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

September 2, 2016

10 CFR 50.73

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

Watts Bar Nuclear Plant, Unit 2
Facility Operating License No. NPF-96
NRC Docket No. 50-391

Subject: **Licensee Event Report 391/2016-002-01, Turbine Driven Auxiliary Feedwater Pump Inoperable for Longer than Allowable Outage Time due to Turbine Speed Control Failure**

This submittal provides Licensee Event Report (LER) 391/2016-002-01. This LER documents an incident where the Technical Specification Limiting Condition for Operation (LCO) 3.7.5 for the Auxiliary Feedwater System was not met. This report is being submitted in accordance with 10 CFR 50.73(a)(2)(i)(B). This supplement supports that a safety system functional failure did not occur.

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,

Paul Simmons
Site Vice President
Watts Bar Nuclear Plant

Enclosure
cc: See Page 2

cc (Enclosure):

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

NRC FORM 366 (11-2015) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2018

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4. TITLE

Turbine Driven Auxiliary Feedwater Pump Inoperable for Longer than Allowable Outage Time due to Turbine Speed Control Failure

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	11	2016	2016	- 002	- 01	09	02	2016	FACILITY NAME N/A	DOCKET NUMBER N/A

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*			
3	☐ 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)
	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	☐ 73.77(a)(1)
0	☐ 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)*
Dean Baker, Licensing Engineer	423-452-4589

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

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

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

On April 14, 2016, during performance of Surveillance Requirement (SR) 3.7.5.2, the Turbine Driven Auxiliary Feedwater pump (TDAFWP) failed to achieve required rated speed of 3950 rpm ± 25 rpm due to an equipment failure. The TDAFWP was declared inoperable, and Technical Specification (TS) Limiting Condition for Operation (LCO) 3.7.5, Condition B, was entered. The equipment was repaired, the TDAFWP was re-tested successfully and returned to service. TS LCO 3.7.5 was exited on May 4, 2016.

On May 11, 2016, a past operability evaluation concluded that the TDAFWP had been inoperable from March 30 through April 17, 2016, during periods of time when the TDAFWP was required for Mode 3 operations. This is reportable as a condition prohibited by TS.

During the same time period, the 2A-A Motor Driven Auxiliary Feedwater Pump (MDAFWP) experienced an oil leak through the inboard bearing housing vent cap that resulted in the need to add approximately 4 ounces of oil on a daily basis. The MDAFWP was determined to be operable.

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I. PLANT OPERATING CONDITIONS BEFORE THE EVENT

Watts Bar Nuclear Plant (WBN) Unit 2 was in Mode 3 at zero percent rated thermal power.

II. DESCRIPTION OF EVENT

A. Event

On April 14, 2016, during the performance of 2-SI-3-923-S, Auxiliary Feedwater Pump 2A-S Comprehensive Pump Test , the Terry Turbine {EIIS:TRB} associated with the Turbine Driven Auxiliary Feedwater Pump (TDAFWP) failed to reach 3950 rpm ± 25 rpm as required by the procedure. As a result, the test was suspended. Following research into the requirement, it was determined that the ± 25 rpm was a conservative value rather than the ± 1% of speed (± 39 rpm) required by the ASME code. Following this 2-SI-3-923-S was revised to incorporate a requirement of 3950 rpm ± 39 rpm. The test was re-performed and while the pump did meet this speed requirement when the pump was started on mini-flow, the speed at full flow (814 gpm) was 3878 rpm which did not meet the minimum 3911 rpm speed requirement. As a result of the failure of the TDAFWP to satisfy the surveillance requirements, the pump was declared INOPERABLE at 0016 hours on April 14, 2016.

During the first performance of the comprehensive pump test on April 14, 2016, the TDAFWP experienced a spurious overspeed trip. The TDAFWP had failed to meet the required speed of 3925 rpm and was being used to fill the steam generators (SGs). The TDAFW Level Control Valves {EIIS:LCV} were secured at 0057 hours, and with the turbine speed control still in Manual the speed rose to approximately 4100 rpm. The turbine speed control {EIIS:SC} was returned to Auto and the speed dropped to approximately 3813 rpm as read by Maintenance and Test Equipment. At this time, the Main Control Room received alarm 60-A, AFW PMP A-S ELEC OVERSPEED TRIP. It was confirmed at the pump that the TDAFWP had in fact tripped. The electronic overspeed setpoint for the turbine is 110% of rated speed, or 4345 rpm. As such, this trip was determined to be spurious. Trouble shooting performed on the TDAFWP determined that a loose connection existed at the power supply to the signal converter in the TDAFWP speed switch. Based on a review of the vendor manual, it was verified that a loose termination could cause a spurious TDAFWP overspeed trip.

On March 29, 2016, system engineering reported that the oil level in the inboard bearing bubbler for the 2A-A Motor Driven Auxiliary Feedwater Pump (MDAFWP){EIIS:P} was empty. It was determined that an oil leak through the inboard bearing housing vent cap was the cause. The initial response was to check the oil bubbler three times per shift and to add approximately 4 ounces of oil on a daily basis. On March 30, 2016, the vent cap was repaired and oil level remained stable. At 2000 hours on March 30, 2016, checks of the oil bubbler were suspended. Oil additions were continued daily (with the exception of April 11th and April 16th) from April 4 through April 17, 2016. The MDAFWP was considered OPERABLE during this timeframe. On April 17, 2016, the 2A-A MDAFWP was considered INOPERABLE for tracking purposes due to increased oil consumption. At the time, Unit 2 was in Mode 4 and required only one train of auxiliary feedwater.

The INOPERABILITY of the TDAFWP is being reported pursuant to 10 CFR 50.73(a)(2)(i)(B), "Any operation or condition which was prohibited by the plant's Technical Specifications.'

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

There were no additional structures, components or systems that contributed to this event.

C. Dates and Approximate Times of Occurrences

Date	Time (EDT)	Event
03/29/16	1659	2A-A MDAFWP oil leak identified by system engineering
03/30/16	1710	2A-A MDAFWP oil leak repaired
03/30/16	2314	Entered Mode 3 with INOPERABLE TDAFWP
04/02/16	0629	Entered Mode 4
04/08/16	1244	Re-entered Mode 3 with INOPERABLE TDAFWP
04/14/16	0016	Commenced and aborted testing of TDAFWP due to low rpm
04/14/16	0057	TDAFWP trips on spurious overspeed
04/15/16	2113	TDAFWP speed controller replaced and pump placed in standby alignment
04/17/16	0338	Entered Mode 4 for repairs to TDAFWP - steam leaks
04/17/16	0906	2A-A MDAFWP considered INOPERABLE for tracking due to a loss of oil
04/20/16	1256	2A-A MDAFWP exits tracking LCO
05/04/16	1414	TDAFWP Surveillance completed successfully
05/11/16		Past OPERABILITY Evaluation determined TDAFWP was INOPERABLE

D. Manufacturer and Model Number of Components that Failed

There were no component failures. The TDAFWP inoperability was due to a loose wire in the speed control circuit likely caused by a human performance error.

E. Other Systems or Secondary Functions Affected

No other systems or functions were affected.

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

The inboard bearing vent cap leak was discovered by auxiliary unit operators during routine building rounds. The oil bubbler was also reported as empty by system engineering.

The failure of the TDAFWP to achieve rated speed and the subsequent TDAFWP trip on electrical overspeed were discovered during surveillance testing on April 14, 2016.

G. Failure Mode and Effect of Each Failed Component

The initial evaluation of the oil leakage on the inboard bearing housing vent cap of the 2A-A MDAFWP concluded that the leakage did not result in the failure of the pump to perform its safety function. The 2A-A MDAFWP was operated throughout the time in question. Monitoring and oil

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additions were performed and the 2A-A MDAFWP was considered OPERABLE. No information has been found to refute the determination of OPERABLE.

As noted in the Description of Event, a loose wire was present in the power supply to the electronic overspeed trip circuit to the TDAFW pump. This condition was present through the entire period that Unit 2 was in Mode 3 from 3/30/16 to 4/2/16 and 4/8/16 to 4/17/16. As such, while the pump was determined to be capable to produce required flow and head at reduced speeds, a spurious overspeed trip could have occurred at any time during this period. In accordance with the WBN Unit 2 Final Safety Analysis Report, failure of the TDAFWP from a mechanical failure or spurious control signal will be addressed through the operation of the 2A-A & 2B-B MDAFWP that provide auxiliary feedwater flow to all 4 Steam Generators.

H. Operator Actions

Due to the failure of TDAFWP to achieve a speed greater than 3925 rpm per procedure 2-SI-3-923-S, the operators entered Technical Specification (TS) Limiting Condition for Operation (LCO) 3.7.5, Condition B, "One AFW train INOPERABLE in MODE 1, 2, or 3 for reasons other than Condition A."

I. Automatically and Manually Initiated Safety System Responses

The condition described in this report did not result in any automatic or manual safety systems activation.

III. CAUSE OF THE EVENT

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

The inability of the TDAFWP to achieve rated speed acceptance criterial was the result of maintenance practices that incorrectly calibrated the speed controller.

The TDAFW pump incurred a spurious overspeed trip as the likely result of maintenance practices. A loose wire was discovered in the power circuit to the electronic overspeed trip module that resulted in the spurious trip. Work Order searches determined that no work was performed on the TDAFW pump overspeed circuit following entry into Mode 3, which indicates that the condition existed prior to entering Mode 3 and as early as November 2015.

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

Troubleshooting identified a loose connection at the power supply to the overspeed trip module. The connection on the test block is a flat plate over bare wire type termination. The technicians performing the troubleshooting reported finding the flat plate visibly loose, requiring approximately one quarter turn of the screw before the plates began to snug on the wire. A review of Vendor Manual revealed that overspeed trip module has an internal, normally energized relay that de-energizes to trip the TDAFWP. As such, it was verified that momentary loss of power due to a loose termination could cause a spurious TDAFWP overspeed trip. Subsequent testing of the

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speed switch following proper termination did not identify any deficiencies associated with the switch.

IV. ANALYSIS OF THE EVENT

The Auxiliary Feedwater (AFW) system's {EIIS:BA} function is to supply, in the event of a loss of the main feedwater supply, sufficient feedwater to the steam generators to remove primary system residual heat and core decay heat. It may also be required in some other circumstances such as the evacuation of the Main Control Room (MCR), cooldown after a Loss of Coolant Accident (LOCA) for a small break, maintaining a water head in the steam generators following a LOCA, a flood above plant grade, Anticipated Transient Without Scram (ATWS) event, 10 CFR 50, Appendix R, Fires and to support normal cooldown.

The TDAFW pump assembly along with the motor driven (MDAFW) pump assemblies provide the motive pressure to ensure adequate flow gets to the steam generators for decay heat removal.

The Design Basis Events that establish AFW system safety function requirements are:

Loss of Normal Main Feedwater (LONF) (including Loss of Offsite Power)
Main Feedline or Main Steamline Breaks (MFLB or MSLB)
Loss of offsite power (LOOP)
Large Break Loss of Coolant Accident (LOCA)
Small Break Loss of Coolant Accident (SBLOCA)

Technical Specification 3.7.5, Auxiliary Feedwater (AFW) System requires all three trains of AFW to be OPERABLE in Modes 1, 2, and 3. Additionally, one train of AFW is required OPERABLE in Mode 4 when the Steam Generators are used for Heat Removal. With one of the required AFW trains (pump or flow path) INOPERABLE in MODE 1, 2, or 3 for reasons other than Condition A, action must be taken to restore to OPERABLE status within 72 hours. This Condition includes the loss of two steam supply lines to the turbine driven AFW pump. The 72 hour Completion Time is reasonable, based on redundant capabilities afforded by the AFW System, time needed for repairs, and the low probability of a Design Basis Accident (DBA) occurring during this time period.

During the timeframe that the TDAFWP was INOPERABLE while in Mode 3, both MDAFWPs were OPERABLE and capable of performing their design function. As a result, sufficient AFW system capability was available. Both MDAFWPs were in-service during the time that the TDAFWP was INOPERABLE. Additionally, while the TDAFWP could not achieve rated speed acceptance criteria, it was capable of meeting Technical Specification flow and pressure requirements at the reduced speed.

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.

As discussed previously, during the timeframe that the TDAFWP was INOPERABLE while in Mode 3, both MDAFWPs were OPERABLE and capable of performing their design function. As a result,

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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.

At the time of this occurrence, Watts Bar Unit 2 had not achieved initial criticality. With the MDAFWPs in service and no decay heat on Unit 2, the ability to shut down the reactor and maintain a safe shutdown condition was not impacted. With no core decay heat, removal of residual heat is not an issue. With no irradiated fuel in the Unit 2 core, an uncontrolled release of radioactive material is not credible, The inoperability of the TDAFWP would not have adversely impacted the ability to mitigate the consequences of an accident.

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.

Watts Bar Unit 2 entered Mode 3 on March 30, 2016 at 2314 hours. The TDAFWP failed to achieve minimum speed acceptance criteria as required by the surveillance and subsequently tripped on electrical overspeed at 0057 hours on April 14, 2016. There were two timeframes of TDAFWP unavailability. The first occurred when Unit 2 entered Mode 3 at 2314 hours on March 30, 2016 and then moved back to Mode 4 at 0629 hours on April 2, 2016. The second occurred when U2 reentered Mode 3 on April 8, 2016 at 1244 hours and subsequently moved back to Mode 4 on April 17, 2016 at 0338 hours. Based on the above, the unavailability window was 2 days, 7 hours and 15 minutes and 7 days, 14 hours and 54 minutes respectively for a total exposure time 9 days, 22 hours and 9 minutes.

VI. CORRECTIVE ACTIONS

This event was entered into the Tennessee Valley Authority Corrective Action Program and is being tracked under condition report (CR) 1163431.

A. Immediate Corrective Actions

The TDAFWP speed control was initially inspected, the loose wire corrected. Subsequently, the speed changer module was replaced, the speed control module was calibrated and the TDAFWP successfully completed TS surveillance requirements.

The 2A-A MDAFWP oil bubbler monitoring and oil additions were performed. Oil additions were continued daily (with the exception of April 11th and April 16th) from April 4 through April 17, 2016.

B. Corrective Actions to Prevent Recurrence

A strainer cup was installed on the 2A-A MDAFWP in the line containing the bearing cover cap. This device prevents oil spray from blowing past the bearing cover cap and successfully stopped the oil leakage.

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VII. ADDITIONAL INFORMATION

A. Previous similar events at the same plant

On May 14, 2011, at 14:28 Eastern Daylight Saving Time (EDT), Watts Bar Nuclear Plant Unit 1 (WBN) entered Mode 3 with the Turbine Driven Auxiliary Feedwater (TDAFW) pump INOPERABLE following maintenance during the WBN Cycle 10 refueling outage. The INOPERABLE condition was identified during performance of Surveillance Requirement (SR) 3.7.5.2 on May 16, 2011. The TDAFW pump failed SR 3.7.5.2 due to equipment failure, and the plant entered Limiting Condition for Operation (LCO) 3.7.5, Condition B. The faulty equipment was repaired and the TDAFW pump was re-tested in accordance with SR 3.7.5.2. The TDAFW pump met the acceptance criteria within the allowable time and the plant exited LCO 3.7.5 at 17:45 on May 19, 2011.

This report (390/2011-03) was subsequently retracted when TVA concluded that the TDAFWP was OPERABLE when the plant first entered Mode 3 following Refueling Outage Cycle 10 and, therefore, did not violate LCO 3.0.4.

B. Additional Information

None.

C. Safety System Functional Failure Consideration

Based on the initial conclusion that the 2A-A MDAFWP could perform it design basis function with the existing oil leak, this condition did not result in a safety system functional failure because two MDAFWPs were capable of supplying AFW to all four steam generators. Follow-up investigation found no evidence to refute the conclusion that the MDAFWPs remained OPERABLE.

D. Scrams with Complications Consideration

There was no scram associated with this event.

VIII. COMMITMENTS

None.