the corrosion bonding of the valve disc to the valve seat.

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.

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III. Cause of the event

A. The cause of each component or system failure or personnel error, if known:

The two-stage pilot valves failed due to the valve disc corrosion bonding to the valve seat.

B. The 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 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 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 on March 19, 2014, and lasted until February 20, 2016 when Unit 3 entered Mode 4.

BFN, Unit 3, TS 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 3, 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 +/- 3 percent of their setpoint values, in accordance with Surveillance Requirement (SR) 3.4.3.1. BFN, Unit 3 has thirteen MSRVs to satisfy this requirement with margin. However, the as-found lift setpoints for three of these valves had drifted outside of the operable range between their installation on March 18, 2014 and February 20, 2016, when Unit 3 entered Mode 4. Based on this evaluation, BFN, Unit 3, operated with inoperable S/RVs for longer than allowed by TS.

During as-found testing at NTS Laboratories, three of the Main Steam Line A, B, and D Relief Valves were found to have as-found lift settings which exceeded the +/- 3 percent setpoint which is required for their operability. This failure was due to corrosion bonding between the valve discs and their seats.

On March 18, 2014, all thirteen BFN, Unit 3 MSRVs were replaced with refurbished valves which were certified to lift within +/- 1 percent of their setpoint. Industrial 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. 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. Therefore, the three failed MSRVs must be declared inoperable for the entire fuel cycle, from March 19, 2014 to February 20, 2016, when Unit 3 entered Mode 4. The duration of MSRV system inoperability was longer than allowed by plant TS 3.4.3.

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V. Assessment of Safety Consequences

System availability was not impacted by this event. The failure of BFN-3-PCV-001-0041, an ADS valve, 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 how 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.

In both analyses, one 1135 psig valve is assumed to be out of service. For the ASME over-pressurization analyses, all valves that were assumed operational have an assumed 6 percent drift. Therefore, the valves with 1155 psig setpoints were assumed to relieve at 1224.3 psig, and therefore, the 1201 psig lift point is bounded by the analysis.

For the ATWS over-pressurization analyses, all 1135, 1145 and 1155 psig valves in operation are assumed to lift well above their setpoints at 1179, 1189 and 1199 psig respectively. With all twelve operable relief valves acting in concert and lifting 44 psig above their respective setpoints, the maximum lower plenum pressure is calculated to be 1404 psig and the maximum dome pressure is calculated to be 1384 psig. These values are well below the allowable 1500 psig limit for the ATWS analyses. None of the other valves during any of the three tests lifted within 30 psig of the analyzed ATWS setpoints. Therefore, one relief valve lifting at a 1201 psig (2 psig above ATWS analyzed setpoint) in concert with the worse case as-found values of the other valves would not exceed the analyzed pressures for ATWS.

The variations in lift setting pressures did not prohibit the ability of the MSRVs to perform their function to open in order to provide over pressure protection. The valve lifting prematurely in concert with the others will not start vessel depressurization sooner than previously analyzed nor will it adversely affect the ability to maintain reactor level inventory. The valve lifting later in concert with the others will not over-pressurize the vessel during any pressure transient.

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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 signals, allowing 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 shut down 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, an 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 three failed MSRVs rendered the entire S/RV system inoperable for the duration of the fuel cycle, from March 19, 2014 to February 20, 2016.

VI. Corrective Actions:

Corrective Actions are being managed by TVA's corrective action program under Condition Report (CR) 962223.

A. Immediate Corrective Actions

All thirteen of the Unit 3 MSRV pilot valves were replaced with refurbished valves during the U3R17 Refueling Outage. As-left testing verified that these refurbished pilot valves were within 1 percent of their name plate setpoints.

B. Corrective Actions to Prevent Recurrence

The discs from the failed pilot valves were analyzed, and their results were documented.

Steps were added to procedure MCI-0-001-VLV002, Main Steam Relief Valves Target Rock Model 7567 Disassembly, Inspection, Rework and Reassembly, to verify the pilot disc finish quality prior to platinum coating.

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VII. Additional Information:

A. Previous Similar Events:

A search of BFN LERs for Units 1, 2, and 3, has found seven LERs for this same issue within the last eight years. This is a common issue throughout the industry, as corrective actions have only been able to mitigate the problem. By documenting and trending the issue, incremental improvement is being made towards a resolution.

A search of the Corrective Action Program for BFN, Units 1, 2, and 3, identified fifteen 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, and 962223. 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 safety-relief valves presented a fundamental design deficiency. An alternate MSRV design/logic/manufacture 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 future reoccurrence. CR 166147 verified that these platinum coatings were in place.

While the use of platinum coated valve discs has mitigated the occurrence of corrosion-induced setpoint, drift, it continues to occur. Industry OE shows that this is a result of platinum coatings flaking off due to the overly-rough Stellite surfaces of valve discs.

B. Additional Information:

There is no additional information.

C. Safety System Functional Failure Consideration:

In accordance with NUREG-1022, this event is not considered a safety system functional failure. While the three inoperable MSRVs had drifted passed their acceptable setpoints, they remained capable of lifting within ASME code limits. Ten additional MSRVs remained operable and capable of lifting within their setpoints and ASME code limits. Because of the aggregate effect of multiple redundant valves, each capable of lifting inside of ASME code limits, the MSRV system remained

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capable of performing its required safety function throughout the duration of the event. Additionally, the valve's ability to open under remote-manual operation, or activation through the ADS or MSRV Automatic Actuation Logics were not affected.

D. Scram with Complications Consideration:

This event did not result in a reactor scram.

VIII. COMMITMENTS

There are no new commitments.