



Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381

April 22, 2015

10 CFR 50.73

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

Watts Bar Nuclear Plant, Unit 1
Facility Operating License No. NPF-90
NRC Docket No. 50-390

Subject: **Licensee Event Report 390/2015-001, Manual Reactor Trip Due to Rapid Loss of Main Condenser Vacuum**

This submittal provides Licensee Event Report (LER) 390/2015-001. This LER provides details concerning a manual reactor trip due to rapid loss of main condenser vacuum at Watts Bar Nuclear Plant, Unit 1. This report is being submitted in accordance with 10 CFR 50.73(a)(2)(iv)(A).

There are no regulatory commitments in this letter. Please direct any questions concerning this matter to Gordon Arent, WBN Licensing Director, at (423) 365-2004.

Respectfully,

A handwritten signature in blue ink, appearing to read "Kevin T. Walsh", is positioned below the word "Respectfully,".

Kevin T. Walsh
Site Vice President
Watts Bar Nuclear Plant

U.S. Nuclear Regulatory Commission
Page 2
April 22, 2015

Enclosure

cc (Enclosure):

NRC Regional Administrator - Region II

NRC Senior Resident Inspector - Watts Bar Nuclear Plant

NRC Project Manager – Watts Bar Nuclear Plant

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

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 Infocollections.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
Watts Bar Nuclear Plant, Unit 1	05000390	1 OF 5

4. TITLE
Manual Reactor Trip Initiated Due to Rapid Loss of Main Condenser Vacuum

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 N/A	DOCKET NUMBER N/A
02	21	2015	2015 - 001 - 00			04	22	2015	FACILITY NAME N/A	DOCKET NUMBER N/A

9. OPERATING MODE		11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: <i>(Check all that apply)</i>			
1	<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)	
	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)	
	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<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)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)	
10. POWER LEVEL	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)	
	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)	
	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)	
	<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)(C)	<input type="checkbox"/> OTHER	
	<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A	

12. LICENSEE CONTACT FOR THIS LER	
LICENSEE CONTACT Geoffrey Cook, Licensing Engineer	TELEPHONE NUMBER (Include Area Code) 423-365-7753

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
E	SD	EXJ	Keystone	N					

14. SUPPLEMENTAL REPORT EXPECTED <input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR

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

On February 21, 2015 at approximately 10:32 am Eastern Standard Time (EST), the Watts Bar Nuclear Plant Unit 1 reactor was manually tripped by control room operators due to a decreasing main condenser vacuum. Subsequent to the reactor trip, the Auxiliary Feedwater system actuated. Control and Shutdown rods fully inserted into the reactor core, and safety systems responded as designed. The unit was stabilized in Mode 3, with decay heat removal via Auxiliary Feedwater and the Steam Generator Atmospheric Dump Valves. The Main Steam Isolation Valves were closed and remained closed during the event.

Tennessee Valley Authority (TVA) has determined that the decreasing condenser vacuum was due to a failure of an expansion joint boot seal in the “C” zone of the main condenser. This seal functions as the expansion joint between the condenser and low pressure turbines. The failure of the seal was due to a non-optimal vulcanization process and inadequate overlap in a joint splice, which significantly weakened the seal and allowed seal water to permeate the seal, further weakening the joint. The failed main condenser boot seal was replaced with a new boot seal on the “C” zone of the condenser. As a preventative measure, the boot seals on the “A” and “B” zones were also replaced.

**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, 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, NEOF-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	6. LER NUMBER			3. PAGE
Watts Bar Nuclear Plant, Unit 1	05000390	YEAR	SEQUENTIAL NUMBER	REV NO.	2 OF 5
		2015	- 001	- 00	

NARRATIVE**I. PLANT OPERATING CONDITIONS BEFORE THE EVENT**

Watts Bar Nuclear Plant (WBN) Unit 1 was in Mode 1 at 100 percent rated thermal power (RTP). There were no structures, systems, or components that were inoperable at the start of the event that contributed to the event.

II. DESCRIPTION OF EVENT**A. Event**

On February 21, 2015 at approximately 10:31 am Eastern Standard Time (EST), Watts Bar Nuclear Plant Unit 1 reactor [EIS: AC] was operating at normal operating temperature and pressure when control room operators observed a rapid decrease in main condenser vacuum [EIS: SG]. Due to the loss of main condenser vacuum and rising levels in the condenser hotwell, control room operators entered the appropriate response procedures and initiated a manual reactor trip at approximately 10:32 am EST. Subsequent to the reactor trip, the Auxiliary Feedwater [EIS: BA] system actuated as designed, in response to isolation of main feedwater flow [EIS: SJ]. Control and Shutdown rods fully inserted, and required safety systems responded as designed. The unit was stabilized in Mode 3, with decay heat removal via Auxiliary Feedwater and the Atmospheric Dump Valves [EIS: JI] (ADVs). The Main Steam Isolation Valves [EIS: SB] were closed and remained closed during the event, and the station was maintained in a normal shutdown electrical alignment.

Main Control Room personnel responded appropriately to the plant transient using abnormal operating instructions which address loss of main condenser vacuum and rapid load reduction. Operations entered: 1-AOI-11, "Loss of Condenser Vacuum," 1-E-0, "Reactor Trip or Safety Injection, ES-01, "Reactor Trip Response, and 1-GO-5, "Unit Shutdown From 30% Power to Hot Standby." Emergency and abnormal procedures were correctly followed, and the plant was placed in a stable condition in Mode 3.

Operations personnel confirmed that the plant response post trip was uncomplicated. Operations personnel, consistent with an uncomplicated shutdown, secured equipment including the following: Condensate Circulating Pumps [EIS: SD] and Raw Water Cooling Pumps [EIS: NN].

This event is reportable under 10 CFR 50.73(a)(2)(iv)(A).

B. Inoperable Structures, Components, or Systems that Contributed to the Event

No inoperable structures, components, or systems contributed to this event.

C. Dates and Approximate Times of Occurrences

Date	Time	Event
2006	N/A	Replaced "C" condenser zone dog bone seal during scheduled refueling outage.
2/21/15	10:31 am EST	Operations entered 1-AOI-11 for loss of main condenser vacuum.
2/21/15	10:31 am EST	Turbine backpressure begins increasing in "C" zone of condenser, followed closely by "B" and "A" zones. Condenser Vacuum Lo/Lo-Lo alarm received in the main control room.

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

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
Watts Bar Nuclear Plant, Unit 1	05000390	YEAR	SEQUENTIAL NUMBER	REV NO.	3 OF 5
		2015	- 001	- 00	

NARRATIVE

Date	Time	Event
2/21/15	10:32 am EST	The plant was manually tripped due to loss of main condenser vacuum.
2/21/15	12:46 pm EST	Event Notification 50839 was made to the NRC.

D. Manufacturer and Model Number of Components that Failed.

The "C" zone main condenser expansion joint boot seal failed at the splice joint. This seal was manufactured and installed by Keystone Rubber.

E. Other Systems or Secondary Functions Affected

There were no systems or secondary functions associated with this event.

F. Method of discovery of each Component or System Failure or Procedural Error

The failure of the main condenser boot seal resulted in a loss of main condenser vacuum, requiring a manual reactor trip. The Tennessee Valley Authority (TVA) investigation of the event revealed that the boot seal had failed on the "C" expansion zone. There were no procedural errors associated with this event.

G. Failure Mode and Effect of Each Failed Component

Other than the main condenser expansion joint boot seal failure, there were no failed components associated with this event.

H. Operator Actions

This was an uncomplicated reactor trip. No special operator actions were required.

I. Automatically and Manually Initiated Safety System Responses

The reactor was tripped manually on decreasing main condenser vacuum. All automatic and manually initiated safety systems responded as expected

III. CAUSE OF THE EVENT

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

The expansion joint boot seal on the "C" condenser to low pressure turbine failed, resulting in loss of condenser vacuum which led to a manual trip. The failure of the seal was due to a non-optimal vulcanization process and inadequately overlapped application which significantly weakened the seal at the splice joint area. Additionally, seal water is supplied to the boot seals to minimize air inleakage through the expansion joint. During the failure analysis conducted to determine the seal failure, it was noted that water had wicked into the polyester fibers of the boot seal, further weakening the splice joint area.

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

An organizational driver for this event was an inadequate risk assessment process for critical maintenance. Specifically, in 2006 (prior refueling outage where the boot seal was replaced) the procedure for oversight of supplemental personnel screening criteria/process was inadequate to ensure proper risk categorization for critical maintenance. The work document used for installation

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

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
Watts Bar Nuclear Plant, Unit 1	05000390	YEAR	SEQUENTIAL NUMBER	REV NO.	4 OF 5
		2015	- 001	- 00	

NARRATIVE

of the expansion joint boot seals in 2006 did not provide adequate site reviews or inspection points. This resulted in inadequate performance of the boot seal splice by the vendor.

Additionally, inspection of the splice area was not part of the condenser expansion joint boot seal inspection process, it would not have identified external degradation in this inspection.

IV. ASSESSMENT OF SAFETY CONSEQUENCES

A. Safety Significance

During the event and subsequent recovery actions, there was no loss of safety systems, structures or components. The Auxiliary Feedwater system started as expected and remained available to remove decay heat after the reactor trip. Other plant systems functioned as required following the manual reactor trip. Control room operators responded appropriately by manually actuating the reactor protection system to shut down the reactor. All control rods fully inserted into the core as designed to control reactivity and temperature of the core. The reactivity effects during this event had no impact on the safety of the core and thus, the event was determined to be of very low safety significance. There was no impact to the health and safety of the public or plant employees as a result of 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

Not applicable.

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

Not applicable.

V. CORRECTIVE ACTIONS

This event was entered into the TVA Corrective Action Program (CAP) and is being tracked under problem evaluation report (PER) 991403.

A. Immediate Corrective Actions

The failed main condenser boot seal was replaced with a new boot seal on the "C" zone of the condenser. As a preventative measure, the boot seals on the "A" and "B" zones were also replaced.

B. Corrective Actions to Prevent Recurrence

In August 2014, TVA implemented a new procedure, NPG-SPP-07.2.16, "Critical Maintenance Identification and Oversight," for outage-related work. This is a new process to add work controls to reduce the risk of introducing latent issues or operational failures due to improperly performed work. Since this is a new process for outage work, to prevent recurrence, outage work packages for the upcoming refueling outage (U1R13) for critical maintenance will be reviewed.

Additionally, Watts Bar will revise the inspection preventative maintenance document to add inspection of the splice along with guidance for inspection criteria in 0-MI-2.002, "Opening and

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

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
Watts Bar Nuclear Plant, Unit 1	05000390	YEAR	SEQUENTIAL NUMBER	REV NO.	5 OF 5
		2015	- 001	- 00	

NARRATIVE

Closing of the Main Condenser Shell and Hotwell," to include necessary inspection details and signoffs for the boot seal inspection by incorporating internal and external benchmarking.

Based on operating experience and the TVA's failure analysis, seal water supply to the boot seals to minimize air inleakage is not necessary and the system has been secured.

VI. ADDITIONAL INFORMATION

A. Previous similar events at the same plant

On August 17, 2001, TVA submitted LER 50-390/2001-001, "Manual Reactor Trip Due to Reduced Circulating Water Flow." This LER describes an event where during normal operation at 100 percent power, the unit was manually tripped due to a rise in back-pressure in the condenser. This was caused by reduced condenser circulating water flow, which resulted from cooling tower fill material obstructing the intake flume screens to the circulating water pumps. However, the root cause was different; no approval was needed to deviate from design output documents, which allowed cooling tower fill repairs and/or replacement other than those issued in the design documents. This resulted in installed supports which failed, leading to this event.

B. Additional Information

None.

C. Safety System Functional Failure Consideration

This condition did not result in a safety system functional failure.

D. Scrams with Complications Consideration

This reactor trip was not complicated.

VII. COMMITMENTS

None.