



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 23, 2015

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3R-C
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 1 – AUDIT REPORT RELATED TO
LICENSE AMENDMENT REQUEST TO REVISE TECHNICAL
SPECIFICATION 4.2.1, FUEL ASSEMBLIES (CAC NO. MF6050)

Dear Mr. Shea:

By letter dated March 31, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15098A446), as supplemented by letters dated May 27, 2015, and June 15, 2015 (ADAMS Accession Nos. ML15147A611 and ML15167A359, respectively), Tennessee Valley Authority (TVA, the licensee) requested an amendment to the Watts Bar Nuclear Plant, Unit 1, Technical Specifications to increase the maximum number of tritium producing burnable absorber rods that can be irradiated per cycle.

The U.S. Nuclear Regulatory Commission (NRC) staff determined that an audit was necessary to perform a detailed review of documentation regarding performance of testing referenced in licensee responses to NRC staff requests for additional information. This audit was performed on November 3 and 4, 2015, at the Pacific Northwest National Laboratory.

The summary report for this audit is enclosed. It includes two open items for which the licensee agreed to provide docketed responses. These open items have been discussed with Mr. Clinton Szabo and other members of your staff, and we understand that TVA will provide a response to the open items by December 31, 2015.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert G. Schaaf".

Robert G. Schaaf, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosure:
Regulatory Audit Report

cc w/enclosure: Distribution via Listserv



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

REGULATORY AUDIT REPORT

TRITIUM PRODUCING BURNABLE ABSORBER RODS

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

By letter dated March 31, 2015, as supplemented by letters dated May 27, 2015, and June 15, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML15098A446, ML15147A611, and ML15167A359, respectively), Tennessee Valley Authority (TVA, the licensee) submitted a license amendment request (LAR) for the Watts Bar Nuclear Plant (WBN), Unit 1, to the U.S. Nuclear Regulatory Commission (NRC).

The proposed LAR, as supplemented, would revise Technical Specification (TS) 4.2.1, "Fuel Assemblies"; TS 3.5.1, "Accumulators"; Surveillance Requirement (SR) 3.5.1.4; TS 3.5.4, "Refueling Water Storage Tank (RWST)"; and SR 3.5.4.3, to increase the maximum number of tritium producing burnable absorber rods (TPBARs) and to delete outdated information related to the tritium production program.

In the March 31, 2015, LAR submittal, the licensee stated that the post-loss-of-coolant accident (LOCA) criticality analysis was performed based on revised assumptions from a series of tests performed at the Pacific Northwest National Laboratory (PNNL). On August 14, 2015, the NRC staff issued a request for additional information (RAI) needed to complete the safety review (ADAMS Accession No. ML15226A466). In RAI item 2, the NRC staff requested information regarding the revised lithium leach rate test assumptions used in the post-LOCA subcriticality assessment referenced in the March 31, 2015, LAR. RAI item 2 requested the following information:

- a. A description of the test conditions, including ambient fluid conditions, fluid flow, installation configuration for the TPBAR, and mechanical loads.
- b. The pellet leach rates observed during the tests.
- c. The projected maximum temperature for the TPBARs during post-LOCA conditions.
- d. Technical justification for the applicability of the test results to the post-LOCA environment that would be experienced by the TPBARs, including fluid flow/turbulence, mechanical vibrations, thermal contraction/expansion, and coolant chemistry.

TVA submitted its response to the August 14, 2015, RAIs by letter dated September 14, 2015 (ADAMS Accession No. ML15258A204). On October 9, 2015, the NRC issued an audit plan (ADAMS Accession No. ML15286A001) requesting access to the detailed test documentation described in the September 14, 2015, RAI response.

Enclosure

AUDIT SCOPE

In the March 31, 2015, submittal, the licensee stated that certain assumptions related to lithium leaching during post-LOCA scenarios are based on a series of lithium leach rate and TPBAR burst tests performed at PNNL. Since the amount of lithium available for neutron capture in the reactor core is a significant input to the post-LOCA subcriticality assessment, the NRC staff's October 9, 2015, audit plan requested the lithium leach rate and TPBAR burst test documentation to better understand the test procedures, results, and analyses. In addition to access to the testing documentation, a tour of available test facilities and interviews with cognizant staff was requested in the audit plan.

AUDIT ACTIVITIES

The audit was conducted at PNNL in Richland, WA, on November 3 and 4, 2015. On November 3, 2015, the NRC held an entrance meeting with PNNL, Department of Energy, and TVA staff (see the last page of this audit summary report for a list of the participants). After introductions, the NRC staff briefly explained the purpose of the audit and stated that if any additional information was needed to support the safety evaluation, a subsequent RAI would be submitted to TVA, or an open item would be included in the NRC staff's audit summary report. PNNL staff gave an overview of the planned activities for the two-day audit, which included a tour of the non-irradiated lithium leach rate test facility located onsite at PNNL. The NRC staff stated that daily meetings with TVA and PNNL staff would be helpful to clarify any information provided, or to request any additional documentation that needed to be reviewed during the audit. The audit team was provided with a private conference room at PNNL to complete the review of the test documentation requested in the October 9, 2015, audit plan.

After the entrance meeting, PNNL staff gave a presentation outlining the licensing history of the tritium production program at WBN, Unit 1 (PNNL-SA-114175). The presentation explained the basic design history of the TPBARs and the purpose of the lithium leach rate tests and TPBAR burst tests. After the presentation, the NRC audit team was escorted to the backup TPBAR fabrication facility to tour the non-irradiated test apparatus and equipment. The tests conducted in this facility are described in detail in PNNL reports TTP-4-100 and TTP-4-629.

The TPBAR burst tests were conducted at a nearby facility owned by AREVA (formerly Framatome-ANP) called the Small Array Reflood and Test (SMART) Facility. These TPBAR burst tests were concluded in 2009. A tour of the TPBAR burst test facilities was not possible because support contracts are not in place to maintain the AREVA test facilities. PNNL provided the report, TTP-1-3010, "Phase Four Full Length TPBAR Burst Testing," which describes in full detail the TPBAR burst test results and procedures, including analysis, test design schematics, photos, and radiographs of test specimens.

On November 3, 2015, at 4:00 p.m., the NRC audit team met with PNNL and TVA staff to request clarifying information regarding assumptions made during the TPBAR burst tests with respect to the applicability of the testing conditions and analysis models to normal and accident conditions expected at WBN, Unit 1. The NRC staff requested that portions of the TTP-1-3010 report be submitted on the docket (see the audit open items section below). No new requests for documentation were made.

During the discussion on November 3, 2015, the NRC staff indicated that a review of the leach rate tests did not result in further questions to support a safety determination. However, the NRC staff had several questions about assumptions made related to the TPBAR burst tests and how the test conditions related to normal operating conditions and post-LOCA conditions. PNNL and TVA staff said a meeting with the cognizant test engineers is needed to address these questions.

First, the staff requested information regarding assumptions made related to TPBAR bursting conditions in the post-LOCA subcriticality analysis. The analysis assumes that 12 inches of TPBAR absorber pellet material is ejected during a TPBAR burst, and that a 12-inch gap results at the most reactive location for the fuel assembly. This axial location is determined independently for each fuel assembly. The March 31, 2015, LAR submittal did not appear to describe if TVA considered the potential impact for increased neutronic coupling between adjacent (or near-adjacent) TPBAR-bearing fuel assemblies where the 12-inch gap might occur at the same axial elevation, even if the elevation was not the most reactive elevation for one or both fuel assemblies. An increase in neutronic coupling may lead to a decrease in the post-LOCA subcriticality margin. PNNL and TVA staff indicated that they would need to coordinate a response to this question with Westinghouse.

On November 4, 2015, at 8:00 a.m., the audit team interviewed the PNNL test engineer, Mr. Robert Gates, and discussed specific questions about the TPBAR burst tests and how the results would be applicable to normal and accident conditions at the plant. The first question was whether the potential exists for a second burst at a different location on the TPBAR. The PNNL test engineer explained that since the TPBAR internal pressure drops very rapidly to ambient pressure (as can be observed in the test results from TTP-1-3010), repressurization would not occur to a sufficient extent to result in a second burst. The remaining two questions related to how the test conditions immediately prior to initiation of the burst test were representative of expected normal conditions at WBN, Unit 1. The explanation provided was that the conditions at the end of the test initialization period were designed to obtain a suitable axial temperature/power profile at a pressure that would result in bursting of the TPBAR soon after the fuel achieved the target temperature. A range of pressures was evaluated to consider the range of expected peak post-LOCA fuel temperatures. The TPBAR burst characteristics are primarily dependent on the TPBAR temperature and pressure at the time of burst, which were appropriately captured. Therefore, the conditions that existed immediately before initiation of the burst test are only relevant insofar as they establish an appropriate axial profile and will result in bursting at the target fuel temperature. Any variation in initial TPBAR temperature or pressure would still result in bursting at the same final TPBAR temperature and pressure. The NRC audit team determined that TVA and PNNL adequately addressed the questions related to the bursting tests in this discussion.

On November 4, 2015, at 10:20 a.m., the audit team had a discussion with TVA staff regarding information provided by Westinghouse to address the concern about the potential of neutronic coupling between adjacent or near-adjacent TPBAR-bearing fuel assemblies. The TVA staff clarified information presented on November 3, 2015, regarding the axial location of the postulated 12-inch gap. Additional information was provided from Westinghouse demonstrating that for expected temperatures, the most reactive node for all fuel assemblies was located at one of the two axial levels used to model the postulated 12-inch axial gap throughout the entire core. As a result, any potential for increased neutronic coupling between fuel assemblies due to

gaps in the TPBAR material at the same axial elevation is conservatively captured in the March 31, 2015, LAR submittal.

On November 4, 2015, at 2:30 p.m., an exit meeting was conducted with the participants listed in Enclosure 1. The following audit conclusions and audit open items were discussed with the PNNL and TVA staff.

Conclusion 1. After reviewing the lithium test leach rate test documentation, the NRC audit team noted that the assumptions appear to be appropriately conservative. The NRC audit team noted that the test assumptions and results support the use of the proposed lithium leaching rates in the post-LOCA subcriticality analysis.

Conclusion 2. After reviewing the TPBAR burst test documentation, the NRC audit team noted that some of the assumptions would need to be re-examined. The post-LOCA subcriticality analysis assumes that 12 inches of TPBAR are ejected, which is intended to bound the gaps that exist between absorber material rods in the TPBAR after bursting occurs. This assumption was originally paired with an instantaneous 50 percent "leaching" loss of Li-6, as described in the previously approved Amendment No. 40 (ADAMS Accession No. ML022790004). In the March 31, 2015, LAR, TVA changed the assumption to a lower 3 percent "instant leaching" at day 1. Because the lower leach rate assumption means that there is less lithium inventory to absorb neutrons at the time of hot leg switchover, there was a reduction in the conservatism of the assumptions used for the subcriticality analysis. As a result, the assumptions associated with the bursting tests needed to be re-examined for their applicability to the current analysis (including the current TPBAR design). Some questions were asked about the applicability of the burst test results to WBN, Unit 1. The responses from the PNNL staff confirmed that the burst testing was adequate to justify the general assumptions about TPBAR bursting. However, one question was asked about how this assumption was implemented in the modeling of the TPBAR for the post-LOCA subcriticality analysis (see audit open item 2).

Audit Open Item 1

Certain sections of the TPBAR burst test documentation, TTP-1-3010, are needed to complete the safety review of the LAR. TVA agreed to submit the following pages of TTP-1-3010, Revision 0, on the docket:

- Statistical Reanalysis of Mark 9.2 and Mark 8.1 TPBAR Test Pellet Length Loss (page v)
- Pellet Length Effect on Mark 9.2 TPBAR Burst Testing (page vi)
- Section 3.0, Description of SMART Facility (pages 5-9)
- Section 4.0, Test Method (pages 10-11)
- Subsection 5.3, Mark 9.2 Test Article Burst Test Summaries (pages 19-32)

Audit Open Item 2

In the post-LOCA subcriticality analysis, one of the assumptions is that the TPBARs have a 12-inch gap in absorber material resulting from a postulated bursting of all TPBARs. This gap is located at the same axial elevation for all TPBAR-bearing fuel assemblies. Westinghouse provided information during the audit to justify the conservatism of this assumption based on the fact that the most reactive axial node for all fuel assemblies is located within the region where the 12-inch gap in TPBAR absorber material is modeled. This information should be submitted

on the docket to support the staff's findings, as well as a discussion of how this assumption in the post-LOCA subcriticality analysis would be assessed if future TPBAR core designs do not demonstrate similar uniformity in the axial location of the most reactive node for all fuel assemblies.

The TVA staff committed to submitting the necessary information on the docket to close out open items 1 and 2.

AUDIT TEAM

Scott Krepel, Reactor Systems Engineer, Division of Safety Systems, Office of Nuclear Reactor Regulation (NRR)
Jeanne Dion, Project Manager, Division of Operating Reactor Licensing (DORL), NRR
Robert Schaaf, Senior Project Manager, DORL, NRR

OBSERVERS

Jennifer Ramos, Sign Language Interpreter
Melissa Klindtworth, Sign Language Interpreter

AUDIT LOCATION

Pacific Northwest National Laboratory
3200 Innovation Blvd.
Richland, WA

AUDIT DATES

November 3 and 4, 2015

DOCUMENTS REVIEWED

- PNNL-SA-114175, PNNL, "Tritium Technology Program-NRC Briefing in Support of Pellet Leaching Audit," November 3, 2015
- TTP-1-3010, PNNL, Revision 0, "Phase Four Full-Length TPBAR Burst Testing," March 20, 2009
- TTP-4-100, Revision 0, PNNL, "LBLOCA Pellet Leach Test Results with Mini-TPBARs," August 5, 2013
- TTP-4-629, Revision 0, PNNL, "Extended Leaching from Mini-TPBARs at LBLOCA Conditions," November 2, 2015
- NDP-98-181, Revision 1, "Tritium Production Core (TPC) Topical Report" (Unclassified, Non-Proprietary Version), February 8, 1999

PARTICIPANT LIST
November 3 and 4, 2015

PNNL Participants

Cheryl Thornhill
Tom Brewer
Larry Bagaasen
Bruce Reid
Mark Mitchell
Roger Graves
Lisa Middleton
Gary Sevigny
Dean Paxton
Ed Love
Bill Richmond
Dave Baldwin
Lisa Copeland
Rachel Robbins
Cindy Marcotte
Robert Gates

Department of Energy, Pacific Northwest Site Office Participants

Bob McCleod
Neomi Mendez

TVA Participants

Carla Borelli
Mark Burzynski
Clinton Szabo (by phone)

December 23, 2015

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3R-C
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 1 – AUDIT REPORT RELATED TO
LICENSE AMENDMENT REQUEST TO REVISE TECHNICAL
SPECIFICATION 4.2.1, FUEL ASSEMBLIES (CAC NO. MF6050)

Dear Mr. Shea:

By letter dated March 31, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15098A446), as supplemented by letters dated May 27, 2015, and June 15, 2015 (ADAMS Accession Nos. ML15147A611 and ML15167A359, respectively), Tennessee Valley Authority (TVA, the licensee) requested an amendment to the Watts Bar Nuclear Plant, Unit 1, Technical Specifications to increase the maximum number of tritium producing burnable absorber rods that can be irradiated per cycle.

The U.S. Nuclear Regulatory Commission (NRC) staff determined that an audit was necessary to perform a detailed review of documentation regarding performance of testing referenced in licensee responses to NRC staff requests for additional information. This audit was performed on November 3 and 4, 2015, at the Pacific Northwest National Laboratory.

The summary report for this audit is enclosed. It includes two open items for which the licensee agreed to provide docketed responses. These open items have been discussed with Mr. Clinton Szabo and other members of your staff, and we understand that TVA will provide a response to the open items by December 31, 2015.

Sincerely,

/RA/

Robert G. Schaaf, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosure:
Regulatory Audit Report

cc w/enclosure: Distribution via Listserv

DISTRIBUTION:

PUBLIC	RidsNrrLABClaytonResource	SKrepel, NRR
LPL2-2 R/F	RidsNrrDorl Resource	JDion, NRR
RidsNrrDssSrxbrResource	RidsRgn2MailCenter Resource	
RidsNrrDorlLpl2-2 Resource	RidsNrrPMWattsBar Resource	

ADAMS Accession No.: ML15345A424

*by memo

OFFICE	DORL/LPLII-2/PM	DORL/LPLII-2/LA	DSS/SRXB*	DORL/LPLII-2/BC	DORL/LPLII-2/PM
NAME	RSchaaf	BClayton (LRonewicz for)	CJackson	BBeasley	RSchaaf
DATE	12/11/2015	12/21/2015	12/09/2015	12/23/2015	12/23/2015

OFFICIAL RECORD COPY