September 23, 2002

Mr. J. A. Scalice
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 1— ISSUANCE OF AMENDMENT TO IRRADIATE UP TO 2304 TRITIUM-PRODUCING BURNABLE ABSORBER RODS IN THE REACTOR CORE (TAC NO. MB1884)

Dear Mr. Scalice:

The Commission has issued the enclosed Amendment No. 40 to Facility Operating License No. NPF-90 for Watts Bar Nuclear Plant, Unit 1. This amendment is in response to your application of August 20, 2001, as supplemented by letters of October 29, November 14, November 21, December 7, December 19, 2001, and January 14, February 19, February 21, May 21, May 23, and July 30, 2002. The amendment allows Watts Bar Nuclear Plant, Unit 1, to irradiate up to 2304 tritium-producing burnable absorber rods in the reactor core each fuel cycle.

A copy of the safety evaluation is also enclosed. Notice of issuance will be included in the Commission's biweekly *Federal Register notice*.

Sincerely,

/RA/

L. Mark Padovan, Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosures: 1. Amendment No. 40 to NPF-90
2. Safety Evaluation

cc w/enclosures: See next page

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TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-390

WATTS BAR NUCLEAR PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 40
License No. NPF-90

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) of August 20, 2001, as supplemented by letters of October 29, November 14, November 21, December 7, December 19, 2001, and January 14, February 19, February 21, May 21, May 23, and July 30, 2002, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-90 is hereby amended to read as follows:

   (2) Technical Specifications and Environmental Protection Plan

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 40, and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance, and shall be implemented prior to starting up from the outage where TVA inserts tritium-producing burnable absorber rods in the core, provided there have been no changes to the facility that materially change the basis for approval of the amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Herbert N. Berkow, Director
Project Directorate II
Division of Project Licensing Management
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Technical
Specifications

Date of Issuance: September 23, 2002

ATTACHMENT TO AMENDMENT NO. 40

FACILITY OPERATING LICENSE NO. NPF-90

DOCKET NO. 50-390

Replace the following pages of the Appendix A Technical Specifications with the attached pages. The revised pages are identified by amendment number and contain vertical lines indicating the area of change.

Remove Pages	Insert Pages
3.5-2	3.5.2
3.5-10	3.5.10
3.7-31	3.7-31
3.7-32	3.7-32
4.0-1	4.0-1
4.0-2	4.0-2
4.0-3	4.0-3
4.0-4	4.0-4
4.0-7	4.0-7
4.0-9	4.0-9
4.0-10	4.0-10
B 3.5-10	B 3.5-10
B 3.5-26	B 3.5-26
B 3.6-44	B 3.6-44
B 3.7-75	B 3.7-75
B 3.7-76	B 3.7-76
B 3.7-77	B 3.7-77

SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 40

TO FACILITY OPERATING LICENSE NO. NPF-90

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

Table of Contents

Abbreviations

ANS	American Nuclear Society
ANSI	American National Standards Institute
ASL	acceptable suppliers list
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
BPRA	burnable poison rod assembly
CCS	component cooling system
CDCT	cask decon collector tank
CFR	Code of Federal Regulations
CLA	cold leg accumulator
CRE	control room envelope
DAC	derived air concentration
DBA	design-basis accident
DNBR	departure from nucleate boiling ratio
DOE	U.S. Department of Energy
DWMS	demineralized water makeup system
ECCS	emergency core cooling system
EOL	end of license
EPA	U.S. Environmental Protection Agency
ERCW	essential raw cooling water
ERG	emergency response guideline
FHA	fuel-handling accident
GDC	General Design Criterion/Criteria
HVAC	heating, ventilating and air conditioning
IFBA	integral fuel burnable absorber
K_{eff}	effective multiplication factor
LBLOCA	large break loss-of-coolant accident
LOCA	loss-of-coolant accident
LTA	lead test assembly
NEI	Nuclear Energy Institute
NQAP	nuclear quality assurance program
NRC	U.S. Nuclear Regulatory Commission
ODCM	off-site dose calculation manual

PNNL	Pacific Northwest National Laboratory
PTS	pressurized thermal shock
QA	quality assurance
RCS	reactor coolant system
RG	Regulatory Guide
RWST	refueling water storage tank
SFP	spent fuel pool
SFPCCS	spent fuel pool cooling and cleanup system
SR	Surveillance Requirement
SRP	Standard Review Plan
TCF	TPBAR [tritium-producing burnable absorber rod] consolidation fixture
TDCT	tritiated drain collector tank
TEDE	total effective dose equivalent
TPBAR	tritium-producing burnable absorber rod
TPC	tritium production core
TPP	tritium production program
TS	technical specification
TVA	Tennessee Valley Authority
UFSAR	updated final safety analysis report
UHS	ultimate heat sink
USE	upper-shelf energy
WABA	wet annular burnable absorbers

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 40 TO FACILITY OPERATING LICENSE NO. NPF-90

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

1.0 INTRODUCTION

By letter of August 20, 2001, as supplemented by letters of October 29, November 14, November 21, December 7, December 19, 2001, and January 14, February 19, February 21, May 21, May 23, and July 30, 2002, the Tennessee Valley Authority (TVA or the licensee) submitted a request for changes to the Watts Bar Nuclear Plant, Unit 1, Technical Specifications (TSs). The requested changes would allow Watts Bar Nuclear Plant, Unit 1, to irradiate up to 2304 tritium-producing burnable absorber rods (TPBARs) in the reactor core each fuel cycle. The supplemental letters provided clarifying information that did not change the initial proposed no significant hazards consideration determination, or expand the application beyond the scope of the notice of the amendment request published in the *Federal Register.*

1.1 Background

Tritium, an essential material in U.S. nuclear weapons, is an isotope of hydrogen that decays at a rate of about 5 percent per year (half of it decays in about 12 years). Thus, tritium must be replenished in nuclear weapons routinely. The United States has not produced tritium since 1988, when the U.S. Department of Energy's (DOE's) production facility at the Savannah River Site in South Carolina closed. Immediate tritium needs are being met by recycling tritium from dismantled U.S. nuclear weapons. According to DOE, resumption of tritium production is essential for maintaining the U.S. nuclear weapons stockpile.

1.1.1 DOE's Strategy to Produce Tritium

DOE is responsible for re-establishing the capability to produce tritium gas by the end of 2005, in accordance with a Presidential directive. On May 22, 1996, the Secretary of Energy and the Chairman of the U.S. Nuclear Regulatory Commission (NRC) signed a joint Memorandum of Understanding. This document establishes the basis for NRC review of DOE's use of commercial reactors for producing tritium.

DOE developed a technology to produce tritium in pressurized-water reactors that uses lithium, rather than boron (which is normally used as a neutron absorber in a reactor core). Irradiating lithium in special rods (TPBARs) in a reactor core will convert the lithium to tritium. Plant

ENCLOSURE

operators can then remove the TPBARs from the fuel assemblies and prepare them for shipping. DOE will ship the TPBARs to its Savannah River Site, where DOE will extract the tritium.

On December 22, 1998, the Secretary of Energy announced that he had chosen the light-water reactor technology as the primary means for tritium production, and selected TVA's Watts Bar and Sequoyah nuclear power plants in Tennessee as the preferred facilities for producing future supplies of tritium.

1.1.2 Producing Tritium in Commercial Light-Water Reactors

Commercial light-water reactors are designed and constructed to produce electrical power. A nuclear reactor core usually has standard burnable poison rod assemblies (BPRAs) inserted into many of the fuel assemblies. The BPRAs absorb excess neutrons, and help control the power in the reactor to ensure an even distribution of heat and extend the time between refueling outages. As previously mentioned, DOE developed another type of BPRA which uses TPBARs. A TPBAR assembly can contain up to 24 TPBARs. It functions in a manner similar to a BPRA, but TPBARs absorb neutrons using lithium aluminate instead of boron. There is no uranium or plutonium in the TPBARs. The licensee will install these TPBAR assemblies in fuel assemblies where standard BPRAs are normally placed.

Tritium is produced when the neutrons strike the lithium material in a TPBAR. A solid zirconium material in the TPBAR (called a "getter") instantaneously captures the tritium as it is produced. The tritium remains trapped in the getter material. DOE will later heat the TPBARs in a vacuum at much higher temperatures than normally occur during the operation of a light-water reactor to extract the tritium. DOE will extract the tritium in its Tritium Extraction Facility located at its Savannah River Site in South Carolina.

In the first phase of the tritium program, NRC evaluated DOE's proposal for testing irradiation of a limited number of fuel assemblies containing TPBARs (lead test assemblies or LTAs) in the Watts Bar nuclear reactor. NRC documented the results of its review in NUREG-1607, which is available to the public. In April 1997, TVA applied for an amendment to the Watts Bar operating license to put 32 TPBARs in the reactor core during one fuel cycle. NRC issued a license amendment to TVA in September 1997 authorizing the test.

TVA loaded the TPBARs in the core during Watts Bar's first refueling outage in the fall of 1997. TVA irradiated the 32 TPBARs and removed them from the reactor during the spring 1999 outage. DOE then shipped the rods containing tritium offsite and examined them to confirm TPBAR design and analytical modeling assumptions. The TPBARs performed as expected during the irradiation, as shown by the monitoring performed during the 17-month irradiation and the subsequent examinations.

The second phase focuses on using TVA's Watts Bar and Sequoyah nuclear plants to produce tritium. NRC reviewed DOE's safety assessments submitted in its "Tritium Production Core Topical Report," NPD-98-181, dated July 30, 1998, and revision of February 10, 1999. DOE's topical report assessed how inserting 3300 TPBARs into the reactor core of a typical large nuclear power plant (a standard or reference plant) would affect it. NRC reviewed the topical report and DOE's responses to staff's requests for additional information against the guidance in NRC NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for

Nuclear Power Plants." NRC's safety evaluation, issued as NUREG-1672, "Safety Evaluation Report Related to the Department of Energy's Topical Report on the Tritium Production Core," in May 1999, documented the NRC's review. Section 5, "Summary and Conclusions," of NUREG-1672 states that DOE satisfactorily addressed many technical issues in their topical report, as documented in the NUREG. However, the NUREG identified issues that a utility would have to address before operating with TPBARs in the core because the parameters of the reference plant might not bound the actual design of an individual plant. Thus, the staff concluded that a utility wanting to irradiate TPBARs must first apply to the NRC for an amendment to the individual facility operating license to do this. NUREG-1672 further indicated that the licensee's application must address plant-specific interface issues before operating with TPBARs to produce tritium. As mentioned in the above Introduction section, TVA submitted a license amendment request to the NRC on August 20, 2001, to do this at Watts Bar. The current schedule for loading the TPBARs into the Watts Bar reactor core is fall 2003.

1.1.3 Public Meetings

NRC held two public meetings early in the evaluation process to give the public an opportunity to comment on the technical issues of the confirmatory test and to inform the public of NRC activities. An initial meeting was held at NRC Headquarters in Rockville, Maryland, in February 1997. Another public meeting was held near TVA's Watts Bar nuclear power plant in Tennessee in August 1997, prior to loading TPBARs into the reactor core. In addition, technical meetings that were open to the public were held on March 23 and August 24, 2000, and August 20, 2001. NRC staff discussed the status of technical issues and proposed schedules for licensing activities at these meetings. NRC also held a meeting for the public in Evensville, Tennessee, on October 2, 2001, to discuss DOE's program to produce tritium and NRC's plans to review the license amendment applications. NRC plans to hold another public meeting in Rhea County, Tennessee, on the evening of October 30, 2002. The NRC will explain the results of its safety evaluations of TVA's license amendment requests for Watts Bar and Sequoyah, and will answer questions at that meeting.

1.1.4 TVA's Amendment Requests

TVA's amendment request of August 20, 2001, proposes inserting up to 2304 TPBARs into the Watts Bar reactor each fuel cycle. TVA would irradiate the TPBARs for one fuel cycle (about 18 months), remove the irradiated TPBARs, insert new TPBARs in the Watts Bar reactor, and repeat the process for the life of the plant. DOE would take possession and ship the irradiated TPBARS to its Tritium Extraction Facility at its Savannah River Site in South Carolina. TVA also sent the NRC an amendment request dated September 21, 2001, requesting NRC approval to insert TPBARs into its Sequoyah, Units 1 and 2, reactors. NRC will document its review of this request in a separate safety evaluation. TVA also submitted letters dated June 23, 2000, September 29, 2000, and May 1, 2001, providing information to the NRC related to tritium production before submitting its license amendment requests.

There are 17 interface issues and additional license changes that the NRC must review and approve before TVA can operate Watts Bar with TPBARs in the reactor core. NUREG-1672 lists these interface issues as follows:

(1) handling of TPBARs

(2) procurement and fabrication

(3) compliance with departure from nucleate boiling (DNB) criterion

(4) reactor vessel integrity analysis

(5) control room habitability systems

(6) specific assessment of hydrogen source and timing or recombiner operation

(7) light-load handling system

(8) station service water system

(9) ultimate heat sink (UHS)

(10) new and spent fuel storage

(11) spent fuel pool cooling and cleanup system (SFPCCS)

(12) component cooling water system

(13) demineralized water makeup system (DWMS)

(14) liquid waste management system

(15) process and effluent radiological monitoring and sampling system

(16) use of LOCTA_JR code for loss-of-coolant accident (LOCA) analyses

(17) anticipated transient without scram (ATWS) analysis

Each of these interface issues is discussed separately below in this safety evaluation. The staff's safety evaluation concludes that TVA's amendment request is acceptable.

2.0 EVALUATION

The NRC's evaluation of each of the 17 tritium production program (TPP) interface issues appears below.

2.1 Interface Issue 1—Handling of Tritium-Producing Burnable Absorber Rods (TPBARs)

This issue deals with the following three items as described in the NRC's May 1999 Safety Evaluation Report (NUREG-1672):

- removing irradiated TPBAR assemblies from fuel assemblies
- moving irradiated TPBARs
- preparing TPBARs for shipping

TVA's letter of August 20, 2001, said that TPBAR assemblies will be already inserted into new fuel assemblies when they are shipped to Watts Bar. After inspection, plant operators can put the fuel assemblies containing TPBARs in the new fuel storage area or can put them into the spent fuel pool (SFP). Normally, licensees insert BPRAs into fuel assemblies to balance reactor power in the core. Burnable poison rods are nearly identical in design to TPBARs, and weigh about the same (58 versus 65 lb, respectively). This allows operators to move TPBAR assemblies using the BPRA handling tool. The hoisting cable on the BPRA tool has a breaking strength of 1700 lb, and TVA tested the tool hoist to 900 lb. Thus, the BPRA tool is capable of handling the weight of TPBAR assemblies safely.

TVA will use the same methods, procedures, and equipment to put fuel assemblies containing TPBARs into the core as it does for fuel assemblies that do not contain TPBARs. After irradiating the TPBARs in the reactor, plant operators will offload the entire core to the spent fuel racks in the SFP.

2.1.1 Removing Irradiated TPBARs From Fuel Assemblies and Consolidating the Rods

TVA reuses fuel assemblies that were irradiated for only one fuel cycle (once-burned). For once-burned fuel assemblies containing TPBARs, plant operators will remove the TPBAR assemblies from the fuel assemblies and temporarily store the TPBAR assemblies in old spent fuel assemblies or TPBAR assembly holding fixtures in the SFP. TVA would then reinsert the once-burned fuel assemblies into the core during the refueling outage. About 30 days after the refueling is complete, plant operators would begin to remove the remaining irradiated TPBAR assemblies from the spent fuel assemblies, disassemble all of the irradiated TPBARs for consolidation, and place them into consolidation canisters. The time to start consolidating the TPBARs is not limited by any safety issues (e.g., decay heat), but rather is based on scheduling. The 30-day estimate corresponds to when the licensee expects to be finished with all outage-related activities, and can begin consolidation efforts. For the consolidation process, TVA will use a specially designed TPBAR consolidation fixture (TCF), which will be installed in the cask loading pit. During consolidation, plant operators will use the TPBAR Assembly Handling Tool suspended from the SFP bridge crane to withdraw the TPBARs from their storage location and transfer them from the SFP to the TCF. A specially designed release tool is used to detach individual absorber rods from the baseplate of the TPBAR assembly. Once released, the rods slide into a specially designed consolidation canister which holds 300 absorber rods. TVA plans to conduct both dry and wet testing of the TPBAR consolidation process at Watts Bar prior to using the equipment to ensure it will operate correctly. TVA estimates that it will take 3 to 4 weeks to consolidate a full reactor core load of TPBARs into the canisters. Operators will return loaded consolidation canisters to the spent fuel racks, where they will remain until removed from the site. The spent fuel bridge crane is used to handle the canisters, and a review of this operation is included with the review of the light-load handling system (see Interface Issue 7).

When not in use, the TCF is removed and stored in the cask laydown area to allow for cask handling and loading. Both the cask laydown area and the cask loading pit are separated from the spent fuel storage racks by a wall. This physical separation protects stored fuel during installation of the TCF.

Operators will use the 125-ton auxiliary building crane to handle the TCF. The crane has both 125-ton and 10-ton hoists. The TCF weighs less than one half of the hook capacity of the 10-ton hoist. Therefore, the auxiliary building crane has adequate capacity to handle the TCF.

2.1.2 Preparing TPBARs for Shipping

The loaded canisters will be transported to the Tritium Extraction Facility at the Savannah River Site in South Carolina, using a specially designed cask. TVA estimates that the cask weighs about 49,000 lb and will hold a maximum of four canisters. DOE has not yet selected the cask vendor, so the number of canisters the cask will contain has not been defined, but it will not be more than four. A consolidation canister containing TPBARs weighs about 750 lb. So, the weight of the cask plus four filled canisters is about 52,000 lb. Operators will use the 125-ton auxiliary building crane to handle the loaded transport cask. Thus, the capacity of the auxiliary building crane far exceeds the weight of a loaded transport cask. TVA estimates that it will take about 5 days to receive, load, decontaminate, and prepare the cask for shipment. DOE is responsible for transporting the casks to its Tritium Extraction Facility.

2.1.3 Moving Irradiated TPBARs

The licensing basis for Watts Bar specifies that heavy-load lifts (greater than 2059 lb) using the auxiliary building crane must comply with the guidelines of Section 5.1.1 of NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants.” In addition, TVA said that for heavy-load lifts associated with TPBARs, the auxiliary building crane complies with Appendix C of NUREG-0612 and thus satisfies the guidelines of Section 5.1.2 of the NUREG, with the exception of satisfying the load-hangup protection and associated testing provisions. To compensate for the absence of load-hangup protection, TVA will ensure that all lifts are controlled by site procedures. These procedures require prelift briefings and trained operators to adequately monitor the lift operation to preclude load hangup. Lifting devices and the interfacing lift points for TPBAR heavy loads comply with the redundancy and increased-safety factors specified in Sections 5.1.1 and 5.1.6 of NUREG-0612.

The licensee evaluated the consequences of a mishandled or dropped fuel assembly containing a TPBAR assembly (24 absorber rods). TVA states that a postulated drop of a fuel assembly containing a TPBAR assembly is bounded by the fuel-handling accident (FHA) analysis. This analysis evaluated the results of an accident occurring both in containment and in the fuel-handling area of the auxiliary building. The licensee states that the accident occurring in containment resulted in the largest offsite doses, but did not exceed the limits of Title 10, *Code of Federal Regulations* (10 CFR), Part 100. The accident occurring in the auxiliary building resulted in the largest control room exposures. However, the operator doses were found to be below the limits of 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 19. This is discussed in detail under Interface Issue 5.

2.1.4 Summary

The design of the TPBAR assemblies allows for the use of existing equipment and procedures that safely handle BPRAs and fuel assemblies. The BPRA tool is capable of handling the weight of TPBARs safely. The auxiliary building crane has adequate capacity to handle both the TCF and a loaded transport cask. TVA plans to conduct both dry and wet testing of the TPBAR consolidation process prior to using the equipment. TVA will use the same methods, procedures, and equipment to put fuel assemblies containing TPBARs into the core as it does for fuel assemblies that do not contain TPBARs. Proposed personnel training, equipment inspections, and procedural controls satisfy NUREG-0612 guidelines. In the unlikely event of an accident associated with TPBAR assembly handling, TVA adequately demonstrated that applicable regulatory offsite and onsite dose limits will not be exceeded. Therefore, the existing light-load handling system satisfies Section 9.1.4 of the NRC's Standard Review Plan (SRP), NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," for TPBAR assembly handling. Based on the above, the staff concludes that TVA's TPBAR assembly handling process is acceptable.

2.2 Interface Issue 2—Procurement and Fabrication Issues

This section addresses the adequacy of TPBAR procurement and fabrication processes with respect to TVA complying with the requirements of 10 CFR Part 50, Appendix B, and 10 CFR Part 21. The quality assurance (QA) relationships among the contracting parties, focusing on the TPBAR supplier procurement and fabrication activities of Pacific Northwest National Laboratory (PNNL) and WesDyne International LLC (WesDyne) were also reviewed. Figure 1 in Appendix A shows the overall flow of QA program requirements for DOE's Tritium Production Program.

2.2.1 Tritium Production Program (TPP)

DOE manages the TPP, including making major procurements. DOE buys TPBAR design, fabrication, irradiation, and transportation services to deliver irradiated TPBARs to its Tritium Extraction Facility. Major DOE suppliers include PNNL, WesDyne, and TVA.

The Interagency Agreement of January 1, 2000, between DOE and TVA provides a means for imposing TVA requirements directly on DOE's TPBAR suppliers. DOE procurement documents for safety-related material, items, and services are reviewed by TVA for acceptance. The Agreement defines TPBARs as safety-related, basic components that shall be supplied in accordance with a QA program that complies with 10 CFR Part 50, Appendix B. The Agreement further requires that TPBARs and services must conform to the guidance of NRC Regulatory Guide (RG) 1.28, Rev. 3, "Quality Assurance Program Requirements (Design and Construction)."

The Agreement passes TVA's "Tritium Production Program Requirements" (TVA-TPPR-99-01, Rev. 1, dated October 6, 2000) through to TPBAR design, analysis, and fabrication suppliers. The Agreement also requires that suppliers be included on TVA's "Acceptable Suppliers List (ASL)." The ASL identifies vendors with QA programs that conform with 10 CFR Part 50, Appendix B, and that are acceptable as suppliers of items and services consistent with the requirements of TVA's QA program.

2.2.2 Tritium Production Program Requirements

Activities associated with TPBAR design, procurement of material and services, fabrication, and delivery are performed in accordance with TVA's NRC-approved nuclear QA program (NQAP), TVA-NQA-PLN89-A, dated July 25, 2000. TVA's NQAP includes provisions for TVA to specify the applicable QA requirements for items or services supplied by others. In accordance with the DOE/TVA Interagency Agreement, TVA has elected to qualify TPBAR suppliers as though they were direct suppliers to TVA. DOE's direct suppliers (PNNL and WesDyne) have submitted their QA programs to TVA and have been placed on TVA's ASL in accordance with the NQAP. Suppliers are maintained on the ASL through annual evaluations and triennial audits.

TVA requires that all TPBAR safety-related materials, items, and services comply with the technical, functional, and quality requirements of TVA-TPPR-99-01. This document requires that TPBARs be designed, fabricated, and delivered in accordance with the methods of the basic and supplementary requirements of American Society of Mechanical Engineers (ASME) NQA-1-1994, and comply with the regulatory positions of RG 1.28, Rev. 3. The staff has reviewed the DOE/TVA Interagency Agreement and TVA-TPPR-99-01, and finds that they establish an effective method for controlling the TPBAR procurement and fabrication process in accordance with applicable NRC regulatory procurement and QA requirements.

2.2.3 Quality Requirements (Direct Suppliers)

DOE selected the following two suppliers of TPBARs:

- PNNL, located in Richland, Washington, is a DOE-owned site operated by the Battelle Memorial Institute.

- WesDyne, a wholly owned subsidiary of Westinghouse Electric Company LLC, also supplies TPBAR fabrication and procurement activities. The TPBAR Fabrication Facility is located at the Westinghouse Fuel Fabrication Plant in Columbia, South Carolina.

2.2.4 Pacific Northwest National Laboratory's (PNNL's) Quality Assurance (QA) Program

PNNL's scope of work includes design and fabrication process improvements associated with tritium production, and material and sub-component procurements to support TPBAR irradiation under a full-scale production program.

TVA has audited PNNL's QA program applicable to this work. The TPBAR design interface agreement between TVA and PNNL is documented in TVA-TPPR-99-02, Rev. 0, dated November 30, 1999. This agreement identifies the controls associated with PNNL obtaining and using technical information from TVA and the TVA fuel vendor in TPBAR design activities. The NRC reviewed TVA's agreement and determined it provides the necessary detail to satisfy 10 CFR Part 50, Appendix B, Criterion 3. Criterion 3 mandates establishing measures to identify and control design interfaces and to coordinate among participating design organizations. PNNL has issued a similar document (TTQP-1-021) for satisfying design interface requirements.

PNNL developed and qualified the TPBAR design and fabrication processes, fabricated and delivered them for use as LTAs, obtained LTA irradiation services from TVA, and performed LTA postirradiation examinations. TVA irradiated the LTAs in the Watts Bar Unit 1 reactor core during Cycle 2, as authorized under License Amendment No. 8, dated September 15, 1997. Monitoring during the 17-month irradiation in Watts Bar and subsequent postirradiation examinations showed the LTAs performed as expected.

The scope of the staff's review included implementing procedures and activities for controlling design, procurement, fabrication, assembly and handling of the LTAs. As part of its review of this license amendment, the staff reviewed the QA program implemented at the PNNL facility and found the program to be acceptable. PNNL's quality controls were effective in complying with the requirements of 10 CFR Part 21 and 10 CFR Part 50, Appendix B.

2.2.5 WesDyne’s Quality Assurance Program

WesDyne’s TPBAR Fabrication Facility performs the following activities:

- receives materials and subcomponents purchased by PNNL
- procures some items (such as end plugs and spring clips)
- assembles, processes, and fabricates final TPBARs
- delivers certified TPBARs to TVA or TVA's nuclear fuel manufacturer(s) for use in Watts Bar

WesDyne has subcontracted TPBAR assembly to Westinghouse Nuclear Fuels in Columbia, South Carolina, and has developed an interface agreement with Westinghouse Nuclear Services for support services.

WesDyne’s TPBAR Fabrication Project Quality Plan (DOE Contract DE-AC02-00DP00229, dated July 31, 2001) commits to comply with 10 CFR Part 50, Appendix B. WesDyne implements the NRC-approved Westinghouse Quality Management System to comply with these requirements (NRC letter to Westinghouse Electric Company LLC, “Changes to Quality Management System Document,” Rev. 4, dated December 7, 2000).

The QA requirements controlling all WesDyne activities related to TPBAR fabrication are defined under the TPBAR Fabrication Project Quality Plan. DOE established and imposed QA program and procurement requirements through the quality requirements of TVA-TPPR-99-01 (described above). As previously mentioned, TVA placed WesDyne on its ASL and has audited WesDyne's QA program.

2.2.6 Quality Requirements (Material/Service Subcontracts)

Quality oversight (such as program reviews, source surveillances, and audits) of material, services, and subcomponent suppliers is the responsibility of PNNL or WesDyne, with a TVA observer participating periodically. Suppliers currently producing parts or providing services to be used in the TPBARs have established and implemented QA programs that meet the requirements of 10 CFR Part 50, Appendix B. These suppliers are on PNNL's Qualified Supplier List. Some suppliers are still establishing manufacturing processes and are not currently producing parts or providing services which will be used to produce TPBARs. These suppliers have been placed on PNNL's Qualified Supplier List as approved with restrictions until the programs have been established and verified through PNNL oversight activities.

For items procured by WesDyne, WesDyne requires subcontractors and suppliers to implement QA programs that meet 10 CFR Part 50, Appendix B, requirements.

2.2.7 Summary

TVA's Tritium Production Program Requirements document (TVA-TPPR 99-01) describes requirements which are applied to the procurement and fabrication of TPBARs to be irradiated in the Watts Bar reactor core. This document provides the technical, functional, and quality requirements associated with the design, analysis, materials, fabrication, and delivery of TPBARs.

The DOE/TVA Interagency Agreement identifies TPBARs as safety-related, basic components. As such, TPBARs and related services furnished under the agreement must be supplied in accordance with a QA program that complies with 10 CFR Part 50, Appendix B, in accordance with RG 1.28, Rev. 3. In addition, the reporting requirements of 10 CFR Part 21 are imposed on suppliers of TPBARs and related services.

DOE selected PNNL and WesDyne to be direct suppliers of TPBARs. The activities of these suppliers are conducted in accordance with QA programs that the NRC has determined to be acceptable in that they conform to the requirements of 10 CFR Part 50, Appendix B. TVA has audited the supplier QA programs for compliance and maintains them on its ASL. In accordance with contractual requirements imposed by the direct TPBAR suppliers, their subcontractors and suppliers of components and services have implemented QA programs that meet the requirements of 10 CFR Part 50, Appendix B, and the reporting requirements of 10 CFR Part 21.

TVA has reviewed the QA programs of DOE's direct suppliers and they qualified as having QA programs that conform to the requirements of Appendix B to 10 CFR Part 50. Through its procurement process, DOE has imposed Part 21 requirements on all TPBAR suppliers. Accordingly, the NRC staff concludes that the overall TPP structure provides for effective control of all supplier activities in compliance with applicable regulatory QA and procurement requirements.

2.3 Interface Issue 3—Compliance With Departure From Nucleate Boiling (DNB) Criterion

This section discusses why the TPBARs do not adversely affect reactor core cooling. As presented in Section 2.4.4 of NRC Safety Evaluation Report, NUREG-1672, Westinghouse analyzed the thermal-hydraulic aspects of operating with TPBARs in a typical Westinghouse reference plant using the acceptance criteria outlined in Section 4.4 of the NRC's SRP. The principal thermal-hydraulic induced design basis for a core with TPBARs (a tritium production core or TPC) is to avoid thermal-hydraulic-induced damage under Condition I (normal steady-state operation), and Condition II (anticipated operational transients from which the plant is expected to recover). TVA's letter of May 1, 2001, and supplemental letters of September 21 and December 19, 2001, submitted Westinghouse's thermal-hydraulic analysis for operating Watts Bar with TPBARs in the reactor core.

2.3.1 Methodology

The methodology used to determine the acceptability of operating with TPBARs in the reactor core is consistent with the current standard Westinghouse methods for inserting new components into Westinghouse cores and DOE's NRC-approved Topical Report NDP-98-153, "Tritium Production Core (TPC)." Westinghouse's analysis assumed that TPBARs are core components not unlike other core components that are routinely inserted into the core for purposes of reactivity and power distribution control. Specifically, a TPBAR is a different type of burnable absorber. As previously mentioned, the physical design of the TPBAR is very similar to the physical design of the existing BPRAs.

Westinghouse performed an analysis to determine the effects of the Watts Bar reactor core thermal-hydraulic conditions on the integrity of the TPBARs. Westinghouse applied standard procedures to evaluate the thermal-hydraulic performance of the bypass flow through the fuel assembly guide thimble tubes and the thermal performance of the TPBARs in the thimble guide tubes. Core components, such as the thimble, were analyzed to ensure mechanical integrity and function. Westinghouse used fuel data, TPBAR data, and appropriate core limits for the Watts Bar core and the NRC-approved VIPRE-01 thermal-hydraulic computer code to perform the analysis. Some of the results of the VIPRE-01 calculations were used to define core conditions, such as core and assembly flow and channel enthalpy rise. These conditions were then used as boundary conditions for the response of the TPBAR. Westinghouse also used the VIPRE-01 computer code to determine the flow distribution in the core and the local conditions in the hot channel for use in the DNB correlation. Westinghouse also performed the following additional detailed analyses:

- an axial power shape study to assure that the limiting power distributions used in the design would still be valid in the presence of TPBARs

- the steamline break with rod withdrawal at power transient to demonstrate the continued acceptability of the DNB design basis for this transient

- the zero-power hypothetical steamline break to demonstrate that the DNB design basis was met

Westinghouse considered dimensional tolerances of the thimble and TPBAR in the input to the model. Bounding values of enthalpy rise and axial power distributions were used for computations of the fuel rod side boundary conditions and for heat generation within the absorber. Westinghouse used generic power distribution profiles for thermal and hydraulic departure from nucleate boiling ratio (DNBR) analyses. Standard inputs were used in explicit core component models to determine loss coefficients and orifice flow paths.

To prevent excessive heat and corrosion, Westinghouse imposed a temperature limit on the TPBAR to keep it below its melting temperature. This limit will prevent surface boiling along the TPBAR within the dashpot region of the thimble and prevents bulk boiling along the length of the thimble. Also, the sum of the flow through all the thimbles and the TPBAR combinations must be less than that allowed by the bypass flow limits that are used to ensure adequate flow for core cooling.

2.3.2 Results of the Analyses

Westinghouse's analyses demonstrated continued integrity of the core in the presence of TPBARs. The results indicated that having TPBARs in the core would not affect the power distributions beyond those already bounded by the thermal and hydraulic design bases. No bulk boiling in the thimble, or surface boiling in the dashpot, will take place. The core bypass flow limit was shown to be met. Westinghouse demonstrated that DNB will not occur on the most limiting fuel rod or TPBAR with at least a 95-percent probability at a 95-percent confidence level. This meets the 95/95 acceptance criterion in SRP Section 4.2. Finally, the results of the DNB analyses showed that the DNBR design basis will continue to be met with the presence of the TPBARs.

2.3.3 Summary

Westinghouse used standard analytical methods consistent with NRC-approved Topical Report NDP-98-153 to evaluate thermal-hydraulic conditions with TPBARs in the core to ensure that an adequate safety margin exists in the thermal-hydraulic design. Westinghouse used the NRC-approved VIPRE-01 thermal-hydraulic computer code to perform thermal-hydraulic analysis.

Westinghouse's analyses show that operating with TPBARs will not have adverse effects on the thermal and hydraulic design or performance of the Watts Bar Unit 1 core. Westinghouse demonstrated that DNB will not occur on the most limiting fuel rod or TPBAR with at least a 95-percent probability at a 95-percent confidence level specified in SRP Section 4.2. The thermal-hydraulic design basis of the TPBARs will also meet applicable acceptance criteria outlined in Section 4.4 of the NRC's SRP with no feature of the TPBAR challenging the cooling capacity of the core.

2.4 Interface Issue 4—Reactor Vessel Integrity Analysis

Section 2.5.3 of the NRC's NUREG-1672 Safety Evaluation Report discussed TVA's analyses of reactor vessel integrity for a typical Westinghouse reactor. As explained in the NUREG, reactor vessel integrity analyses depend on specific reactor vessel materials used, and the actual neutron fluence experienced, in a reactor. These issues are discussed below for the Watts Bar reactor.

TVA's letter of May 1, 2001, addressed this issue. Appendices G and H to 10 CFR Part 50, and 10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock (PTS)," pertain to this issue. Appendix H to 10 CFR Part 50 specifies material surveillance program requirements to monitor changes in the fracture toughness properties of the reactor vessel that occur as a result of exposure of these materials to neutron irradiation. The requirements of Appendix G to 10 CFR Part 50 and the PTS rule ensure that the material property changes due to neutron irradiation (termed "neutron embrittlement") are sufficiently low that the plant is operated only under conditions with sufficient safety margins against fracture of the reactor vessel.

The requirements in Appendix G to 10 CFR Part 50 state that the Charpy V-notch upper-shelf energy (USE) level for the reactor vessel must exceed 68 joules (50 ft-lb) throughout the service life. If it is anticipated that a vessel may fall below 68 joules (50 ft-lb) before the end of the plant license, continued plant operation can occur if the NRC approves the licensee's analysis demonstrating "margins of safety against fracture equivalent to those required by Appendix G of the ASME Code."

The PTS rule establishes screening criteria that define a limiting level of neutron embrittlement beyond which plant operation cannot continue without further plant-specific evaluation. The PTS screening criteria are given in terms of reference temperature, RT_{PTS}.

As explained in NRC Safety Evaluation Report NUREG-1672, the following analyses apply to Interface Issue 4:

- surveillance capsule withdrawal schedule
- heatup and cooldown pressure-temperature curves
- PTS
- emergency response guideline (ERG) limits
- USE

Neutron embrittlement of reactor vessel material affects reactor vessel integrity. Neutron fluence is the main parameter used to characterize the extent of embrittlement expected in the future. For example, the level of neutron embrittlement depends on neutron fluence, with higher fluence equating to greater embrittlement, assuming that all other parameters remain constant. Therefore, change in neutron fluence is a key consideration in the impact of the tritium production core on reactor vessel integrity analysis.

2.4.1 Neutron Fluence

For TPCs, TVA inserts new fuel assemblies into the reactor each refueling outage. During that evolution, TVA might also put once-burned assemblies on the outer periphery. This loading results in higher neutron leakage compared to low-leakage loading configurations. Higher neutron leakage (neutron source) will increase the vessel fluence. This evaluation reviews the methodology TVA used to evaluate fluence and the acceptability of the resulting fluence values.

The method TVA used to estimate the projected value of pressure vessel fluence to the end of the license (EOL) is based on the discrete ordinates approach with a one- and two-dimensional synthesis (following RG 1.190, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Rev. 1)." The original fluence projections for the reactor vessel were performed in conjunction with the evaluation of Surveillance Capsule U dosimetry that was analyzed at the end of Cycle 1. The loading pattern for Cycle 1 was based on uniform distribution of new assemblies throughout the core, which results in a conservative fluence evaluation compared to low-leakage patterns which were subsequently implemented at Watts Bar. Comparing the relative values of the source distribution of the design basis and the equilibrium tritium production cycle indicates that the design basis is conservative by a large margin. Therefore, the design basis neutron fluence value used to determine the EOL neutron embrittlement for the reactor vessel is conservative relative to the estimated EOL value resulting from the TPC.

The presence of the TPBARs does not alter the spectrum of the neutron leakage source because Li-6 is a thermal neutron absorber. Therefore, although the TPBARs suppress the local power, they do not affect the neutron leakage spectrum. This is one of the reasons why the plant-specific source estimate is conservative with respect to the design value. TVA plans to lower peak vessel fluence by inserting TPBARs in key peripheral locations to reduce the power in specific fuel assemblies that affect peak vessel fluence.

The staff finds that TVA's method for estimating fluence follows RG 1.190. The expected neutron embrittlement of the reactor vessel resulting from the presence of TPBARs in the core remains within the design basis, and is, therefore, acceptable.

2.4.2 Surveillance Capsule Withdrawal Schedule

TVA concluded that the current surveillance capsule withdrawal schedule remains valid because the neutron fluence projection bounds the current estimate of the EOL fluence. The staff concurs with this conclusion.

2.4.3 Heatup and Cooldown Pressure-Temperature (P-T) Curves

The heatup and cooldown P-T curves for Watts Bar have been determined by scaling the design basis EOL neutron fluence to the operating period covered by the curves. For Watts Bar, the conservative evaluation of the EOL fluence corresponds to a conservative estimate of the neutron fluence used to determine the P-T curves. Therefore, the P-T curves remain valid.

2.4.4 Pressurized Thermal Shock (PTS)

Since the EOL design-basis neutron fluence projection bounds the estimated EOL neutron fluence for the TPC, the existing RT_{PTS} value for Watts Bar remains valid for the actual EOL conditions. Therefore, Watts Bar will remain within the screening criteria of the PTS rule.

2.4.5 Emergency Response Guideline (ERG) Limits

TVA developed the ERG limits using the design-basis EOL neutron fluence projection. Since this fluence value bounds the estimated EOL neutron fluence projection for the TPC, the ERG limits remain valid.

2.4.6 Upper Shelf Energy (USE)

Watts Bar is required to comply with the Charpy USE requirements of Appendix G to 10 CFR Part 50 (e.g., by all reactor vessel materials exhibiting no less than 50 ft-lb Charpy USE) through at least 8.6 effective full-power years. The NRC previously approved TVA's equivalent margins analysis, required by Appendix G to 10 CFR Part 50 to justify operation through EOL. This is documented in the NRC's Supplement No. 14 to NUREG-0847, "Safety Evaluation Report Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2," dated December 1994. As described in this report, the staff conditioned its acceptance of TVA's analysis on TVA's determining the actual fracture resistance of the limiting reactor vessel material through supplemental fracture toughness testing of specimens included in the Watts Bar reactor vessel surveillance program. License Condition Number C.(5) in the operating license for Watts Bar requires TVA to perform supplemental fracture toughness (J-R curve) testing on specimens removed from surveillance capsules W and X. This supplemental testing is intended to validate the equivalent margins analysis, submitted on October 15, 1993, to demonstrate compliance with the requirements of Appendix G to 10 CFR Part 50 through EOL for Watts Bar. The staff concludes that this license condition is sufficient to ensure that Watts Bar will remain in compliance with the Charpy upper shelf energy requirements of Appendix G to 10 CFR Part 50 through EOL.

2.4.7 Summary

The method TVA used to estimate the projected value of pressure vessel fluence follows RG 1.190. Comparing the relative values of the source distribution of the design basis and the equilibrium tritium production cycle indicates that the design basis is conservative by a large margin. Therefore, the TPC will result in lower EOL neutron fluence than the design-basis fluence. Reactor vessel P-T curves, the existing RT_{PTS} value, and ERG limits for Watts Bar remain valid for the actual EOL conditions.

License Condition Number C.(5) requiring TVA to perform J-R curve testing on specimens removed from surveillance capsules W and X is sufficient to ensure that Watts Bar complies with the Charpy upper shelf energy requirements of Appendix G to 10 CFR Part 50 through EOL. Therefore, the conclusions reached for the Watts Bar reactor vessel through EOL bound those for the TPC.

2.5 Interface Issue 5—Control Room Habitability Systems

This section addresses the impact of TPBARs on design-basis accident radiological consequences, specifically control room habitability as addressed in Sections 1.5.5 and Section 2.15.6 of Enclosure 4 to TVA's letter of August 20, 2001, and the supplemental TVA letters of May 21, 2002, and May 23, 2002.

DOE's Tritium Production Core Topical Report, NDP-98-153, concluded that the control room doses for a LOCA would exceed the Part 50 Appendix A, GDC-19, "Control room" criteria at the reference plant. In the topical report, DOE stated that this situation arises due to the assumed high leakage rate from emergency core cooling systems (ECCSs) outside of the containment. Accordingly, TVA analyzed the doses for all design-basis accidents (DBAs) at Watts Bar, although the interface issue specifically referred to the ECCS leakage contribution to the LOCA doses. TVA described the analyses in Section 2.15.6, "Radiological Consequences of Accidents," of Enclosure 4 to its letter of August 20, 2001. Section 2.15.6 addresses the potential radiological impact of operation with the maximum number of TPBARs installed for various design-basis accidents. Staff's review of TVA's analyses is provided below.

2.5.1 Specific Design-Basis Accidents (DBAs)

The staff assessed the DBA analysis results reported in TVA's amendment submittal. The staff evaluated each analysis input and assumption against descriptions in the Watts Bar updated final safety analysis report (UFSAR), regulatory guidance, and staff experience from similar reviews. The staff performed independent analyses to confirm the conservatism of TVA's analyses.

TVA considered the impact of TPBAR operation on the following previously analyzed DBAs:

- loss of offsite power
- waste gas decay tank failure
- loss-of-coolant accident (LOCA)
- main steamline break
- steam generator tube rupture

- fuel-handling accident
- failure of small lines carrying primary coolant outside containment
- rod ejection accident

TVA determined that the consequences for the LOCA bounded impacts of the TPBARs on the rod ejection accident. For the remaining analyses, TVA stated that, with a few exceptions, analysis inputs and assumptions will not change for the Watts Bar core fully loaded with TPBARs. Most of the analyses were updated as follows:

- Initial source terms were revised, taking into account TPC parameters.

- ARCON96 control room atmospheric dispersion coefficient (χ/Q) values were determined and used for many of the analyses.

- TVA determined the total effective dose equivalent (TEDE) for each accident. These supplement, but do not supplant, the whole-body and thyroid dose results currently in Watts Bar's licensing basis.

- TVA used dose conversion factors from the Environmental Protection Agency's (EPA's) Federal Guidance Reports 11 and 12 (EPA402-R-83-081 and EPA-520/1-88-020).

- For accidents other than the FHA and LOCA, TVA assumed that all of the tritium gas in two failed TPBARs (24,106.9 curies(Ci)) would be released to the reactor coolant. This assumption was defined in DOE's topical report for the tritium source term for the worst-case design-basis TPBAR failures. The staff reviewed and found the assumption acceptable in NUREG-1672.

With regard to the FHA, TVA revised the analysis assumptions concerning the fraction of core inventory in the fuel gap. TVA based the revised numbers largely on the information contained in NUREG/CR-5009, "Environmental Effects of Extending Fuel Burnup Above 60 GWd/MTU." The staff notes that NUREG/CR-5009 was prepared to support an environmental impact statement and the analyses performed for this report were not intended to have the degree of conservatism needed for DBA analyses. Although the staff has used NUREG/CR-5009 as a basis for increasing the fraction of I-131, the staff does not consider NUREG/CR-5009 an appropriate basis for reducing gap fractions. In preparing RG 1.183, the staff provided new guidance on gap fractions. Although originally approved for use with alternative source terms, the staff has decided to make these gap fractions applicable to the traditional TID14844 source terms in the draft RG DG-1113. With the exception of Xe-135, the TVA gap fractions are more conservative than the RG 1.183 / DG-1113 guidance. Even at a fraction of 0.1, Xe-135 is a small contributor to FHA doses. Based on the above, the staff has determined that the gap fractions assumed by TVA in this FHA result in suitably conservative offsite and control room doses.

2.5.2 Control Room Unfiltered Inleakage

TVA assumed an unfiltered inleakage into the control room envelope (CRE) of 51 cfm. The staff requested TVA to provide additional information to substantiate this assumption. In its response to this request, TVA described its 1995 evaluation of the potential CRE inleakage pathways and the testing performed on the identified vulnerabilities. TVA has not performed an integrated test of the Watts Bar CRE to confirm that no unrecognized inleakage paths exist. Integrated testing at several U.S. power reactors has shown leakage exceeding that assumed in control room habitability analyses. Therefore, the CRE licensing and design bases and applicable regulatory requirements may not be met. The testing experience also indicated that the typical pressurization surveillance test may not be reliable in identifying sources of unfiltered inleakage. The NRC has conducted several public meetings with its stakeholders on this issue since 1998 and recently published a series of proposed draft regulatory guides and a proposed generic communication on control room habitability (67 FR 31385). The generic communication advises licensees of the staff's findings related to inleakage testing. It also will request licensees to submit information that demonstrates that the facility CRE complies with the current licensing and design basis and applicable regulatory requirements.

In the interim, the staff has determined that there is adequate assurance that the radiation doses to Watts Bar control room personnel will not impede response actions necessary to protect the public. The staff based this finding on (1) the vulnerability evaluations and integrity testing already performed by TVA, (2) the available margin between doses postulated assuming 51 cfm and the applicable habitability criteria, and (3) the limited impacts that tritium doses have on the previously analyzed doses. Therefore, the TVA unfiltered inleakage assumption of 51 cfm is acceptable for this amendment request. However, this approval does not exempt TVA from future regulatory actions resulting from the final generic communication.

2.5.3 Control Room Atmospheric Dispersion Coefficient (χ/Q) Values

As noted above, TVA recalculated control room χ/Q values using the ARCON96 code. The staff compared the revised values to those used previously and deemed them to be reasonable based on the staff's experience in similar reviews and knowledge of the differences in the methodology. The staff finds the revised χ/Q values acceptable.

2.5.4 Use of Total Effective Dose Equivalent (TEDE)

The DBA analyses in the Watts Bar licensing basis determined that whole-body and thyroid doses, due to inhalation of radioiodine, are consistent with the guidelines in 10 CFR Part 100 and GDC-19. TVA also reported values for the TEDE for informational purposes. TVA calculated these TEDE results to appropriately account for the radiological consequences of the increased tritium in the TPC core. TVA stated that it does not consider the TEDE results to be the licensing basis for Watts Bar. The existing whole-body and thyroid dose calculation methods remain the licensing bases for Watts Bar.

The staff agrees that tritium is not adequately addressed by the existing whole-body and thyroid dose criteria for two reasons:

- The decay emission energy of tritium is insufficient to penetrate the skin and contribute to the whole-body dose.

- The thyroid dose is explicitly limited to inhalation of radioiodine.

The use of TEDE as a dose quantity addresses these limitations. The staff considered whether it would be appropriate to request that TVA incorporate the TEDE results into the Watts Bar licensing bases along with corresponding dose criteria. However, TVA's analyses show that TPC operation has little impact on postulated TEDE doses. The analyses also show that using the existing dose results, expressed in whole-body and thyroid dose quantities, continue to provide bounding estimates of the radiological consequences of the accident during TPC operations.

The staff reviewed the assumptions, inputs, and methods used by TVA to assess the radiological impacts of the proposed TPC operation at Watts Bar. In doing this review, the staff relied on information placed on the docket by TVA. The staff finds that TVA used analysis methods and assumptions that are adequately conservative and consistent with applicable regulatory guidance. The staff accepted the TEDE acceptance criteria proposed by TVA and compared the doses estimated by TVA to the proposed criteria. The staff also compared the whole-body and thyroid doses estimated by TVA against the corresponding criteria.

2.5.5 Summary

TVA analyzed the doses for all DBAs. The staff evaluated each DBA analysis input and assumption against descriptions in the UFSAR, regulatory guidance, and staff experience from similar reviews. The NRC finds that TVA used analysis methods and assumptions that are adequately conservative and consistent with applicable regulatory guidance. The staff also performed independent analyses to confirm the conservatism of TVA's analyses. The DBA analyses in the Watts Bar licensing basis determined that whole-body and thyroid doses, due to inhalation of radioiodine, are consistent with 10 CFR Part 100 and GDC-19.

The staff determined that there is adequate assurance that the radiation doses to Watts Bar control room personnel will not impede response actions necessary to protect the public. This finding is based on (1) the vulnerability evaluations and integrity testing already performed by TVA, (2) the available margin between doses postulated assuming 51 cfm and the applicable habitability criteria, and (3) the limited impacts that tritium doses have on the previously analyzed doses.

The staff finds that the licensee's estimates of the exclusion area boundary, low-population zone, and control room doses will continue to comply with 10 CFR Part 100 and GDC-19.

2.6 <u>Interface Issue 6—Specific Assessment of Hydrogen Source and Timing of Recombiner Operation</u>

This issue pertains to post-LOCA hydrogen generation inside containment. The concern is that an uncontrolled, hydrogen-oxygen recombination inside containment could cause containment pressure to rise to unacceptable levels and damage the containment.

A reactor loaded with TPBARs can impact post-LOCA hydrogen generation inside containment by adding tritium and hydrogen to the non-TPBAR hydrogen inventory. For plants operating with conventional cores (without TPBARs) four sources are considered to generate hydrogen following a LOCA:

- metal-water reaction with the fuel cladding
- corrosion of materials in contact with spray and sump solutions
- radiolysis in the sump and core solutions
- hydrogen in the reactor coolant system (RCS) inventory prior to the accident

When operating with TPBARs in the core, two additional sources of post-LOCA hydrogen need to be considered: the metal-water reactions with the zirconium components in TPBARs, and the tritium and hydrogen in the TPBARs prior to the accident. Radiolysis, which is a function of decay energy of the fission products would be negligible for a TPC, since the burnup is not considerably different than a conventional core operating with 18-month fuel cycles.

Criteria for combustible gas control are provided in 10 CFR Sections 50.44 and 50.46, and Appendix A, General Design Criteria 5, 41, 42, and 43. Analysis should demonstrate that a single system train is capable of maintaining the combustible gas concentrations at levels that preclude uncontrolled hydrogen-oxygen recombination. RG 1.7 states that the lower flammability limit for hydrogen in the containment should not exceed 4.0-volume percent. TVA states that for Watts Bar, with a total containment free volume of 1,230,000 cubic feet, a volume of 4.0 percent equates to approximately 49,200 standard cubic feet (scf) of hydrogen.

TVA used an NRC-approved code to calculate that the total additional hydrogen contributed by the TPBARs for release to the containment following a large break LOCA (LBLOCA) was 1474 scf, as shown by the following breakdown:

- zirconium-water reactions with the TPBAR getter material, which is composed of nickel-plated Zircaloy—1094 scf
- tritium gas released from the TPBARs—364 scf
- hydrogen released from neutrons interacting with a helium isotope (^3He) inside the rods—16 scf

NRC staff reviewed TVA's analysis inputs and assumptions and found them to be acceptable.

TVA also considered potential chemical reactions in which hydrogen could be formed, particularly those involving the lithium aluminate ($LiAlO_2$) pellets inside the TPBARs. $LiAlO_2$ consists of lithium oxide (LiO_2) and alumina (Al_2O_3). These are the highest oxidation states that exist for lithium and aluminum. Since these pellets are fired at very high temperatures, no unoxidized lithium metal would be present. Therefore, reactions of the $LiAlO_2$ ceramic in the TPBAR burst node volume with reactor coolant would produce hydroxides, with no accompanying formation of hydrogen gas.

The Watts Bar emergency operating procedures which have been reviewed and are in place present the need to start a hydrogen recombiner train when the containment volumetric percentage of hydrogen reaches 3 percent. This concentration is determined by one of two independent containment atmosphere analyzer trains that are controlled by the technical specifications. Previous UFSAR analyses for a conventional (non-TPBAR) core indicated that for an LBLOCA, with no recombiners started, the containment hydrogen concentration reached 3.75-volume percent 4 days following event initiation. With an additional 1474 scf of hydrogen from a TPC, TVA's analysis indicated that the containment hydrogen concentration reached 3.78-volume percent 2 days following event initiation. If one recombiner train is started at 24 hours after event initiation for the TPC case (when containment hydrogen concentration is 3.19-volume percent), the peak containment hydrogen concentration is limited to 3.56-volume percent for up to 6 days. Having up to 24 hours to place a recombiner train in service to maintain the containment hydrogen concentration below 4.0-volume percent is adequate to satisfy the guidance contained in RG 1.7.

2.6.1 Summary

TVA used an NRC-approved code to calculate the total additional hydrogen contributed by the TPBARs following a LBLOCA and NRC staff reviewed the analysis inputs and assumptions and found them to be acceptable. The staff concludes that TPBARs will not be a significant contributor to the post-LOCA hydrogen inventory. Also, operating with TPBARs will not significantly impact the total hydrogen concentration within the containment when compared to the values associated with the non-TPBAR core. TVA has emergency operating procedures in place to maintain the maximum containment hydrogen concentration at less than the lower flammability limit of 4.0-volume percent, with one recombiner train started at a 3-volume percent hydrogen concentration approximately 24 hours after a LBLOCA.

2.7 Interface Issue 7—Light-load Handling System

This section deals with TVA's systems (e.g., the SFP bridge crane and associated canister lifting tool) for handling TPBARs and loaded consolidation canisters. This issue needs to be evaluated because the TPBARs weigh slightly more than the standard BPRAs (65 verses 58 lb, respectively) that the system normally handles.

Section 9.1.4 of the NRC's SRP provides guidance applicable to handling light loads for refueling (light loads are loads less than the weight of one fuel assembly and its associated handling tool). The review criteria in this SRP section ensure that the light-load handling system design is reliable and that the consequences of potential light-load drops are bounded by the analyzed consequences of the design-basis fuel-handling accident. Light-load handling encompasses TPBAR handling and consolidation because a fuel assembly with TPBARs and a loaded consolidation canister each weigh less than a fuel assembly with a rod cluster control assembly.

NUREG-0612 was written for heavy-load handling. However, TVA has incorporated many of the guidelines of NUREG-0612 in its light-load canister-handling program. TVA did this to demonstrate that there is an extremely small potential for unrestrained drops of loaded canisters at Watts Bar rather than evaluate the potential consequences of unrestrained drops of a loaded canister. In its letter of May 21, 2002, TVA described the specific measures applicable to consolidation canister handling and their degree of conformance with NUREG-0612 guidelines.

As discussed under Interface Issue 1, plant operators will transport an irradiated TPBAR assembly from its location in the SFP to the TCF located in the cask loading pit during the consolidation process. The consolidation process consists of releasing the absorber rods from the baseplate and placing the rods in a specially designed canister. Each canister is designed to accommodate a maximum of 300 TPBARs. Plant operators then transfer the loaded canister to the designated SFP cell location using a canister handling tool suspended from the SFP bridge crane.

Plant operators will use the SFP bridge crane to handle TPBAR assemblies and consolidation canisters within the SFP. The weight of a loaded canister submerged in water is less than 700 lb, and a loaded canister weighs less than 1000 lb in air. Since the SFP bridge crane has a rated load capacity of 4000 lb, the bridge crane has a large structural safety factor when handling the consolidation canister. An additional safety measure is provided by administrative controls requiring the use of a safety lanyard on the canister handling tool. This lanyard limits the canister descent in the fuel pool, prevents canister tipping, and is sized to stop the canister from the maximum hook speed of 40 ft/min. A PNNL analysis determined that no TPBAR cladding failures are expected to occur during an accidental impact with a rigid structure at that hook speed. Therefore, the TPBARs are adequately protected from damage during routine handling.

Although lacking many features specified in NUREG-0612 for single-failure-proof cranes, the SFP bridge crane and associated canister lifting tool provide a reliable means of handling the TPBAR consolidation canisters. The large safety factor resulting from the low weight of the consolidation canister relative to the rated load of the SFP bridge crane assures that critical load supporting components (e.g., hoist brakes, load-block attachment point, wire rope, reeving system, and hoist drum bearings) would have an extremely low probability of failure. In addition, the SFP bridge crane has some features common to single-failure-proof cranes (e.g., interlocks to prevent simultaneous motion of the bridge and hoist, redundant and diverse upper-limit switches, and a load monitoring device). The canister lifting tool is designed in accordance with the requirements of American National Standards Institute (ANSI) N14.6, “Standard for Special Lifting Devices for Shipping Container Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials,” such that it will also have increased safety factors. The tool will be tested and inspected to ensure safe operation, and the tool has an air-actuated, fail-closed safety latch to ensure the tool hook will not inadvertently disengage from the canister lifting bail.

Plant operators will move fuel inside the SFP in addition to handling consolidation canisters. TVA described the administrative controls that it will implement to minimize the potential for damage to stored consolidation canisters from potential FHAs. These controls include placing canisters in the outside row near one corner of the SFP, which is well away from any planned fuel movement path.

TVA states that the light-load handling system complies with the intent of NUREG-0612 for consolidation canister handling. Since each consolidation canister holds up to 300 TPBARs, and since the proposed maximum core inventory of TPBARs is 2304 TPBARs, the staff expects the total number of consolidation canister handling evolutions per operating cycle to be small. Considering the expected number of consolidation canister handling evolutions and the features identified to reduce the potential of a load drop, the staff concludes that the potential for dropping a consolidation canister is extremely small. The administrative controls applied to fuel handling ensure that the potential for damage to a consolidation canister from an FHA is also extremely small.

2.7.1 Summary

TPBARs and consolidation canisters are adequately protected from damage during routine handling due to the following:

- The SFP bridge crane has a large structural safety factor when handling TPBAR assemblies or a consolidation canister.

- Administrative controls require the use of a safety lanyard on the canister handling tool. This limits canister descent in the fuel pool, prevents canister tipping, and is sized to stop the canister.

- The canister lifting tool is designed in accordance with the requirements of ANSI N14.6 and will be tested and inspected to ensure safe operation.

- No TPBAR cladding failures are expected to occur during an accidental impact with a rigid structure at the maximum hook speed.

The staff finds that applicable guidelines of Section 5.1 of NUREG-0612 are satisfied and that the equipment and administrative control measures proposed for handling TPBARs and the consolidation canisters are acceptable.

2.8 Interface Issue 8—Station Service Water System

The effect of TPBARs on a plant station service water system and the extent of the effect on available margins in the system is plant-specific. Therefore, TVA performed a specific analysis for the effect of TPBARs on Watts Bar's station service water system. The NRC's review of this analysis follows.

The NRC issued Amendment No. 37 to TVA on February 21, 2002, in response to TVA's application of April 20, 2001, as supplemented on October 29, 2001, and November 14, 2001. The amendment revised the Watts Bar UFSAR to change TVA's SFP cooling analysis methodology for Watts Bar. The revised cooling analysis allowed an increase in the maximum heat removal capacity of the SFP cooling system and addressed TPP Interface Issues 8, 9, 11, and 12. The staff's safety evaluation associated with that amendment reached the following conclusions for Interface Issue 8:

- The Watts Bar essential raw cooling water (ERCW) system has adequate cooling capacity and margin to perform its safety and nonsafety functions with the additional heat loads imposed by TPC activities.

- TPP activities will not have an adverse impact on the ERCW heat removal capabilities.

- The design capacity and reliability of the ERCW system are adequate for the increased decay heat resulting from TPP activities.

2.9 Interface Issue 9—Ultimate Heat Sink (UHS)

The Tennessee River is the UHS for Watts Bar. The purpose of the UHS is to provide a source of cooling water for decay heat removal. Watts Bar's component cooling system (CCS) removes heat from the SFP cooling and residual heat removal systems and transfers it to the ERCW system. Heat in the ERCW system is then transferred to the UHS. During plant cooldown, additional heat from irradiated TPBARs in the SFP must be transferred to the UHS. The NRC's Safety Evaluation Report, NUREG-1672, said that the UHS needs to be analyzed on a plant-specific basis because plants have various UHS designs.

As previously mentioned, the NRC issued Amendment No. 37 to TVA on February 21, 2002, revising the UFSAR to address several TPP items, including Interface Issue 9. The staff's safety evaluation associated with that amendment reached the following conclusions for Interface Issue 9:

- The UHS has adequate cooling capacity and margin to perform its safety and non-safety functions with the additional heat loads imposed by TPC activities.

- TPP activities will not have an adverse impact on the UHS heat removal capabilities.

2.10 Interface Issue 10—New and Spent Fuel Storage

This issue involves maintaining new and spent fuel assemblies in a safe, subcritical, coolable array during all credible storage conditions. NUREG-1672 said that TVA had to analyze this issue because fuel rack analysis is plant-specific.

Holtec International (Holtec) report HI-961513, Rev. 2, dated October 1996, contains criticality analyses of stored spent fuel containing no burnable absorber rods. TVA's submittal of November 21, 2001, contains Holtec's criticality analyses (Holtec report HI-2012620) for storing assemblies containing TPBARs and other burnable poisons in the SFP. The analyses used the NRC-approved KENO5a Monte Carlo and CASMO4 codes. NRC staff reviewed the analyses inputs and assumptions and found them to be acceptable. These analyses also address burnup and the presence of other types of burnable absorbers, such as wet annular burnable absorbers (WABAs) and integral fuel burnable absorbers (IFBAs). The analyses accounts TPBARs and burnable absorber rods in fuel assemblies while maintaining the effective multiplication factor (k_{eff}) $\leq$ 0.95 under normal and abnormal conditions.

2.10.1 Criticality Calculations Associated With Assemblies Containing TPBARs

NRC SRP Sections 9.1.1 and 9.1.2 and regulations such as GDC-62 provide guidelines and requirements for storing new and spent fuel. At Watts Bar, new fuel assemblies (including assemblies with TPBARs, WABAs, and IFBAs), may be stored in the new fuel storage vault prior to insertion into the reactor core. New fuel assemblies containing TPBARs will have a lower reactivity than fresh fuel assemblies that do not contain poisons. The original criticality analyses in Holtec report HI-961513 for new fuel storage configuration will remain valid for new fuel assemblies with TPBARs because of their lower reactivity.

The current licensed spent fuel storage capacity at Watts Bar is 1610 fuel assemblies. This total storage capacity includes 224 Region 2 racks that were fabricated and licensed but never installed. There are currently 244 spent fuel assemblies in the SFP. TVA committed in its submittal of October 29, 2001, not to install these Region 2 racks since they were not analyzed for storing spent fuel assemblies that contained TPBARs. Like the new fuel racks, the spent fuel racks have been analyzed for fuel assemblies up to 5 weight percent ^{235}U. For conservatism, fuel was assumed to operate with TPBARs or WABAs, which were then removed before the spent fuel was stored in the spent fuel racks. TVA took credit for fuel burnup and IFBAs, where appropriate.

2.10.2 Methodology

Holtec's analyses used the most reactive design and the most reactive temperature to set the storage requirements. The analyses accounted for the following:

- bias and uncertainty associated with the benchmarking of the methodology
- bias for the underprediction of reactivity due to boron particle self-shielding
- uncertainty due to mechanical tolerances in the manufacturing process

2.10.3 Normal Conditions

TVA used the NRC-approved CASMO-4 code to calculate the reactivity of the fuel assemblies currently in use or anticipated for storage in the Watts Bar spent fuel racks. Calculations showed that the Westinghouse 17x17 V5H fuel assembly exhibits the highest reactivity at the burnups of interest in this analyses (0 to 35 gigawatt days per metric ton of uranium (GWD/MTU)). TVA used the 17x17 V5H fuel assemblies in all subsequent criticality calculations. TVA carried out CASMO-4 calculations to account for uncertainties associated with densities, enrichments, mechanical tolerances, and TPBAR loadings.

2.10.4 Abnormal or Accident Conditions and Soluble Boron Requirements

Although the NRC permits taking credit for the soluble boron (poison) normally present in the SFP, most abnormal or accident conditions will meet the limiting reactivity ($k_{eff} \leq 0.95$) even without soluble poison. TVA analyzed all postulated accidents (dropped fuel assembly, water temperature and density effects, eccentric positioning of a fuel assembly within the rack, abnormal and misplacement of fresh fuel assembly, etc.) for this amendment request. TVA's spent fuel storage rack analyses took credit for boron in accordance with the methodology described in the Holtec's HI-961513 report. This methodology ensured that $k_{eff} \leq 0.95$, as recommended in ANSI/American Nuclear Society (ANS)-57.2-1983 and required by 10 CFR 50.68.

The analyses contained in Holtec's HI-2012620 report show that misplacing a fresh fuel assembly in a water cell is the most serious postulated condition (configuration 3). In this case, the misplaced assembly has the potential to exceed the limiting reactivity, $k_{eff} \leq 0.95$ (but always less than 1.0), should there be a concurrent accident where all the boron in the SFP is lost. The analyses showed that adding 55 ppm of soluble boron will bring k_{eff} in the storage rack to ≤ 0.95, including bias and uncertainties. The same analyses also showed that a misplaced fuel assembly outside the periphery of a storage module, or a dropped assembly lying on top of the rack, would have a smaller reactivity effect. However, the 55 ppm soluble boron required to meet the misplaced assembly in the water cell would more than offset and bound these other accident reactivity additions.

2.10.5 Criticality Analyses Results

TVA evaluated four different storage configurations of fresh and spent fuel assemblies in its Watts Bar SFP analyses. The analyses showed that all four storage configurations meet the NRC's requirement of $k_{eff} \leq 0.95$. The results of all four configurations were tabulated and provided in TVA's submittal of November 21, 2001. The Holtec analyses showed that the burnup requirements for the storage of spent fuel in configurations 1 and 2 remain the same as those determined in Holtec's earlier HI-961513 report.

The NRC staff reviewed and evaluated TVA's analyses for including TPBARs and other burnable absorbers into TVA's spent fuel analyses. The staff determined that the analyses were conducted in accordance with the requirements of GDC-62 and other regulatory documents for preventing criticality in fuel storage and handling, and thus are acceptable. The spent fuel analyses shows that the design and operations of Watts Bar plant will maintain $k_{eff} \leq 0.95$ under all postulated accidents for the abnormal and accident conditions.

2.10.6 Heat Generation Within a Consolidation Canister

TVA also evaluated the heat production from a fully loaded consolidation canister and its potential effect on the spent fuel racks. The potential heat generation within the consolidation canister is small enough that it can be safely stored in the existing fuel racks. An irradiated absorber rod will only produce about 3 watts of heat 30 days after reactor shutdown. This is equivalent to a maximum heat load of 900 watts/canister, assuming a fully loaded canister contains a maximum of 300 absorber rods. This heat load is small given that adequate circulation is provided through the open topped canister and through the drainage/cooling holes on the sides and bottom of the canisters. Therefore, the staff concludes that this configuration will provide adequate natural circulation.

2.10.7 Summary

TVA's analyses used the NRC-approved KENO5a Monte Carlo and CASMO4 codes. NRC staff reviewed the analyses inputs and assumptions and found them to be acceptable. Because all fuel pool criticality analyses indicated that k_{eff} will remain less than or equal to 0.95, the staff concludes that using TPBARs at Watts Bar will not adversely impact the safe operation of the plant relative to new and spent fuel storage.

2.11 <u>Interface Issue 11—Spent Fuel Pool Cooling and Cleanup System (SFPCCS)</u>

The SFPCCS cools the spent fuel during all operating and accident conditions. NUREG-1672 documented the staff's review of the effect of TPBARs on this system for a typical Westinghouse plant. However, TVA had to perform an analysis for Watts Bar to determine SFP temperatures with TPBARs installed because the capacity of the SFP and associated cooling system design varies among plants.

As previously mentioned, the NRC issued Amendment No. 37 to TVA on February 21, 2002, revising the UFSAR to address several TPP items, including Interface Issue 11. The revised SFP cooling analysis methodology for Watts Bar increased the maximum acceptable heat load from 32.6 to 47.4 million British Thermal Units per hour. TVA conservatively estimated that a full TPC would add approximately 1.0 million British Thermal Units per hour. The staff's safety evaluation of that amendment concluded that the SFPCCS had adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by TPP activities.

2.12 Interface Issue 12—Component Cooling Water System (CCS)

As mentioned in Interface Issue 9, the Watts Bar's CCS removes heat from the SFP cooling and residual heat removal systems and transfers it to the ERCW system. NUREG-1672 said that irradiated TPBARs place little additional heat load on the SFP cooling system. However, the additional heat load from full-core offloads associated with the TPC could increase the demands on the CCS. Thus, TVA had to analyze the effect of full-core offloads on the CCS at Watts Bar.

As previously mentioned, the NRC issued Amendment No. 37 to TVA on February 21, 2002, revising the UFSAR to address several TPP items including Interface Issue 12. The staff's safety evaluation of that amendment reached the following conclusion for Interface Issue 12:

- The CCS has adequate cooling capacity and margin to perform its safety and nonsafety functions with the additional heat loads imposed by tritium production activities

- TPP activities will not have an adverse impact on the CCS heat removal capabilities.

2.13 Interface Issue 13—Demineralized Water Makeup System (DWMS)

The DWMS of a typical Westinghouse plant is nonsafety related and supplies high-purity makeup water to other plant systems. Having TPBARs in the core will increase tritium levels in the RCS. TVA might have to use the DWMS to replace some of the water in the RCS to dilute the tritium. NUREG-1672 concluded that a licensee must analyze the plant-specific capability of the DWMS since this system differs from plant to plant. The NRC's review of TVA's analysis for Watts Bar follows.

The Watts Bar operating license requires enough makeup capacity to ensure safe operations under all normal and abnormal conditions. TVA states that 2.5 μCi/gm is the current, observed, maximum tritium level in the Watts Bar RCS. Using conservative assumptions, TVA estimates that operating with a TPC may increase that level to as high as 9.0 μCi/gm. The increase in RCS tritium level is due to tritium permeation through the TPBARs. To maintain the RCS tritium levels at conventional core levels, additional feed and bleed operations might be necessary. Any increase in feed and bleed operations would place increased demands on the DWMS for the required makeup. There is no NRC regulatory limit on RCS tritium level.

TVA performed an analysis to determine the adequacy of the existing DWMS to meet the increased feed demands which may result from TPC operation. TVA determined that the current feed and bleed methods are adequate to handle the potential maximum tritium levels of 9 μCi/gm with the TPBARs. TVA's evaluation determined that the existing DWMS has a capacity to produce demineralized makeup water at a nominal 175 gal/min. Additionally, there are 500,000 gal of demineralized water stored in tanks. TVA's evaluation concluded that the capacity of the DWMS is adequate for plant operation with the TPBARs.

TVA's analysis assumed two TPBARs would fail at the end of the fuel cycle, which would raise the tritium concentration in the RCS to 105 µCi/gm. This would require an additional 150,000 gal of feed capacity to reduce the concentration level to 9 µCi/gm. The storage capacity of demineralized water in existing onsite tanks exceeds 500,000 gal. Additional licensee calculations demonstrated that doses to the public from effluents and the tritium release concentrations will remain below offsite dose calculation manual (ODCM) limits and 10 CFR Part 20 release limits. The ODCM reflects the plant-specific, applicable requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I.

2.13.1 Summary

Based on the above stated tank capacities and assumptions, the staff concludes that Watts Bar has demonstrated that sufficient storage and water makeup capacity will be available to adequately meet any increased feed and bleed demands from normal and abnormal TPC events. The worst case need for makeup water (i.e., 150,000 gal in the event of two failed TPBARs) is far less than the capability of the DWMS to provide water. Public doses from TPC operation are not expected to result in exceeding regulatory limits for effluent release and tritium concentration.

2.14 <u>Interface Issue 14—Liquid Waste Management System</u>

This issue concerns the impact of increased tritium levels in the RCS from TPBARs on the liquid waste management system. Larger volumes of primary coolant need to be processed and discharged through the liquid waste management system to address tritium buildup in the RCS. In NUREG-1672, the NRC staff said that a licensee had to analyze plant-specific effluent concentrations, dose limits, dilution flow rates, and the tritium monitoring programs for a plant operating with TPBARs. NRC review of these Watts Bar-specific analyses continues below.

Primary coolant discharge volumes have the potential to rise with TPC operations if increased feed and bleed is required. As stated in Interface Issue 13, operation with a TPC may increase RCS tritium levels to 9.0 µCi/gm, due to normal reactor tritium production plus tritium permeation from the TPBARs. TVA must assure the adequacy of Watts Bar's storage capacity for potential increased discharge volumes. If increased RCS feed and bleed is required, it may be necessary to do one of the following:

- Temporarily store the increased volume of tritiated liquid on site in order to allow discharge of other plant liquid waste.

- Dilute the tritiated liquid to ensure that 10 CFR Part 20 discharge limits are met.

Watts Bar has two holdup tanks, each with a capacity of 126,000 gal, to accommodate any additional liquid waste. One tank is used to process normal plant liquid wastes and the other tank is used for processing tritiated liquid wastes. Plant conditions would dictate the length of temporary storage time required, which could vary from several days to several weeks. Other tanks used to process liquid waste for release to the environment include a monitor tank with a capacity of 20,462 gal and a cask decon collector tank (CDCT). These tanks process liquid from the two holdup tanks and dilute it with cooling tower blowdown before releasing that liquid to the environment.

Potential leakage from the RCS and plant equipment must also be accounted for. Drainage from the reactor building floor and equipment drains is routed to the tritiated drain collector tank (TDCT), which has a capacity of 24,700 gal. Drainage from the auxiliary building floor and equipment drains is routed to the floor drain collector tank, which has a capacity of 23,000 gal. Normal leakage from the SFP cooling system goes to, and is factored into, the capacity of the TDCT. Adequate storage capacity exists on site with the hold-up tanks, monitor tank, CDCT, and TDCT. Leakage from the RCS and various plant systems (including floor drains) is very much less than the storage capacity of these tanks.

For normal TPBAR operation, TVA evaluated the major source of liquid waste to the systems and determined that the normal RCS feed and bleed operation for boron control will be maintained throughout the plant operating cycle. The anticipated coolant discharges with the TPC will be comparable to current plant practice. The maximum tritium level in the RCS is about 9 μCi/gm for the TPC with nominal tritium release and design-basis permeation from TPBARs. For the design-basis abnormal operation, assuming the failure of two TPBARs at the end of the fuel cycle, the additional 150,000 gal of makeup capacity from the DWMS can reduce the RCS concentration level to 9.0 μCi/gm. This assumption was defined in DOE's topical report for the tritium source term for the worst-case design-basis TPBAR failures. The staff reviewed and found the assumption acceptable in NUREG-1672.

In its evaluation, TVA collected site-specific data during the extended operating cycle with the tritium LTAs to estimate the impact on station radiological conditions from the expected increased amounts of tritium. The RCS maximum tritium levels recorded were approximately 2.5 μCi/gm with a cycle RCS tritium mean value of approximately 1.0 μCi/gm. To assess the potential impact on plant workers from the tritium, TVA calculated the peak tritium derived air concentration (DAC) fractions that could be expected inside the containment building. The DACs are regulatory radiation values, contained in 10 CFR Part 20, for airborne radioactive material and are used to assess the dose to a radiation worker. The licensee calculated that with no modifications to the current boron control feed and bleed methodologies, the design-basis RCS maximum tritium values will be approximately 9 μCi/gm with a cycle mean of approximately 3.6 μCi/gm. These values translate into an estimated containment peak tritium DAC fraction of approximately 0.6 and an average containment tritium DAC fraction of about 0.3. TVA estimated that the containment average tritium DAC fraction equates to an effective dose rate of about 0.7 mrem/hr. The addition of this dose rate will not have a significant impact on the licensee's ability to control worker radiation doses using the controls and practices in the existing radiation protection program.

The licensee's evaluation concluded that population doses from radioactive liquid and gaseous effluent releases associated with both TPC normal and abnormal operation (failure of two TPBARs under irradiation and the assumed release of associated inventory of tritium to the primary coolant) will remain below applicable ODCM limits, and tritium release concentrations will remain within the 10 CFR Part 20 and ODCM release limits.

In addition, TVA reviewed its existing radioactivity monitoring programs for outdoor liquid storage tanks and verified that a postulated accident which involved the uncontrolled release of the tank contents will not exceed the 10 CFR Part 20 limits at the nearest potable water supply or the nearest surface water supply.

2.14.1 Summary

The staff has reviewed TVA's analyses regarding this interface issue and finds no errors or inappropriate assumptions. The liquid waste management systems met NRC SRP guidance and the TPP will not significantly change the ability of these systems to properly dispose of radioactive effluents. Waste liquid storage tank capacity far exceeds the volumes expected to result from the TPP, even under abnormal conditions. Based on the above, the staff agrees with TVA's evaluations, as follows:

- Watts Bar has sufficient storage and water makeup capacity to adequately meet the increased feed and bleed demands from normal and abnormal TPC events.

- The potential radiological impact on plant workers, members of the public, and the environment from operation with the TPC is acceptable to ensure that compliance with all regulatory dose limits will be maintained.

2.15 Interface Issue 15—Process and Effluent Radiological Monitoring and Sampling System

NUREG-1672 said that the NRC staff must review the details of laboratory instrumentation and sampling frequencies and locations for process and effluent monitoring at plants with TPBARs. The acceptance requirements for the process and effluent radiological monitoring and sampling system are based on meeting the following regulations:

- 10 CFR 20.106, as it relates to radioactivity in effluents to unrestricted areas

- GDC-60, as it relates to waste management design and the control of releases of radioactive materials to the environment

- GDC-63 and GDC-64, as they relate to the radioactive waste system design for monitoring radiation levels and leakage

TVA has reviewed Watts Bar process and effluent monitoring and sampling equipment and determined that equipment and programmatic changes are necessary to support TPC operations. These changes involve modifying the auxiliary building and shield building heating, ventilating, and air conditioning (HVAC) to permit continuous exhaust sampling instead of periodic grab sampling. These sampling systems will be fixed systems with individual trains monitoring each HVAC system. They will not be used to initiate any automatic actions in the systems being monitored. Since the auxiliary building HVAC also services the fuel building, portable tritium air monitors will be used in the fuel building during movement or consolidation of irradiated TPBARs. Procedures will also be in place for using and calibrating these portable tritium air monitors.

Another continuously monitored, gaseous radiation release point is the condenser vacuum exhaust (air ejector). This monitor uses increased gamma activity to indicate primary-to-secondary leakage and alarms in the main control room. Monitor output is also sent to the process computer. Output from this monitor is read twice a day to identify any potential incremental increases below the alarm setpoint. If an increase in count rate is detected, plant operators will get a noble gas sample to validate the monitor response. Plant operators also collect and analyze a noble gas grab sample weekly. If either the weekly grab sample or the sample taken to validate the monitor response contains radioactivity, plant staff will take tritium, particulate, and iodine samples and factor them into the environmental release documentation.

Other procedural modifications include enhanced RCS tritium and SFP liquid sampling. Currently (with a non-TPC), TVA samples RCS tritium concentration weekly. For TPC operations, TVA will sample RCS tritium concentration 3 times a week for concentrations below 9 µCi/gm, and daily for concentrations between 9 µCi/gm and 15 µCi/gm. For concentrations above 15 µCi/gm, TVA will take mitigating actions which involve expanded tritium monitoring. While irradiated TPBARs are stored in the SFP, liquid tritium sampling will occur weekly. As TVA stated, a portable tritium air monitor will be used when moving or consolidating irradiated TPBARs. Plant operators will also sample SFP liquid daily, and will sample the waste gas decay tanks for tritium prior to any planned release when irradiating TPBARs.

2.15.1 Summary

Based on the above evaluation, the staff concludes that TVA has addressed the items intended in NUREG-1672 regarding the process and effluent radiological monitoring and sampling systems at Watts Bar. These systems, with the enhancements described in TVA's submittals, are sufficient to adequately meet regulatory requirements for TPC operation. Effluent releases from TPC operation for both normal and abnormal (two TPBAR failures) conditions are not expected to result in exceeding 10 CFR Part 20 or ODCM limits.

2.16 Interface Issue 16—Use of LOCTA_JR Code for Loss-of-Coolant Accident Analyses

The LOCTA_JR computer code is used to evaluate the thermal response of TPBARs to a LOCA. This code performs one-dimensional radial heat conduction calculations for a fuel rod. NUREG-1672 states that the NRC staff had not yet approved this code for licensing applications. The purpose of Interface Issue 16 is to document the staff's subsequent approval of this code.

On June 23, 2000, TVA submitted Westinghouse Topical Report WCAP-15409, "Description of the Westinghouse LOCTA_JR 1-D Heat Conduction Code for LOCA Analysis of Fuel Rods," to the NRC for review and approval. The NRC staff completed its review of WCAP-15409 and concluded in a January 17, 2001, letter to TVA (Accession No. ML010170152) that the report was acceptable for referencing in licensing analyses.

2.17 Interface Issue 17—Anticipated Transient Without Scram (ATWS) Analysis

An ATWS is an anticipated operational occurrence requiring a reactor scram (automatic insertion of control rods) that does not occur due to a common-mode fault in the reactor protection system. NUREG-1672 states that the TPP applicant must submit a plant-specific ATWS analysis to the NRC. The NRC reviewed the ATWS analysis for Watts Bar, described in TVA's letter of September 29, 2000. The NRC's letter of March 16, 2001 (Accession No. ML010750049) concluded that using TPBAR cores in Watts Bar conforms to the ATWS rule as specified in 10 CFR 50.62(c)(1) for Westinghouse plants and was therefore acceptable.

3.0 EVALUATION OF TECHNICAL SPECIFICATION CHANGES

3.1 Description of Changes

TVA's letter of August 20, 2001, requested changes to the Watts Bar TS as discussed below.

3.1.1 TS 3.5.1—Cold Leg Accumulator - Boron Concentration Increase

This proposed change to Surveillance Requirement (SR) 3.5.1.4 increases the cold leg accumulator (CLA) boron concentration from the present range of 2400 to 2700 ppm to a range of 3500 to 3800 ppm.

3.1.2 TS 3.5.4—Refueling Water Storage Tank (RWST) Boron Concentration Increase

This proposed change to SR 3.5.4.3 (and associated TS Bases page) increases the RWST boron concentration from the present range of 2500 to 2700 ppm to a range of 3600 to 3800 ppm.

In addition, TVA changed the associated TS Bases Section B3.5.4, "Applicable Safety Analyses," to increase the minimum RWST boron concentration from 2500 ppm to 3600 ppm. This reflects the minimum value used in the post-LOCA sump analysis for core subcriticality. TVA also increased the maximum RWST boron concentration in the Bases from 2700 ppm to 3800 ppm to reflect the maximum values used in the hot leg switchover time calculation.

3.1.3 TS 3.7.15—Plant Systems/Spent Fuel Assembly Storage

TVA proposed this change to remove reference to Figure 3.7.15-1 and to remove Figure 3.7.15-1, which results in removing the Region 2 racks from use. TVA also changed the associated TS Bases to describe this.

3.1.4 TS 4.2.1—Design Features/Reactor Core/Fuel Assemblies

This proposed change to Section 4.0, "Design Features," allows inserting a maximum of 2304 TPBARs into the Watts Bar reactor core for irradiation purposes. The specific number of TPBARs to be irradiated during a given cycle will be determined by cycle-specific safety analyses, but will be less than or equal to 2304.

Currently, in paragraph 4.2.1 of TS Page 4.0-1, the last sentence reads as follows:

> For Unit 1, Cycle 2, Watts Bar is authorized to place a limited number of Tritium Producing Burnable Absorber Rod lead test assemblies into the reactor in accordance with TVA's application dated April 30, as supplemented June 18, July 21 (3 letters), and August 7 and 21, 1997.

This request would change this sentence to read:

> For Unit 1, Watts Bar is authorized to place a maximum of 2304 Tritium Producing Burnable Absorber Rods into the reactor core in an operating cycle.

3.1.5 TS 4.3.3—Design Features/Fuel Storage/Capacity

This change is requested to modify TS 4.3.3 to remove paragraph 4.3.3.2 concerning Region 2 racks. Removing the TSs for the Region 2 racks reduces the SFP storage capacity from 1610 to 1386 fuel assemblies. TVA never installed these racks in the Watts Bar SFP. These changes also give a more detailed description of storage restrictions based on burnup.

3.1.6 Bases 3.5.2—Emergency Core Cooling Systems/ECCS - Operating

TVA's August 20, 2001, letter requested changing the ECCS switchover time for the containment sump from core injection to hot leg recirculation (from the sump) from 9 hours to 5.5 hours. However, in response to a request for additional information dated June 6, 2002, sent to TVA during review of the Sequoyah tritium license amendment request, TVA revised the recirculation switchover time stated in this Bases from 5.5 to 3 hours. TVA requested this change in its letter of July 30, 2002.

3.1.7 Technical Specification Bases 3.6.7—Hydrogen Recombiners

TVA changed TS Bases 3.6.7 related to the hydrogen recombiners to add the tritium inventory in the TPBARs as a possible hydrogen source that may accumulate in containment following a LOCA. TVA also documented that the hydrogen concentration in the primary containment would reach 4.0-volume percent in about 3 days if no recombiner was functioning. Previously, the Bases said that hydrogen concentration in the primary containment would reach 3.4-volume percent in about 5 days after the LOCA and 4.1-volume percent about 2 days later if no recombiner was functioning.

3.2 <u>Evaluation of Technical Specification Changes</u>

3.2.1 TS 3.5.1, and 3.5.4—Cold Leg Accumulator and RWST Boron Concentration Increase and Bases 3.5.2—Emergency Core Cooling Systems/ECCS - Operating

TVA changed these Bases to revise the switchover time for containment sump to hot leg recirculation from 9 hours to 3 hours. This change is necessary due to the increases in the boron concentrations in the RWST and the CLAs. These increases in boron concentrations decrease the time to reach boron precipitation limits, thus requiring a shorter switchover time. However, the time being shortened does not change the switchover function, and the evolution is controlled by emergency operating procedures.

The post-LOCA long-term core cooling analysis requires maintaining a subcritical boron concentration following a LOCA after all boration sources are injected and mixed in the containment sump. These boration sources include the CLAs, the RWST, and the melted ice from the ice condenser.

When large amounts of excess neutron poison are added to a core, such as with TPBARs, all the poisons compete for neutrons and the negative worth of each poison (including the RCS boron) decreases. The positive reactivity insertion due to the negative moderator coefficient during the cooldown from hot full power to cold conditions following the LOCA must be entirely overcome by RCS boron. Because the RCS boron is now worth less, a higher concentration is needed to maintain subcriticality during accident conditions. The ice (at approximately

1900 ppm) is a dilution source which has to be overcome by the RWST concentration to reach a mixed sump concentration high enough to prevent criticality.

TVA requested changes to these TSs and their associated Bases to increase the boron concentration in the CLA and the RWST from a range of 2400 to 2700 to a range of 3600 to 3800 ppm. TVA's analysis shows that increased boron concentration is needed to compensate for the effects of TPBARs decreasing the neutron absorption capability of the soluble boron in the core. Since the boron concentration in the core is worth less with TPBARs in the core, a higher boron concentration is needed to maintain the core subcritical during accident conditions.

The NRC requested a description of the boric acid accumulation evaluation model TVA used to comply with 10 CFR 50.46(b)(5). TVA provided a summary of the hot leg switchover time evaluation model it used to establish that boric acid will not precipitate in the long term following LOCAs. The model is consistent with the traditional 1975 model used for the Westinghouse-designed nuclear steam supply systems. TVA also discussed conservatisms and nonconservatisms associated with the model. The following table shows predicted times for initiating hot leg injection for four cases.

Case	Case Description	Switchover Time, Hours
1	Traditional analysis with no allowance for boric acid saturation concentration uncertainty	7.23
2	Traditional analysis with allowance for boric acid saturation concentration uncertainty	5.56
3	Case 1 with Appendix K decay heat generation rate assumption	5.38
4	Case 2 with Appendix K decay heat generation rate assumption	4.16

Based on this information, TVA stated that ". . . the Watts Bar emergency operating procedures will be revised to require initiation of hot leg ECCS recirculation within 3.0 hours following a LBLOCA for the tritium production core rather than 5.5 hours. The 3.0 hour switchover time requirement does not increase operator burden during LOCA mitigation and recovery and will provide an added measure of conservatism with respect to the tritium production core long-term cooling analysis."

The staff has recognized a number of potential shortcomings in existing evaluation models used to determine time to hot leg switchover as a result of its recent reviews of such models. Consequently, it anticipates that a generic review and evaluation will be accomplished to assess the need for any model changes. In the meantime, TVA's commitment to ensure switchover within 3 hours provides sufficient additional conservatism that the staff is confident that the effects of its potential modeling concerns are adequately bounded. Should NRC criteria or regulations change such that the staff's conclusions regarding the licensee's prediction of the time to hot leg switchover are invalidated, the licensee will be notified and required to revise and resubmit its predictions.

3.2.2 TS 3.7.15 and its Associated TS Bases—Plant Systems/Spent Fuel Assembly Storage

TVA proposed deleting Figure 3.7.15-1 in TS 3.7.15 and revising the associated Bases to reflect the deletion. Figure 3.7.15-1 refers to burnup credit limitations in Region 2 storage racks. There is no need for Figure 3.7.15-1 since the Region 2 racks have never been installed. Therefore, the proposed change is acceptable.

3.2.3 TS 4.2.1—Design Features/Reactor Core/Fuel Assemblies

The purpose of this proposed change is to limit the number of TPBARs that can be inserted into the reactor core in an operating cycle. Currently, TS 4.2.1 does not specify the number of TPBARs to be used on a per cycle basis. The requested change to TS 4.2.1 will limit the number of TPBARs that can be placed in the reactor in future cycles to 2304 or less. The number placed in the core will be cycle specific as determined by cycle-specific safety analysis. Watts Bar core design safety analyses are performed in accordance with NRC-approved analytical computer codes. TVA reports the key parameters and safety limits to the NRC in the core operating limits report as required by Watts Bar TS 5.9.5.d. The maximum numbers of TPBARs in a given core design result from those analyses. For Watts Bar, the core design parameters, as well as the physical configuration of the core, dictate the maximum number of TPBARS. Because NRC-approved codes are used for these analyses, the staff finds this change to the TS to be acceptable.

3.2.4 TS 4.3.3—Design Features/Fuel Storage/Capacity

The licensee proposed to modify TS Section 4.3.3 to remove paragraph 4.3.3.2 from the TS for Region 2 racks. The Region 2 racks described in the TS section are not currently installed in the Watts Bar plant. The reason for removing paragraph 4.3.3.2, resulting in the reduction of the total SFP storage capacity, is that TVA does not plan to install or utilize the storage option described in this paragraph. Providing a more detailed description of fuel storage restrictions allows more flexibility in the storage of spent fuel. Because these racks were never installed, removal of the reference to them in the TSs will not impact the safety of the SFP. Therefore, the staff finds this change to be acceptable.

3.2.5 Technical Specification Bases 3.6.7—Hydrogen Recombiners

TVA stated that the purpose of this change is to address tritium and hydrogen inventories in the TPBARs that would be available for release during postulated accidents. This change properly describes the sources that TVA considered in evaluating the adequacy of the combustible gas control functions. As indicated in Interface Issue 6 of this safety evaluation, the modification to include tritium from TPBARs in the Bases serves to completely describe considerations included in the evaluation for TPBAR irradiation. This proposed change does not alter the TS requirements related to, or the safe operation of, the hydrogen recombiners at Watts Bar. This proposed change is administrative in nature and involves only identifying another source of hydrogen gas (tritium) in the Bases. Therefore, the staff finds the proposed revision to TS Bases 3.6.7, Hydrogen Recombiners, acceptable.

4.0 FINAL NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The Commission's regulations in 10 CFR 50.92 state that the Commission may make a final determination that a license amendment involves no significant hazards consideration if the operation of the facility, in accordance with the amendment, would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety.

As required by 10 CFR 50.91(a), the licensee provided its analysis of the issue of no significant hazards consideration in its August 20, 2001, amendment request. The staff reviewed the licensee's analysis and, based on its review, it appeared that the three standards of 10 CFR 50.92(c) were satisfied. Therefore, the NRC staff proposed to determine that the amendment request involves no significant hazards consideration, and published its proposed determination in the *Federal Register* for public comment on December 17, 2001 (66 FR 65005).

The staff has completed its evaluation of the licensee's proposed amendment as discussed in Sections 2.0 and 3.0 above. Based on its evaluation, the staff has determined that the proposed amendment does not significantly increase the probability or consequences of an accident previously evaluated; does not create the possibility of a new or different kind of accident from any accident previously evaluated; and does not involve a significant reduction in a margin of safety. The evaluation below, in relation to the three standards of 10 CFR 50.92, supports the staff's final no significant hazards consideration determination.

<u>First Standard</u>—The amendment does not significantly increase the probability or consequences of an accident previously evaluated.

TVA and the NRC staff considered the impact of operating Watts Bar with TPBARs on the following previously analyzed DBAs:

- loss of offsite power
- waste gas decay tank failure
- loss-of-coolant accident
- main steamline break
- steam generator tube rupture
- fuel-handling accident
- failure of small lines carrying primary coolant outside containment
- rod ejection accident

Operating Watts Bar with TPBARs does not significantly increase the probability that any of the above accidents can occur. The proposed changes do not influence the probabilities of the above accidents. A nuclear reactor core usually has standard BPRAs inserted into many of the fuel assemblies. A TPBAR is simply another type of BPRA. A TPBAR functions in a very similar manner to a BPRA, and there is no uranium or plutonium in the TPBARs. Watts Bar plant operators would install these TPBARs in fuel assemblies where standard BPRAs are normally placed.

Regarding the FHA, TVA will use the same methods, procedures, and equipment to handle TPBARs as it does to safely handle fuel assemblies that do not contain TPBARs. TPBARs are nearly identical in design to BPRAs, and weigh about the same (65 versus 58 lb, respectively). The staff evaluated TVA's provisions for handling TPBARs and concluded that the equipment and administrative controls that TVA will apply to handling TPBAR assemblies and transport casks provide reasonable assurance of safety. The combination of the following provides adequate defense-in-depth to assure an extremely small probability of a load drop during TCF- and cask-handling operations and satisfies NUREG-0612 guidelines:

- using the auxiliary building crane for these manipulations
- proposed personnel training
- equipment inspections
- procedural controls

Plant operators now handle fuel assemblies containing rod cluster control assemblies during refueling manipulations. A fuel assembly with TPBARs and a loaded consolidation canister each weigh less than a fuel assembly with a rod cluster control assembly. Considering the expected number of consolidation canister handling evolutions and the features identified to reduce the potential of a load drop, the staff concluded that the potential for dropping a consolidation canister is extremely small. The administrative controls applied to fuel handling ensure that the potential for damage to a consolidation canister from a fuel-handling accident is also extremely small. This outcome satisfies the guidelines of Section 5.1 of NUREG-0612. Accordingly, handling a fuel assembly with TPBARs or a loaded consolidation canister does not increase the probability of an FHA.

Increasing boron concentration in the RCS accumulators and the RWST does not affect any initiating event for the DBAs. Thus, operating with TPBARs does not significantly increase the probability that any of the above accidents can occur.

TVA and the staff analyzed the consequences of plant operation with the maximum number of TPBARs installed for all of the above DBAs. In Section 2.5.1 of this safety evaluation, the staff determined that most DBA analysis inputs and assumptions did not change for the Watts Bar core fully loaded with TPBARs. The most changes occurred to the FHA. The staff determined that these changes resulted in suitably conservative offsite and control room doses. Section 2.5.4 of this safety evaluation explains that TVA's DBA analyses determined the whole-body dose and the thyroid dose due to inhalation of radioiodine, are consistent with the guidelines in 10 CFR Part 100 and GDC-19. The staff concluded that TVA's estimates of the exclusion area boundary, low-population zone, and control room doses will continue to comply with 10 CFR Part 100 and GDC-19 with TPBARs in the reactor core.

The staff evaluated the consequences of postulated FHA accidents on reactivity in Section 2.10 of this safety evaluation. TVA analyzed all postulated accidents (dropped fuel assembly, water temperature and density effects, eccentric positioning of a fuel assembly within the rack, abnormal and misplacement of fresh fuel assembly, etc.) for this amendment request. TVA's analysis showed that misplacing a fresh fuel assembly in a water cell is the most serious postulated condition. The analysis showed that adding 55 ppm of soluble boron would bring k_{eff} in the storage rack to $\leq$ 0.95. The staff determined that the analyses were conducted in accordance with the requirements of GDC-62 and other regulatory documents for preventing criticality in fuel storage and handling, and thus are acceptable. The spent fuel analysis shows that the design and operations of the Watts Bar plant will maintain $k_{eff} \leq 0.95$ under all postulated accidents for the abnormal and accident conditions. Thus, the consequences of previously evaluated FHAs involving reactivity are not significantly increased.

As discussed in Section 3.2.1 of this safety evaluation, the change in the boron concentration in the RCS accumulators and the RWST increases the amount of boron in the sump during a LOCA. These increases in boron concentrations decrease the time to reach boron precipitation limits in the reactor core, thus requiring a shorter switchover time. TVA changed the relevant Bases to revise the switchover time for containment sump to hot leg recirculation from 9 hours to 3 hours to prevent any potential boron precipitation in the core. However, the time being shortened does not change the switchover function, and the evolution is controlled by emergency operating procedures. Based on the above, the staff concludes that the amendment does not significantly increase the consequences of an accident previously evaluated.

<u>Second Standard</u>—The amendment does not create the possibility of a new or different kind of accident from any previously analyzed.

As noted in various sections of this safety evaluation, the staff evaluated the proposed changes in accordance with the applicable NRC regulations, NUREGs, RGs, SRP sections, and industry codes and standards. No unproven techniques or methodologies were used in the analyses and design of the TPBARs. Section 1.1.2 of this safety evaluation explains how TVA irradiated a limited number of fuel assemblies containing test TPBARs (LTAs) in the Watts Bar nuclear reactor during one fuel cycle. TVA irradiated the 32 TPBARs and removed them from the reactor. DOE then shipped the rods offsite and examined them to confirm TPBAR design and analytical modeling assumptions. The TPBARs performed as expected during the irradiation, as shown by the monitoring performed during the 17-month irradiation and the subsequent examinations.

The staff evaluated the effect of TPBARs on reactor core cooling in Section 2.3 of this safety evaluation. The analysis method Westinghouse used to determine the acceptability of operating with TPBARs in the reactor core is consistent with the current standard Westinghouse methods for inserting new components into Westinghouse cores and DOE's NRC-approved Topical Report NDP-98-153, "Tritium Production Core (TPC)." Westinghouse's analyses demonstrated continued integrity of the core in the presence of TPBARs. Fuel integrity was assured by demonstrating that DNB will not occur on the most limiting fuel rod with at least a 95-percent probability at a 95-percent confidence level. The results of the DNB analyses showed that the DNBR design basis will continue to be met. The thermal-hydraulic design of the TPBARs meets the requirements of Section 3.6.2 of the NRC's SRP and is below the operating temperature analyzed in the structural analysis of Section 3.4 of that document. Thus, the analyses conducted by Westinghouse show that operating with TPBARs will not have adverse effects on the thermal and hydraulic design or performance of the Watts Bar Unit 1 core or create the possibility of a new or different kind of accident.

Dropping a loaded consolidation canister or a fuel assembly containing a TPBAR assembly is bounded by the fuel-handling accident analysis. Accordingly, handling a loaded consolidation canister or a fuel assembly with TPBARs does not create the possibility of a new or different kind of accident.

As discussed above and in Section 3.2.1 of this safety evaluation, the change in the boron concentration in the RCS accumulators and the RWST increases the amount of boron in the sump during a LOCA. These increases in boron concentrations decrease the time to reach boron precipitation limits in the reactor core, thus requiring a shorter switchover time. TVA revised the switchover time for containment sump to hot leg recirculation from 9 hours to 3 hours to prevent any potential boron precipitation in the core. However, the time being shortened does not change the switchover function, and the evolution is controlled by emergency operating procedures. Thus, this does not create the possibility of a new or different kind of accident. Based on the above, this amendment does not create the possibility of a new or different kind of accident from any previously analyzed.

<u>Third Standard</u>—The amendment does not involve a significant reduction in the margin of safety.

In evaluating a potential significant reduction in the margin of safety, the staff evaluated the following safety issues that could have been impacted by operating Watts Bar with TPBARs:

- handling of TPBARs
- procurement and fabrication of TPBARs
- compliance with departure from nucleate boiling criterion
- reactor vessel integrity analysis
- control room habitability systems
- specific assessment of hydrogen source and timing or recombiner operation
- light-load handling system
- station service water system
- ultimate heat sink
- new and spent fuel storage
- spent fuel pool cooling and cleanup system
- component cooling water system
- demineralized water makeup system
- liquid waste management system
- process and effluent radiological monitoring and sampling system
- use of LOCTA_JR code for loss-of-coolant accident analyses
- anticipated transient without scram analysis

The NRC staff concluded in this safety evaluation that TVA satisfactorily addressed the above issues, and all proposed changes met applicable NRC regulations, NUREGs, RGs, SRP sections, and industry codes and standards. NRC staff determined the following to conclude that the amendment does not involve a significant reduction in the margin of safety:

- The design of the TPBAR assemblies allows for the use of existing equipment and procedures that safely handle BPRAs and fuel assemblies. The existing light-load handling system satisfies Section 9.1.4 of the NRC's SRP, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," for TPBAR assembly handling, and the proposed TPBAR assembly handling process is acceptable.

- The overall TPP structure provides for effective control of all supplier activities in compliance with applicable regulatory QA and procurement requirements. TVA has reviewed the QA programs of DOE's direct suppliers and they qualified as having QA programs that conform to the requirements of Appendix B to 10 CFR Part 50. Through its procurement process, DOE has imposed Part 21 requirements on all TPBAR suppliers.

- Operating with TPBARs will not have adverse effects on the thermal and hydraulic design or performance of the Watts Bar Unit 1 core. The Watts Bar Bases will continue to be met for the structural integrity of the assembly due to thermal and hydraulic effects. The analyses also showed that the bypass flow and the DNB criterion will continue to be met with no feature of the TPBAR challenging the cooling capacity of the core.

- Material property changes due to neutron irradiation (termed “neutron embrittlement”) are sufficiently low that the plant is operated only under conditions with sufficient safety margins against fracture of the reactor vessel.

- The exclusion area boundary, low-population zone, and control room doses will continue to comply with 10 CFR Part 100 and GDC-19.

- TPBARs will not be a significant contributor to the post-LOCA hydrogen inventory. Operating with TPBARs will not significantly impact the total hydrogen concentration within the containment when compared to the values associated with the non-TPBAR core. The maximum containment hydrogen concentration reaches 3.78-volume percent 2 days following event initiation. This is less than the lower flammability limit of 4-volume percent. If one recombiner train is started at 24 hours after event initiation for the TPC case (when containment hydrogen concentration is 3.19-volume percent), the peak containment hydrogen concentration is limited to 3.56-volume percent for up to 6 days.

- TVA will use the same methods, procedures, and equipment to handle TPBARs as it does to safely handle fuel assemblies that do not contain TPBARs, as discussed under the First Standard segment above. The staff evaluated TVA’s provisions for handling TPBARs and concluded that the equipment and administrative controls that TVA will apply to handling TPBAR assemblies and transport casks provide reasonable assurance of safety. A combination of provisions provides adequate defense-in-depth to assure an extremely small probability of a load drop during TCF- and cask-handling operations and satisfies NUREG-0612 guidelines. Considering the expected number of consolidation canister handling evolutions and the features identified to reduce the potential of a load drop, the staff concluded that the potential for dropping a consolidation canister is extremely small.

- The Watts Bar essential raw cooling water system has adequate cooling capacity and margin to perform its safety and nonsafety functions with the additional heat loads imposed by TPC activities. TPP activities will not have an adverse impact on the ERCW heat removal capabilities.

- The ultimate heat sink has adequate cooling capacity and margin to perform its safety and nonsafety functions with the additional heat loads imposed by TPC activities. TPP activities will not have an adverse impact on the UHS heat removal capabilities.

- Analysis of the SFP containing TPBARs showed that adding 55 ppm of soluble boron would bring k_{eff} in the storage rack to $\leq$ 0.95. The staff determined that the analyses were conducted in accordance with the requirements of GDC-62 and other regulatory documents for preventing criticality in fuel storage and handling, and thus are acceptable.

- The SFPCCS had adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by TPP activities.

- The CCS has adequate cooling capacity and margin to perform its safety and non-safety functions with the additional heat loads imposed by tritium production activities. TPP activities will not have an adverse impact on the CCS heat removal capabilities.

- Watts Bar has sufficient storage and water makeup capacity to adequately meet any increased feed and bleed demands from normal and abnormal TPC events.

- The process and effluent radiological monitoring and sampling systems at Watts Bar, with the described enhancements, are sufficient to adequately meet regulatory requirements for TPC operations. Effluent releases from TPC operation for both normal and abnormal (two TPBAR failures) conditions will not result in exceeding 10 CFR Part 20 or ODCM limits.

- Westinghouse Topical Report WCAP-15409 is acceptable for referencing in licensing analyses.

- Using TPBAR cores in Watts Bar conforms to the ATWS rule as specified in 10 CFR 50.62(c)(1) for Westinghouse plants and is, therefore, acceptable.

- Changing the switchover time for containment sump to hot leg recirculation from 9 hours to 3 hours is controlled by emergency operating procedures and does not change the switchover function.

Thus, the proposed amendment does not involve a significant reduction in the margin of safety. On the basis of the above evaluation, the NRC has made a final determination that the proposed amendment does not involve a significant hazards consideration.

5.0 COMMENTS ON PROPOSED NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The NRC received written comments by a letter dated January 16, 2002, from Dr. Kenneth D. Bergeron regarding the staff's December 17, 2001, proposed no significant hazards consideration determination (66 FR 65005). The Blue Ridge Environmental Defense League also submitted written comments on January 16, 2002, which incorporated Mr. Bergeron's comments by reference.

The NRC's letter to Dr. Bergeron from Dr. Brian Sheron of September 6, 2002, addresses the above comments that directly pertain to TVA's license amendment request. This letter (Accession No. ML022410310) is accessible electronically from the Agencywide Documents Access and Management System (ADAMS) Public Electronic Reading Room on the Internet at the NRC Web site, http://www.nrc.gov/reading-rm/adams.html.

6.0 STATE CONSULTATION

On August 15, 2002, in accordance with the Commission's regulations, the Tennessee State official was notified of the proposed issuance of the amendment. The State official, Debra Schults of the Tennessee Bureau of Radiological Health, had no comments.

7.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.21, 51.32, and 51.35, an Environmental Assessment and Finding of No Significant Impact has previously been prepared and published in the *Federal Register* on August 26, 2002 (67 FR 54826). Accordingly, based on the environmental assessment, the Commission has determined that the issuance of this amendment will not have a significant effect on the quality of the human environment.

8.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

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Appendix A

Figure 1 — Flow of QA Program Requirements