



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

June 30, 2016

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 390/2016-006-00, Undersized Room Cooler Fan Shaft Results in Loss of Centrifugal Charging Pump**

This submittal provides Licensee Event Report (LER) 390/2016-006-00. This LER provides details concerning maintenance performed on a safety related room cooler which resulted in a reportable condition. This report is being submitted in accordance with 10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(v)(D).

Please direct any questions concerning this matter to Gordon Arent, WBN Licensing Director, at (423) 365-2004.

Respectfully,

A handwritten signature in black ink, appearing to read 'Paul Simmons', written over a white background.

Paul Simmons
Site Vice President
Watts Bar Nuclear Plant

Enclosure
cc: See Page 2

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cc (Enclosure):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Watts Bar Nuclear Plant



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

Watts Bar Nuclear Plant, Unit 1

2. DOCKET NUMBER

05000390

3. PAGE

1 OF 6

4. TITLE

Undersized Room Cooler Fan Shaft Results in Loss of Centrifugal Charging Pump

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
05	13	2016	2016	006	00	06	30	2016	N/A	N/A
									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 checked="" 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)(i)(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 Dean Baker, Licensing Engineer	TELEPHONE NUMBER (Include Area Code) 423-452-4589
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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	VF	FAN	ELLIS	Y					

14. SUPPLEMENTAL REPORT EXPECTED

YES (If yes, complete 15. EXPECTED SUBMISSION DATE) NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

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

On May 13, 2016, Watts Bar Nuclear Plant Unit 1 (WBN1) determined that a condition prohibited by Technical Specifications had previously occurred. During the Fall 2015 WBN1 outage, maintenance performed on the 1B-B centrifugal charging pump (CCP) room cooling fan introduced a condition that resulted in a subsequent bearing failure of the room cooling fan on December 4, 2015. This condition would have prevented the 1B-B CCP pump from performing its specified function for its designed mission time. Based on the reduced reliability of the fan, the 1B-B CCP was considered to be inoperable from October 7, 2015 until the fan was repaired and returned to service on December 6, 2015. During this time period, there were several short time periods when the 1A-A CCP was inoperable.

An investigation into the cause of the failure was completed on April 21, 2016. The cause of the fan bearing failure was an undersized fan shaft, resulting in the 1B-B CCP fan having excess shaft to bearing clearance which caused the bearing inner ring to loosen from the eccentric locking collar. These excessive clearances allowed the fan bearing inner ring to slide on the shaft. The sliding rotation of the inner ring on the shaft resulted in excessive heat being generated within the bearing leading to catastrophic failure.

This event is being reported pursuant to 10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(v)(D).

NRC FORM 366A
(11-2015)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104

EXPIRES: 10/31/2018



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

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1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Watts Bar Nuclear Plant, Unit 1	05000390	2016	- 006	- 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).

II. DESCRIPTION OF EVENT

A. Event

On May 13, 2016, Watts Bar Nuclear Plant Unit 1 (WBN1) determined that a condition prohibited by Technical Specifications (TS) had previously occurred. During the Fall 2015 WBN1 outage, maintenance performed on the 1B-B centrifugal charging pump (CCP) room cooling fan {EISS:FAN} introduced a mechanical condition that resulted in a subsequent bearing failure of the room cooling fan on December 4, 2015. This condition could have prevented the 1B-B CCP pump from performing its specified function for its designed mission time. Based on the reduced reliability of the fan, the 1B-B CCP was considered to be inoperable from October 7, 2015 until the fan was repaired and returned to service on December 6, 2015. During this time period, there were several short time periods when the 1A-A CCP was inoperable due to low component cooling system (CCS) {EISS:CC} flow to its bearing and gear oil coolers and once when the 1A-A CCP was placed in pull-to-lock.

This event is being reported pursuant to 10 CFR 50.73(a)(2)(i)(B) as a condition prohibited by TS and 10 CFR 50.73(a)(2)(v)(D) as a condition that could have prevented the fulfillment of a safety function needed to mitigate the consequences of an accident.

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

There were no additional structures, components or systems other than the 1B-B CCP room cooler that contributed to this event.

C. Dates and Approximate Times of Occurrences

Date	Time (EST)	Event
9/27/15	N/A	Preventative maintenance performed on the 1B-B CCP room cooler.
10/07/15		1B-B CCP room cooler returned to service
11/11/15	1543-1545	The 1A-A CCP was inoperable due to low CCS flow while performing a preservice pump test of the 1B-B CCS pump.
	1555-1556	
11/12/15	0108-0117	The 1A-A CCP was inoperable due to low CCS flow while performing a preservice pump test of the 1B-B CCS pump.
11/12/15	1215-1607	The 1A-A CCP was inoperable as the result of being placed in pull-to-lock for the Cold Overpressure Mitigation System.
12/04/15	0300	Review of evidence (after the fact) determines this is the time when the 1B-B CCP room cooler is not performing its safety function.
12/04/15	1042	1B-B CCP room cooler found not cooling and belts thrown
12/04/15		Condition Report (CR) 1111791 generated to evaluate fan failure and correct.
12/06/15	0322	Repairs completed on 1B-B CCP room cooler and fan returned to service.

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Date	Time (EST)	Event
1/26/16		A past operability evaluation associated with the 1B-B CCP room cooler determines the fan was operable up until failure.
3/06/16		CR 1146474 generated to perform an equipment apparent cause evaluation (EACE) on the 1B-B CCP room cooler failure.
4/21/16		CR 1146474 EACE Approved
5/13/16		CR 1165380 determines this issue to be reportable to NRC.
6/23/16		Past Operability Evaluation associated with the 1B-B CCP and 1A-A CCP approved.

D. Manufacturer and Model Number of Components that Failed

Ellis & Watts fan cooler, Model ACH101.

E. Other Systems or Secondary Functions Affected

Other than the 1B-B CCP and 1A-A CCP, no other systems or functions were affected.

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

The immediate failure of the fan was discovered during operations tours.

G. Failure Mode and Effect of Each Failed Component

The cause of the fan bearing failure was an undersized fan shaft, resulting in the 1B-B CCP fan having excess shaft to bearing clearance which caused the bearing inner ring to loosen from the eccentric locking collar. These excessive clearances allowed the fan bearing inner ring to slide on the shaft. The sliding rotation of the inner ring on the shaft resulted in excessive heat being generated within the bearing leading to catastrophic failure.

H. Operator Actions

Upon identifying the failure of the 1B-B CCP room cooler on December 4, 2015, the Technical Specification Limiting Condition of Operation (LCO) 3.5.2 was entered for the 1B-B CCP.

I. Automatically and Manually Initiated Safety System Responses

There were no automatic or manual safety systems responses required. Upon declaring the 1B-B CCP inoperable, the 1A-A CCP was placed in service.

III. CAUSE OF THE EVENT

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

The cause of the fan bearing failure was an undersized fan shaft, resulting in the 1B-B CCP fan having excess shaft to bearing clearance which caused the bearing inner ring to loosen from the eccentric locking collar. These excessive clearances allowed the fan bearing inner ring to slide on

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the shaft. The sliding rotation of the inner ring on the shaft resulted in excessive heat being generated within the bearing leading to catastrophic failure. During maintenance on the 1B-B CCP room cooler, procedures associated with the bearing replacement did not confirm the fan shaft size to be outside design specifications.

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

There were no human performance causes associated with this failure.

IV. ANALYSIS OF THE EVENT

On December 4, 2015 at 1042, WBN personnel discovered the 1B-B CCP room cooler with belts thrown and not cooling. The reason the belts were thrown was discovered to be failure of the outboard flange bearing on the fan shaft of the cooler. Preventative maintenance was performed on the fan unit during the WBN Unit 1 outage on September 27, 2015 and returned to service on October 7, 2015. At the time the preventative maintenance was performed in October 2015, workers discovered that the remote grease fitting line to the flange of the bearing assembly was missing. This grease line was not restored prior to the fan being returned to service.

The fan failure on December 4, 2015 was documented in Condition Report (CR) 1111791, and the fan was repaired and returned to service on December 6, 2015. The evaluation performed by CR 1111791 addressed this issue as a human performance event because of the missing grease line. Subsequently, in the past operability evaluation for CR 1111791, WBN concluded that, based on interactions with the bearing manufacturer, the cause of the bearing failure was not the broken grease line.

In order to determine the cause of the bearing failure and to support a determination of reportability, WBN generated CR 1146474 to perform an equipment apparent cause evaluation (EACE) associated with the 1B-B CCP room cooler fan failure. This EACE determined that the cause of the fan bearing failure was an undersized fan shaft.

The CCPs are a component of the Emergency Core Cooling System (ECCS){EILS:BQ}, providing high head injection into the Reactor Coolant System (RCS). The Specified Safety Function of the ECCS is to cool the reactor core as well as to provide additional shutdown capability following initiation of an accident. The specified mission time for the CCPs is 100 days. Because the fan had an undersized shaft, the room cooler fan was unable to support the mission time of the 1B-B CCP following an accident. Based on the results of the EACE, the installed fan had a mechanical condition that impacted the fans specified safety function. The room cooler fan was determined to be inoperable from the date of its return to service on October 7, 2015 until it was repaired on December 6, 2015. Accordingly, the associated CCP is considered to be inoperable for the same time period.

During the period of inoperability of the 1B-B CCP (October 7 through December 6, 2015), the 1A-A CCP remained operable except for four specific limited time intervals. On November 11 and 12, 2015, the 1A-A CCP experienced low CCS flow to its associated bearing and gear oil coolers for time periods of 2 minutes, 1 minute and 9 minutes. If proceduralized operator actions had not been taken to restore adequate flow, the pumps could have failed to perform their specified functions. In addition, on November 12, 2015, with the 1B-B CCP in service, the 1A-A CCP was inoperable due to being placed in pull-to-lock for the cold overpressure mitigation system (COMS) in preparation for entry into Mode 4. If an accident

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had occurred at this time, without operator action to restore the 1A-A CCP, a loss of the 1B-B CCP would be expected to occur prior to completing its mission time.

A risk review was performed related to this condition. While the 1B-B CCP was inoperable, it was available to perform its safety function. The risk review shows that with an unavailability of five days during this period, the core damage frequency associated with the 1B-B CCP remained below 1E-6.

V. ASSESSMENT OF SAFETY CONSEQUENCES

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

The 1A-A CCP and associated room cooler remained operable except for four short time periods during the period between October 7, 2015 and December 6, 2015. During the time periods of low flow the 1A-A CCP, while not operable, was available. Considering operator responses to restore adequate CCS flow to the 1A-A CCP, there is confidence that the 1A-A CCP would have been able to perform its function had an accident occurred.

During the time period when the 1A-A CCP was in a pull-to-lock status for COMS, the plant was in a condition authorized by TS which limited operability of the charging system to one pump. In the event of an accident, it is reasonable to conclude that operator action would have been taken to start the 1A-A CCP if required.

- 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

Based on review of the time that cooling stopped, and a calculation performed to estimate the time of the bearing failure, the total time that the fan for the 1B-B CCP was not available was from December 4, 2015 at 0300 until December 6, 2015 at 0322, or 48 hours and 22 minutes.

VI. CORRECTIVE ACTIONS

This event was entered into the Tennessee Valley Authority (TVA) Corrective Action Program and is being tracked under CRs 1111791, 1146474, 1165380, and 1177072.

- A. Immediate Corrective Actions

The failed CCP room cooler was repaired and returned to service.

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B. Corrective Actions to Prevent Recurrence

The procedure governing maintenance of belt driven equipment will be revised to explicitly measure shaft size and validate against design requirements. The tensioning requirements for belt driven equipment will also be revised such that the lowest tension will be used that does not result in belt slipping.

VII. ADDITIONAL INFORMATION

A. Previous similar events at the same plant

On November 3, 1995, WBN Unit 1 reported a construction deficiency related to cooler fan shaft damage under 10 CFR 50.55(e). A final report was provided by TVA on December 4, 1995. The cause of the fan shaft damage was over tensioning of the fan belts. Contributing causes were (1) loose bearing to shaft fit, (2) improper alignment of shafts, (3) flexible bearing support mounts, and (4) shaft material susceptible to deflection and grooving with harder materials.

B. Additional Information

None.

C. Safety System Functional Failure Consideration

A safety system functional failure was present during the time periods when both the 1B-B CCP was inoperable and when the 1A-A CCP was inoperable for the short time periods identified. When considering reasonable and proceduralized operator actions associated with the 1A-A CCP, however, there is confidence that the safety system function would not have been lost in the event of an accident.

D. Scrams with Complications Consideration

There was no scram associated with this event.

VIII. COMMITMENTS

None.